

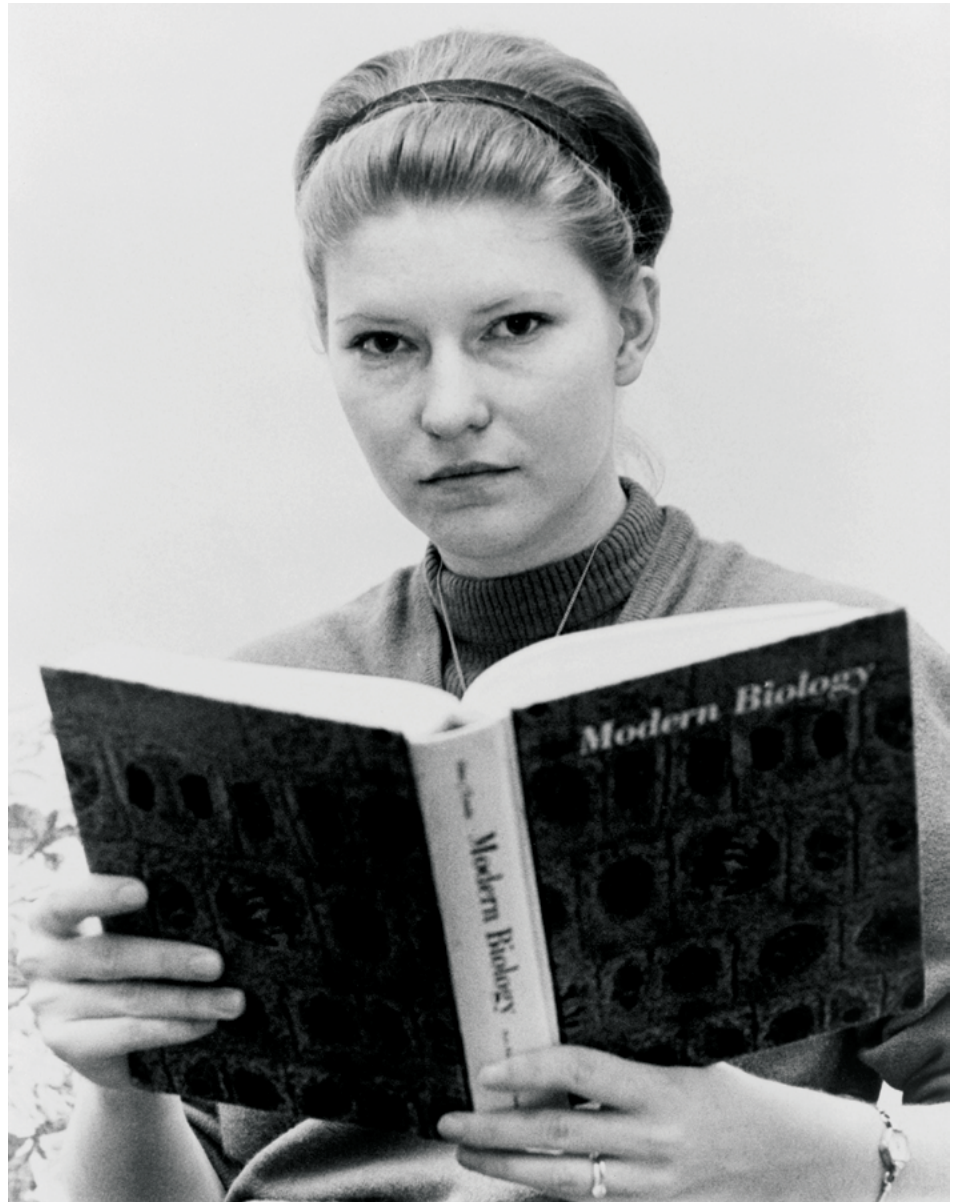
reports

OF THE NATIONAL CENTER FOR SCIENCE EDUCATION | FALL 2018 | VOLUME 38 | NO 4

Looking Back with Epperson, Fifty Years Later p.4

Susan Epperson, the plaintiff in Epperson v. Arkansas, 393 U.S. 97 (1968), holding her assigned class biology textbook that contained material on evolution. The U.S. Supreme Court invalidated an Arkansas statute prohibiting teaching of evolution in the public schools.

Contributor: Everett Collection Inc
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VOL 38, NO 4, FALL 2018

ISSN 1064-2358 ©2018 by the
National Center for Science
Education, Inc, a not-for-profit 501(c)(3)
organization under US law. *Reports
of the National Center for Science
Education (RNCSE)* is published by NCSE
to promote the understanding of
evolutionary and climate science.
NCSE is a nonprofit, tax-exempt
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American Association for the
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RNCSE is published 4 times a year.

Address editorial correspondence
to editor@ncse.com

Write to the publisher regarding
address changes, missing issues,
purchases of back issues, reprint
rights, and related issues.
publisher@ncse.com

Dear NCSE members,

I am excited to welcome you to the latest issue of *RNCSE*. Like every issue, it contains not only stories that highlight the work of NCSE, but also stories that explore the issues and events important to NCSE supporters, whether in the context of history, public policy, current events—or even the family dinner table.

A lot of work goes into producing *RNCSE* each quarter, and nearly every staff member is involved. Our editor, Stephanie Keep, not only guides and coordinates those efforts but also solicits work from important voices outside of NCSE, including, in this issue, those of Amanda Glaze, Randy Moore, and Donald R. Prothero.

We all enjoy working on *RNCSE*, and want you to look forward to reading it. We hope it is always informative, stimulating, and inspiring. But we are, after all, a scientific organization and that means we would prefer not to base our work entirely on hope. We want data! We want evidence!

So I am asking you to participate in a research project. All you have to do is fill out the survey on the next page and mail it back to us (or complete it online). Since communication is a highly valued component of scientific enterprise, I promise to report back to you on the results. And then like any good researchers, we will use the data we collect to inform our decisions and make *RNCSE* even more valuable to you in the future.

I am confident, though, that this quarter's feature story will be of interest to you here in the present. It has been fifty years since a ban on teaching evolution was declared unconstitutional in *Epperson v. Arkansas*. It has been over twenty years since the international climate science community declared that the impact of human activities on the climate was unequivocal. And yet, as I said in a recent commentary in *Education Week*: "Every year, we win battle after battle—but we see little sign that the war is over."

Ensuring that science is taught accurately and effectively has been our central mission at NCSE for decades; unfortunately, I'm confident that NCSE will still be needed years from now. I know our mission is important to you, so I hope you will consider joining our Legacy Society by including NCSE in your estate plan. There's more information on the back cover of this issue.

Thank you for all the many ways you contribute to our work—with your contributions of money, ideas, and local involvement. We couldn't do anything without you!

Gratefully,



Ann Reid is the
executive director of NCSE.
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Once you're done, tear or cut this paper out along the dotted line and return it using the self-addressed, postage-paid envelope in the center of this issue of *RNCSE* (no donation required).

Everyone who submits a completed survey will be entered into a drawing for a \$100 Amazon gift card!



(If you prefer to take the survey online, please visit <https://tinyurl.com/rncsesurvey>)

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THANK YOU!

Looking Back with Epperson, Fifty Years Later



Susan Epperson with (left) Don Langston, an assistant attorney general for Arkansas and (right) AEA's counsel Eugene Warren.

Photo courtesy of Susan Epperson

This past July (2018), I had the pleasure of hosting NCSE [Teacher Ambassadors](#) at Georgia Southern for a two-day workshop. During our time together, we shared and explored content and best practices for teaching; covering everything from recent fossil discoveries to how to deal with conflict in the classroom. Early on, Stephanie Keep gave us a quick run-down on the history of evolution education in the United States, including the legal cases that set precedent for science teaching. One slide featured a black-and-white photograph of a woman I had seen before, but many of our

teachers had not. The picture (seen on the cover of this issue of *RNCSE*) was of Susan Epperson, classroom teacher and advocate. Keep told the assembled teachers to remember that this was all recent history. So recent, she said, that the lead plaintiff in the Supreme Court case [Epperson v. Arkansas](#), which overturned a ban on teaching evolution and set precedent for the unconstitutionality of similar laws, is still actively supporting science education today.

To commemorate the fiftieth anniversary of her case, NCSE asked if I would be willing to reach out to Susan Epperson and ask her to reflect on her experiences. What an opportunity! Evolution education is a topic that is very dear to my heart. Like Epperson, I was raised in a religious community in the South. Also like Epperson, I have experienced firsthand the pressures, concerns, and challenges that learning and teaching evolution can bring in this region, well known for cultural and political undercurrents that tend to be seen as in conflict with evolutionary science. For a person to have the strength of will to stand up for teachers in the way that Susan Epperson did is inspiring and empowering to future generations of science teachers and advocates alike. It's a story worth telling, because today, fifty years later, there continue to be efforts to undermine and dilute the teaching of evolution in both blatant and surreptitious ways. We need Epperson's story to remind us of what can and should be done in the face of challenges to the teaching of accepted science.

Epperson v. Arkansas

The 1927 Arkansas law under which Susan Epperson sued was similar to Tennessee's Butler Act of 1925, under which John T. Scopes was prosecuted. But where the Butler Act only imposed a fine, its Arkansas counterpart allowed the offending teacher to be dismissed. An unsuccessful attempt to repeal the law in 1965 prompted the Arkansas Education Association (AEA) to orchestrate a lawsuit challenging the law's constitutionality. At the time, Susan Epperson taught biology at Central High School in Little Rock. She was expected to use a textbook that discussed human evolution, making her an ideal plaintiff. She was in a position to contend that the law was unconstitutional and also that it required her to choose between miseducating her students and being fired. I asked Epperson why she thinks she was recruited, and she said, "It's possible [Executive Secretary of the AEA] Forrest Rozzell and his lawyer had me in mind when I was hired ... Mr. Rozzell knew I was a Christian, a native of Arkansas, thus not some 'outside agitator,' which might be avenues of attack from any opposition."

Epperson's challenge to the law was instantly a matter of public controversy and drew a range of reactions. "[I received] many very encouraging positive notes, from people I knew and some I didn't," she told me. "[But I also got] quite a few notes telling me I am going to hell, also some comparing me to a monkey." What about from your colleagues? I asked. Epperson responded, "My principal, Mr. Harry Carter, was completely supportive, saying, 'This has needed doing for a long time. If you have any trouble with anyone in the building, let me know.' Wonderful to have that kind of support. One teacher did confront me in the teachers' lounge saying, 'You're just a pawn in their hands.' But I happily recall a note Mrs. Patty Hadley, English teacher, left in my box saying, 'Bully for you!' Those sorts of memories help make it all worthwhile!"

The state trial began on April 1, 1966. Epperson (who had been told by her lawyer to expect the case to be settled out of court) was nervous but appeared calm and collected on the witness stand. "After some moments of panic, I just knew I needed to follow through with what I had said I'd do." The court's decision, issued on May 27, 1966, was that the anti-evolution law was unconstitutional. The state promptly appealed the decision to the Arkansas Supreme Court, which upheld the constitutionality of the



Epperson having lunch with John Scopes in 1969.
Photo courtesy of Susan Epperson

anti-evolution law in a two-sentence decision issued on June 5, 1967. Epperson and her lawyers in turn appealed to the Supreme Court, which agreed to hear the case. On October 16, 1968, oral arguments were heard

with Epperson in attendance. The unanimous decision in favor of Epperson was announced less than a month later, on November 12, 1968.

From Bans to “Balance”

The Supreme Court’s decision was featured in headlines around the country. John T. Scopes, whom Epperson met for lunch in 1969, told the Associated Press that the decision came “43 years too late.” By the time of the *Epperson* decision, the Butler Act was already a thing of the past, repealed by the Tennessee legislature in 1967. Still on the books, though, was Mississippi’s 1926 anti-evolution law. It was swiftly challenged, and in 1970, the Mississippi Supreme Court found that “in *Epperson* ... the Supreme Court ... has for all practical purposes already held that our anti-evolution statutes are unconstitutional.”

Of course, the affirmed unconstitutionality of evolution bans did not deter anti-evolution groups for long. In the wake of the *Epperson* decision, efforts to “balance” the teaching

DINNER PARTY 101: Why Aren't We Healthier?



My family dinners have little in the way of boundaries. Relatives have no problem taking second helpings with reckless abandon, forcing the whole table to view endless pictures of their summer vacation, and seriously oversharing about their medical problems. Once, seeing an opportunity, a relative stopped midway through a gruesome surgical epic to ask me: “If we are so evolved, why aren’t we healthier?”

I know that the question was meant to needle me, and I could have scoffed and had another mouthful of food, but I thought it was a great question. So I seized the opportunity to talk science. Many human health issues provide not only fascinating case studies in evolution but also a chance for people to engage with evolution in a way that affects them personally.

When replying to my relative, I resisted the urge to begin by launching into the usual Evolution 101 spiel about how natural selection only increases the frequency of traits that help individuals have the most offspring raised to maturity. While useful background to understanding why diseases such as osteoarthritis, which primarily affect post-reproductive individuals, are largely beyond natural selection’s influence, such a didactic approach could seem patronizing, especially at the dinner table. And the point about natural selection doesn’t help to explain the prevalence of many common illnesses anyhow.

Instead, I began by explaining that many illnesses are themselves evidence of evolution, and that doctors are increasingly analyzing diseases using evolutionary medicine, which seeks to understand how our evolutionary history influences how and why we get sick. For example, there are the ailments that are a result of the mismatch between our biology and our rapidly changing environment. Humans have awful knee, back, and hip problems, for example, many of which are predictable given our rapid (in evolutionary terms anyway) change from a hunter-gatherer lifestyle to one in which we spend most of our time hunched over a computer keyboard. There are also ailments that are in fact beneficial! Fevers and fatigue, for example, are side effects of our remarkable immune system’s ability to overheat pathogens and our equally remarkable brain’s ability to preserve bodily homeostasis and keep us from overexerting ourselves.

Discussions like these can help drive personal investment in basic science. When most people think of evolution, they think of dinosaurs, finches, and Lucy—which are all important, but ultimately not directly relevant to their everyday lives. By being able to engage in an evolutionary conversation about illness, you not only make evolution personal for your relatives but also avoid having to see more vacation photos!

— KATE CARTER

of evolution in the public schools with various supposedly scientifically credible alternatives, whether biblical creation, creation science, or “intelligent design,” became common. These efforts were challenged in the federal courts, with victories for the cause of evolution education in such cases as [Daniel v. Waters](#) (1975), [McLean v. Arkansas](#) (1982), [Edwards v. Aguillard](#) (1987), and [Kitzmiller v. Dover](#) (2005)—all citing the *Epperson* decision as a crucial precedent.

The View from Arkansas

As for Epperson’s home state of Arkansas, the legislature has not been swayed by the pattern of losses. Anti-evolution bills have been introduced many times, even as recently as 2017. The hostility toward evolution in the state has left its mark, as it has in so many other communities in the South and around the nation. In 2009, Mark W. Bland and Randy Moore surveyed Arkansas public high school biology teachers about what they present about evolution, finding that 27 percent of teachers disagreed with the statement that teaching creationism was inappropriate, going a long way to explaining why a full 23 percent were teaching creationism in their classrooms. While headway is being made in supporting and encouraging teachers to teach evolution, public opinion on the matter has not changed as much as might be hoped in the last 30 years. Even the mere mention of the word “evolution” in science education standards continues to be a source of controversy—especially in the South.

An Agent of Change

Looking back fifty years later, I asked Epperson what she took away from it all. “Well, obviously our case did not solve the problem. As long as preachers tell their congregations that [evolution] is an anti-God idea, then there will be efforts to remove it from classes. I have learned that one cannot debate the validity of evolution with students in class. Evidence that evolution occurred is abundant, so look at the science.”

In other words, scientific evidence exists for us to follow where it leads. With students, we must define what science is and what it is not. Science is based on evidence, not on faith; science is self-correcting, and it is not setting out to prove or disprove but rather to open our understanding through discovery.

Speaking with Epperson was an amazing experience. Her willingness to stand up for what she believes, especially at a time when she had so much to lose and felt pressure to abandon her cause from many directions, should be a reminder to us all that anyone, including a young high school science teacher in Little Rock, has the potential to bring about great change.

Acknowledgments

Thanks to Mark W. Bland, Randy Moore, Eugenie C. Scott, and especially Susan Epperson, for discussions and resources.

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Court reporter's typewriter and storyboard featuring events after the trial.

Photo: Randy Moore

PLACE & TIME A Renovated Museum at Ground Zero of

After months of renovation, the Rhea History and Scopes Trial Museum reopened on June 11, 2018, in Dayton, Tennessee. Planning and fundraising for the significant upgrades (the first since 1973) began in late 2016. On the day of the reopening, a private breakfast and reception was held by Bamber Photography in the former Trinity United Methodist Church (in which, during the trial, pro-evolution preacher

Charles Potter spoke). At the reception, donors and other people instrumental in updating the museum were recognized. Local elected officials and others were then led through the museum by Tennessee governor Bill Haslam, who noted that the museum makes “certain that this very special part of not just our state’s history, but the whole country’s history, is preserved.”

The museum was redesigned by Nashville-based Advent, a company led by Rhea native John Roberson that specializes in museum displays. The space showcases several storyboards detailing the key players and events before, during, and after the

trial. Included are the Butler Act (the law used to prosecute John Scopes), and profiles of John Scopes himself, William Jennings Bryan (a prosecuting attorney representing Tennessee), Clarence Darrow (a defense attorney representing Scopes), and the city of Dayton in 1925.

Visitors are offered summaries of the cases mounted by both lawyers and reminded of famous quotes from the two men (Darrow’s “Life is full of awakenings. Man is bound to keep on finding out you can’t put blinders on the world if you try,” and Bryan’s “There can be no settlement of a great cause without discussion, and people will not discuss a cause until



Craig W. Benkman of the University of Wyoming, **Kristin P. Jenkins** of the BioQUEST Curriculum Consortium, and **Roger D. K. Thomas** of Franklin and Marshall College were all elected as Fellows of the American Association for the Advancement of Science in 2017. Congratulations to all. (And let the NCSE office know if we overlooked your name on AAAS's list!)

Duane Jeffery, a former member of NCSE's board of directors, a member of its advisory council, and professor emeritus of biology at Brigham Young University, was honored with the National Science Teachers Association's Presidential Citation for 2018. The award is conferred to a person or organization that has significantly promoted science education through extraordinary contributions. The award was presented at a special banquet and ceremony on March 16, 2018, at the NSTA's conference in Atlanta, Georgia.

NCSE is delighted to congratulate **Michael E. Mann** on his selection to receive the 2018 Public Engagement with Science Award from the American Association for the Advancement of Science, in recognition of his "tireless efforts to communicate the science of climate change to the media, public[,] and policymakers." He received the award during the AAAS's annual meeting in Austin, Texas, on February 17, 2018. Nominating Mann for the award, Susan Hassol, director of the non-profit science and outreach project Climate Communication, wrote, "Mann has done more to engage with the public on science than most active scientist-communicators do in an entire career," according to a press release from the AAAS. Hassol added, "There is no scientist reaching greater numbers of people with such depth of communication as Michael Mann." Mann is Distinguished Professor of Atmospheric Science at Penn State University, with joint appointments in

the Department of Geosciences and the Earth and Environmental Systems Institute. He is also director of the Penn State Earth System Science Center. His latest book, coauthored with Tom Toles, is *The Madhouse Effect* (Columbia University Press, 2016). A member of NCSE's Advisory Council, he received NCSE's first Friend of the Planet Award in 2014.

—GLENN BRANCH



Art work by Ray Troll © 2017 www.trollart.com

the Evolution/Creationism Controversy

their attention is drawn to it"). The verdict and legacy of the trial are also presented.

In addition to the storyboards, various artifacts from the trial are prominently displayed, including:

- examples of handmade monkey dolls popular during the trial
- twenty-nine handwritten pages of the Circuit Court's minutes of the trial
- sheet music for "Darwin's Monkey Trot," written by Raymond Faifer, J. D. Boren, and Helen Boren (Faifer and J. D. Boren were in Dayton to see the trial and promote their song, a copy of which they gave to Darrow and Bryan)

- correspondence, including a letter dated June 25, 1925, in which Bryan tells prosecuting attorney Wallace Haggard that "we are evidently in better position in regard to evidence than they are ... It will be interesting to learn who among them is willing to subject himself to cross examination on this subject about which they talked so loudly in the press" and that Darrow's "attitude on religious questions will offset his ability"
- the typewriter (seen at left) used by W. Hugh Norvell, the court reporter for the trial
- the badge of Sheriff Robert "Bluch" Harris, a local law enforcement of-

ficer charged with maintaining law and order in the courtroom

The Rhea History and Scopes Trial Museum continues to be housed in the basement of the Rhea County Courthouse, which was built in 1891 and made a National Historical Landmark in 1976. The renovated museum also features displays about other major events in Rhea County's history, including the arrival of the railroad, the rise and fall of Dayton Coal & Iron Company, and the establishment of Bryan College.

Randy Moore is the H. T. Morse-Alumni Professor of Biology at the University of Minnesota, Twin Cities. His most recent book, coauthored with Kara Felicia Witt is *The Grand Canyon: An Encyclopedia of Geography, History, and Culture*, (ABC-CLIO, 2018). Rmoore@umn.edu



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.

CALIFORNIA, ANGELS CAMP

After a creationist high school student expressed discontent with a district policy that “religious theories ... shall not be discussed in science classes” in December 2017, the *Sonora Union Democrat* reports that “the district has no plans to change the policy or put it on a school board agenda for a discussion.” The student’s family is considering filing suit, although the district’s policy derives from the California School Boards Association and is believed to comply with applicable law.

CONNECTICUT

Senate Bill 345, as introduced, would have required the teaching of climate change “consistent with the Next Generation Science Standards” in Connecticut’s public schools, even though Connecticut adopted the NGSS in 2015. Amended to allow rather than to require such teaching, the bill passed the Senate but died when the legislature adjourned on May 11, 2018. Its text was included in House Bill 5360, however, which passed the House of Representatives and the Senate before receiving Governor Malloy’s signature.

FLORIDA

When the Florida legislature adjourned on March 11, 2018, two pairs of bills that would have undermined the integrity of science education died: House Bill 827 and Senate Bill 1644, which would have required the evaluation of instructional materials suggested by the public, and House Bill 825 and Senate Bill 966, which would have allowed districts to use alternatives to the state science standards and required “[c]ontroversial theories and concepts ... [to] be taught in a factual, objective, and balanced manner.”

IDAHO

When the Idaho legislature ended its session on March 28, 2018, a three-year-long struggle over new state science standards ended, with a generally positive outcome. The Senate Education Committee voted in February 2018 to approve a proposed new set of science standards for Idaho without change, although earlier in the month, the House Education Committee deleted a standard referring to human influence on climate change. Both chambers would have had to agree in order for the standards to be rejected.

IOWA

House File 2317, introduced in the Iowa House of Representatives on February 12, 2018, and referred to the House Education Committee, would have reverted the state’s science standards to “the science standards utilized by school districts in this state during the 2014–2015 school year”—just before the state adopted the Next Generation Science Standards. The chief sponsor, Sandy Salmon (R–District 63), objects to the NGSS’s treatment of climate change and evolution. The bill died in committee later in February 2018.

LOUISIANA

Senate Resolution 33, introduced in the Louisiana Senate on March 20, 2018, would have commended a former state senator, Bill Keith, “on his support and endorsement of teaching creationism in public schools.” Keith sponsored Louisiana’s Balanced Treatment for Creation-Science and Evolution-Science Act in the state senate in 1981. The law was subsequently overturned as unconstitutional by the Supreme Court’s decision in *Edwards v. Aguillard* in 1987. The resolution died when the legislature adjourned in May 2018.

OHIO

On February 13, 2018, the Ohio state board of education voted to adopt a new set of science standards—although not without what seems to have been a last-minute attempt to undermine the teaching of evolution. Sarah Fowler (District 7) proposed to amend the high school standards by adding a claim that “scientific conclusions are necessarily based on philosophical assumptions.” Her amendment failed on a 2–14 vote and the standards were then approved on a 15–1 vote.

PENNSYLVANIA, EVERETT

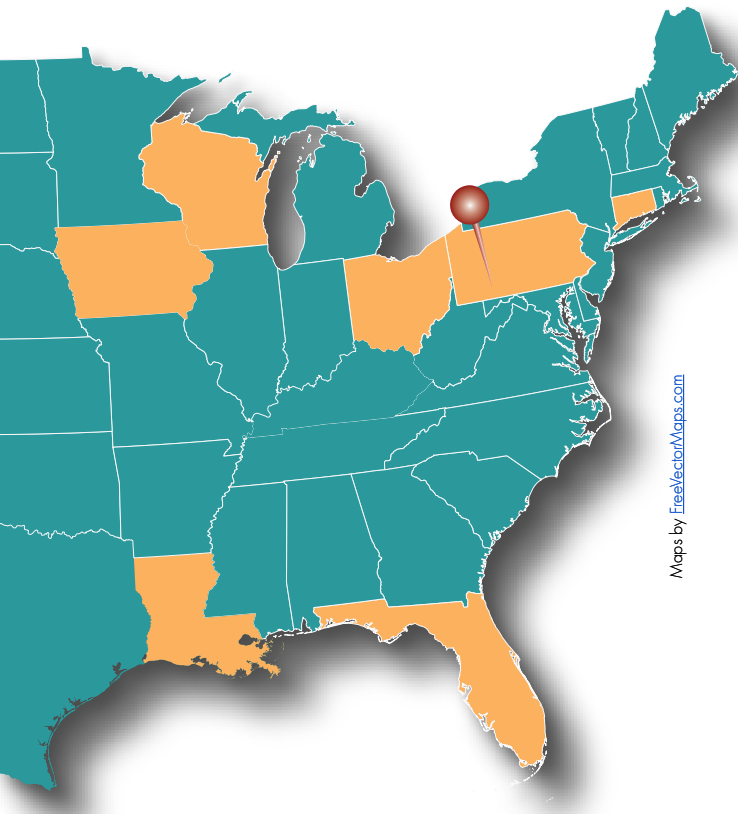
“For the second time in a decade, a state appeals court has told a taxpayer that he can’t sue his school district because it teaches the theory of evolution in science class,” reported PennLive. Thomas J. Harclerode’s 2016 complaint against the Everett Area School District Superintendent and School Board over the teaching of evolution was dismissed for lack of standing, and the dismissal was upheld because Harclerode failed to file a timely statement of errors with the trial court.

WASHINGTON

When Governor Jay Inslee signed Senate Bill 6032 into law on March 27, 2018, the state of Washington committed to provide \$4 million “to provide grants ... for science teacher training in the [N]ext [G]eneration [S]cience [S]tandards”—adopted by Washington in 2013—“including training in the climate science standards.” In a press release, E3 Washington, the state’s association for environmental and sustainability educators, described the signing as “a major victory for climate education and K–12 students across the state.”

WISCONSIN

A pair of “Campus Free Speech Acts,” Assembly Bill 299 and Senate Bill 250, died in the Wisconsin legislature on March 28, 2018, when they failed to meet a deadline. Judging from the text of the bills, science education would not have obviously been affected. But during a committee hearing, two of the sponsors of AB 299 suggested that the teaching of evolution and climate change might be affected by the bill’s passage, according to the *Capital Times*.



FAREWELL TO EMILY SCHOERNING AND WELCOME TO KATE CARTER



NCSE bids a fond farewell to **Emily Schoerning**, who joined NCSE as its first Director of Community Organizing and Research in 2015. A microbiologist by training, Schoerning

brought to NCSE a passion for science education and outreach that she found while a postdoctoral researcher. Particularly noteworthy was her development and supervision of NCSE’s Science Booster Club program, aimed at rallying communities to support local science education. Initially piloted with a single club in Iowa City in 2015, the program now includes clubs in a dozen states, which have together reached almost 200,000 people at community

events. As her title suggested, Schoerning was also involved in acquiring and analyzing data on the program’s efficacy. The first article based on her research on the project’s impact was recently published in *JCOM Journal of Science Communication*. In 2017, she was elected as the Research Division Director of the National Science Teachers Association. All of us at NCSE wish her the best in her new endeavors.

Replacing Schoerning is **Kate Carter**, who started as NCSE’s new Director of Community Science Education in July 2018. Carter comes to NCSE from Harvard University, where she earned her Ph.D. in human evolutionary biology. Her experience includes teaching a



course on human evolutionary biology and conducting extensive informal science education activities in such venues as the Museum of Science, Boston, the Carnegie Museum of

Natural History, and Harvard University. At NCSE, she will be directing and expanding NCSE’s Science Booster Club program. “I am firmly convinced that positive encounters with science produce community support for science education,” she commented. “I am eagerly looking forward to the opportunity to help to bring authentic, accurate, and fun science activities to communities across the country.” Carter may be reached at carter@ncse.com.

Sometimes an unusual juxtaposition is actually the best fit. Take an okapi, for instance. At first glance, it seems like an odd and perhaps clunky combination of a giraffe and a zebra, but it is in fact a well-adapted animal, finely tuned by evolution to be successful in its environment. Similarly, the NCSE Teacher Ambassador Program for Evolution (which we call EVO TAP for short), may seem like an unconventional combination of professional development and brainstorming. But it will, we hope, result in a series of workshops finely tuned to successfully deliver quality evolution instruction by training participating teachers in the use of NCSE's unique no-conflict approach as well as engaging them as fellow architects of a unique misconception-based evolution curriculum.

The Inaugural Workshop

The first EVO TAP meeting, held at Georgia Southern University on July 16–17, 2018, welcomed a [diverse group of teachers](#). Attendees travelled from across the country to rendezvous in Statesboro, Georgia. Teaching at a broad range of grade levels, at schools public and private, urban, suburban, and rural, with a wide range of experience both in their careers and their lives, they shared one common trait—a love for teaching evolution.

The teachers came into the workshop knowing that it was only the beginning of their commitment to being NCSE Teacher Ambassadors. The meeting was the launchpad from which they will deliver professional development to educators in their own areas, many of whom may lack the confidence or background knowledge to teach evolution thoroughly and forthrightly.

During our two days together, we presented the group with the framework for a five-lesson evolution unit. The lessons begin with a focus on the mechanisms of evolution, then cover fundamental concepts and patterns of evolution, and end with an exploration of the evidence for evolution. Most evolution curricula begin with the evidence



and then proceed to explain the mechanisms and patterns. Why didn't we choose to lead off with the strongest facts and evidence, from homologous genes to fossils of walking whales? Well, we chose to flip this script for two data-driven reasons: leading with the mechanisms provides

a better approach by both overcoming resistance to the topic and inoculating students against misconceptions.

A Research-Backed Approach

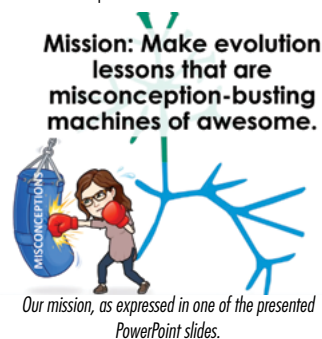
A lot of research has been conducted into how people learn. From it, we know that for students to truly internalize a concept, they must construct their understanding through problem-solving and hands-on engagement. Lessons that guide students through this process of discovery help them to examine evidence in a way that produces real and long-lasting comprehension. Furthermore, research exploring effective science communication indicates that simply providing evidence as an argument against misconceptions or outright resistance is ineffective. For students who might enter the classroom believing that they “do not believe in evolution,” confronting them with evidence is far more likely to reinforce their beliefs and misconceptions and harden their resolve to hold on to them than it is to change their minds.

So instead our unit begins with an aspect of evolution that most people, even those committed to a creationist worldview, do not object to: that there is variation among individuals in a population. From there, teachers move incrementally to speciation, macroevolution and modeling using trees, and then finally evidence. This allows them to ask their students, “If evolution works the way we have discussed, what would you predict you'd see in the fossil record, or in genes, or in biogeography?” What the students will find, of course, is that evolution has incredible predictive and explanatory power. But they get to discover that for themselves—they aren't simply told it—and that will make all the difference to many students.

Misconceptions Galore

Along the way, major misconceptions about evolution are addressed head-on. Students (and frankly, educators, too) will overcome the ideas that evolution is driven by purpose or intention, that all traits are adaptive, that natural selection ensures that only the fittest will survive (and that the fittest always means the strongest and fiercest), that evolution gives organisms what they need to survive, and of course, that evolution is “just” a theory. Educators will also be trained to respect students’ beliefs and to never tell a student that they must choose either science or their religion.

The misconception that religion and evolution are incompatible was addressed by our host expert, Amanda Glaze. Glaze is an assistant professor in the College of Education at Georgia Southern University, and an expert on the teaching of evolution, particularly in the southern United States. Glaze knows of what she speaks—a former classroom teacher herself, she was raised in an evangelical Southern Baptist family and taught to accept the inerrancy of the Bible. Her understanding and sensitivity to the challenges of teaching evolution was invaluable to our teachers, some of whom had followed similar pathways through their own professional education and life experience. Glaze provided a powerful and succinct message: It is not our job as educators to overturn a student’s worldview—it is instead our job to help students explore and understand science.



Next Steps

Discussion at the workshop centered around the misconceptions each lesson could address. Specific lessons were identified and explored, but the emphasis was more on discussing potential challenges and specific learning outcomes from each lesson, how each lesson would fit into the unit, and how individual teachers could adapt the lessons to their own classrooms and grade levels.

The teachers will field-test the unit during the 2018–2019 school year with their different age groups and on their own time frames. They will collect data through pre- and posttests that NCSE will compile and analyze to study how the approach affects student learning. Putting their Teacher Ambassador hats back on, each teacher will then work with administrators in their school or district to organize a summer 2019 workshop and will recruit teachers who can benefit from their investment, enthusiasm, and skills.

NCSE will help every step of the way. The ultimate goal of the EVO TAP program is to reach the teachers who are less confident and capable of teaching evolution effectively. This approach to teacher professional development is unconventional, but if we can reach these traditionally hard-to-reach teachers, then we can make a greater improvement in the quality of evolution education than previous programs have been able to. It may be like riding an okapi, but the potential impact is tremendous. And we’re glad to have your support on this wild ride.

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WHAT WE’RE UP AGAINST Senators Attacking Climate Central

The National Science Foundation is receiving criticism on account of a four-million-dollar grant to Climate Central that enabled the non-profit organization to educate hundreds of television meteorologists across the country about climate change through its Climate Matters program. In a June 2018 letter to the NSF’s inspector general, four senators—Ted Cruz (R–Texas), Rand Paul (R–Kentucky), James Lankford (R–Oklahoma), and Jim Inhofe (R–Oklahoma)—charged that the grant sought “to influence political and social debate rather than conduct scientific



research,” thus potentially violating both the foundation’s mission and a federal law prohibiting federal employees from taking public political positions. Climate Central’s Ben Strauss responded that the grant supported “informal public science education concerning well-established science,” adding, “Climate Central is not an advocacy organization, and the scientific consensus on climate change is not a political viewpoint.” Climate Central was a recipient of NCSE’s Friend of the Planet award for 2018.

—GLENN BRANCH

Breaking Down Barriers to Science at the State Fair

Dish soap, table salt, and rubbing alcohol. These three simple ingredients, found in nearly everyone's home, are all that it takes to pull out DNA from fruit. How do I know? Because for three days in August 2018, I was working together with University of Iowa graduate students and community volunteers to do just that at the Iowa State Fair.

A Return to the Iowa State Fair

Almost 900 families got to experience the “aha!” moment that comes when you physically touch clumps of DNA and realize not only that DNA is an actual *thing* but also that it is found in all organisms, even the ones we eat. Among some of the more colorful reactions, many kids remarked just how the DNA looked and felt like boogers, and one boy, fed up with having to share with his

sister all day, decided that it made a good projectile weapon in sibling warfare! But all were amazed at how easy and fun it was to see DNA, typically inaccessible except on the pages of science books, up close.

While the state fair may seem like an awkward venue for science experiments, University of Iowa Sci-

... all were amazed at how easy and fun it was to see DNA.

ence Booster Club members are seasoned veterans here. NCSE's first Science Booster Club started presenting at the state fair in 2016, and the scope of its activities has only grown since then. In 2018, it partnered with University of Iowa's Mobile Museum to develop an interactive digital DNA game and conduct DNA extractions of fresh produce. It is all part of the club's mission to help visitors understand what DNA is and where it is found.

Also noteworthy in 2018 was the presence of new leaders from around Iowa. Ashley Collins from the Western Iowa SBC, Anna Ward from the Muscatine SBC, and Alaine Hippee from the Quad Cities SBC all took shifts inside the Mobile Museum to share evolution activities with the public. Having a variety of new presenters is



Dish soap, table salt, and rubbing alcohol are all you need to pull DNA from cells of apples.

Photo: Kate Carter

useful not only for visitors to the exhibit but also to the volunteers themselves—working together to share science is actually quite a bit of fun!

From Visitor to Volunteer

“Science is fun” is an often overlooked but crucial take-away message from Science Booster Club activities. Far too often, scientists are viewed as stoic and solitary individuals researching esoteric subjects within the confines of a laboratory. This misconception not only underestimates the diversity of scientists and scientific endeavors but also establishes a clear division between “Scientists” and “Non-Scientists”—“Them” and “Us.” In a place like the Mobile Museum where volunteers and visitors can

Joe Jalinsky, one of the coordinators for the Iowa City SBC, ready to extract DNA with visitors to the SBC tent.

Photo: Kate Carter



learn alongside one another, this division starts breaking down—to positive effect. Here, volunteers and visitors alike are learning that science is doable and enjoyable.

Breaking down barriers in accessibility is an important first step in improving educational outcomes and developing a framework for a lifelong love of science. As visitors leave, they hopefully begin to realize that they are fully capable of thinking like a scientist. Science’s enormous explanatory power is accessible to everyone, even those seeking answers to such fair-oriented questions as “Why do some people become ill on circular rides?” and “Why is fried butter so delicious?” In a testament to horizontal learning, some previous year’s visitors have become this year’s volunteers!

Building on a Foundation of Outreach

Outreach opportunities are personally important to me because of the way they have impacted my own life. I grew up in a small town in western North Carolina, and I don’t remember hearing about evolution or climate change until high school. On a whim, I started volunteering at a natural history museum, interpreting at the touch tank and presenting some of the live shows. I enjoyed interacting with visitors, and moreover I gained insights into science and scientific methods through these interactions. These experiences led me not only to pursue science as a career but also to continually seek out ways to communicate science to others. I have personally learned so much more from outreach activities than I would have from academia alone, and I thrill to be able to offer these experiences to others.

Since joining NCSE as the new Director of Community Science Education in July 2018, I have seen firsthand what a positive impact the Science Booster Clubs have had in their communities. Many of our clubs are in scientifically underserved regions where the opportunity to engage in science outside the classroom is rare. Even in areas where resistance to climate change and evolution education is strong, we have found that people are responsive to respectful conversations, especially when they are with members from their own community. It is exciting to talk to club leaders and volunteers and hear that they are being asked to return because of the success of earlier endeavors. I am thrilled to

be stepping into a role where there are so many dedicated volunteers engaging in this important work.

Going for Nationwide Ahas!

As I move forward, I am eager to reproduce the success of the Iowa Science Booster Clubs on a national level. All over the country, many clubs are already growing, with plans to expand their number and scope. Finding community-appropriate solutions and creating a local corps of volunteers will certainly be a challenge, but I am heartened by the stories coming from our fifteen existing booster clubs. I am hoping soon to launch a nationwide graduate student fellowship program, in which graduate students can gain science outreach skills as they start booster clubs in their own community. I am also releasing our fall 2018 Science Booster Club activity, which uses a design challenge framework to explore sea level rise.

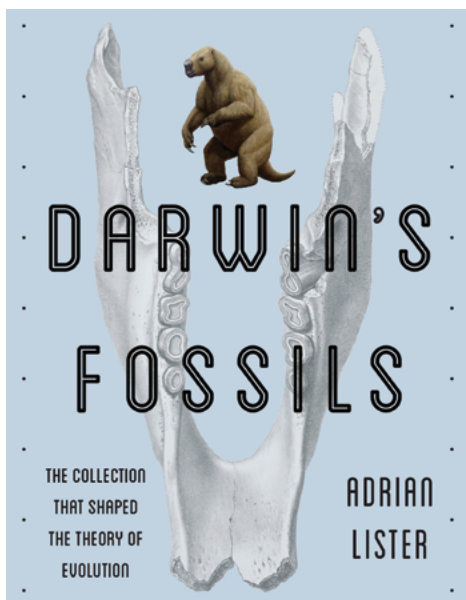
**Here,
volunteers and
visitors alike
are learning
that science
is doable and
enjoyable.**

Watching the “aha!” moments elicited from DNA extraction at the Iowa State Fair, I am reminded how important it is that everyone realize that “thinking like a scientist” is not something that should be relegated to labs and classrooms. Being a scientist and thinking like a scientist does not require stoicism or lab coats, just curiosity, critical thinking, and a pile of DNA mush (the fried butter helps, too). I am excited to start working with the Science Booster Club volunteers as they facilitate these realizations at events across the country.

Kate Carter is NCSE’s Director of Community Science Education. carter@ncse.com



THE RNCSE REVIEW



Darwin's Fossils: The Collection that Shaped the Theory of Evolution

authors **Adrian Lister**

publisher: **Smithsonian Books, 2018**

reviewed by: **Donald R. Prothero**

One of the highlights of my visit to the Natural History Museum in London in 2016 was a chance to go behind the scenes into the research collections, which are off-limits to the public. There I got to see and touch the actual fossils that Darwin brought back from his 1831–1836 voyage aboard the *Beagle*. It was not just the electric thrill of picking up specimens that Darwin himself collected over 186 years ago and reading the labels written in Darwin's own hand that exhilarated me, but realizing how crucial these discoveries were to the eventual development of his theory of natural selection.

Indeed, as Adrian Lister (a paleobiologist at the National History Museum, London) points out in his outstanding book on the subject, it was these very fossils, and their incredible weirdness, that started Darwin on the path of thinking that species have changed over time and that most fossil species are now extinct. Some were relatives of living mammals, such as the giant ground

sloths and the armadillo kin known as glyptodonts, but most were members of extinct mammalian groups with no close living relatives or descendants. Biology textbooks often present the Galápagos

[I]t was the discovery of these strange fossils that started Darwin on his path to understanding a mechanism of evolution...

finches as Darwin's key discovery, but as later scholars have shown, Darwin didn't even realize what he had collected on the Galápagos Islands at the time. No, it was the discovery of these

strange fossils that started Darwin on his path to understanding a mechanism of evolution, along with his geological experiences guided by the gradualistic uniformitarian teachings of Lyell.

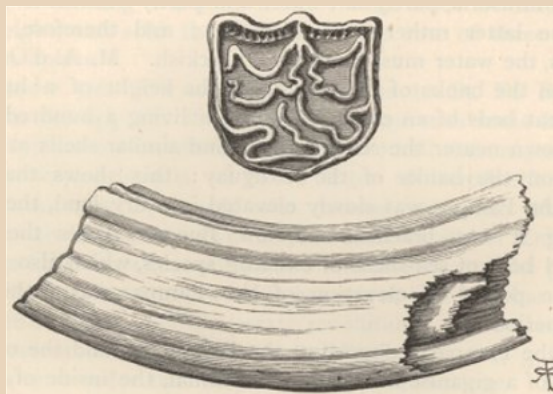
The one exception to all these unfamiliar mammals was the fossil horse tooth Darwin found at Bajada de Santa Fe, which he wrote about in a number of publications (see sidebar). Even this discovery, though, was surprising, since it showed that horses had once lived in South America long before Europeans reintroduced them in the sixteenth century. The rest of the specimens were puzzles not only to Darwin but also to zoologist and paleontologist Richard Owen, who published the actual descriptions. Neither of them could imagine that less than a century later, paleontologists would realize that these odd fossils were members of extinct families of mammals that evolved during sixty million years of isolation in South America, so they superficially resembled horses, mastodonts, camels, rhinos, hippos, and others, but did so by means of convergent evolution from unrelated ancestors.

Adrian Lister does a fabulous job in this book, not only tracking down the exact details of where and how and when Darwin acquired these fossils, but also explaining how they were originally interpreted and how we understand them today. There are numerous color photographs of the original fossils, Darwin's notes on them, color reconstructions of the animals as visualized today, and even photographs of some of the living relatives. Lister describes not only the peculiar mammals but also the marine invertebrate and plant fossils

that Darwin collected, the geological discoveries he made in Patagonia and Chile, and even his later discoveries that led to his (later proven correct) theory of the origin of coral atolls. In the final chapter, Lister explains the process by which Darwin's collections were described and published and emphasizes how important his fossils were to changing his way of thinking, guiding him to the idea that species could change. This is the least appreciated part of his discoveries, and one that needs serious consideration, since Darwin scholars (and textbooks) have overemphasized the discoveries in the Galápagos Islands while underestimating how important Darwin's geological work and fossil collecting were to his thought processes.

The book is beautifully produced as a color paperback, and at 230 well-illustrated pages with large type, it is not a long read. I strongly recommend that anyone interested in Darwin, paleontology, or the history of biological and paleontological thought take a serious look at this book. It corrects a longstanding blind spot in Darwin scholarship, which has failed to recognize the incredible importance of these fossils in the history, and for the future, of biology and paleontology.

Donald R. Prothero has taught geology and paleontology for forty years at places like Caltech, Columbia University, Vassar College, and Occidental College; he is currently at Cal Poly Pomona. He is the author of over forty books and over 300 scientific papers, mostly in geology and mammalian paleontology. He has received a Guggenheim Fellowship, the 2013 Shea Award for outstanding writing in the geological sciences, the 2015 Gregory Award for service to vertebrate paleontology, and NCSE's Friend of Darwin award in 2016. donaldprothero@att.net



Fossil tooth of horse, from Bahia Blanca. From the 1890 illustrated edition of Charles Darwin's Journal of Researches (commonly known as The Voyage of the Beagle) published by John Murray.

From the Horse's Mouth

... I at St Fe Bajada found a horses tooth in the same bank with parts of a Megatherium; if it had not been a horses tooth, I never should have for an instant doubted its being coeval with the Megatherium. — Yet the change of habits, proved by the frequency of the arrow heads, convinces me that the horse was not an original inhabitant. —

—Darwin's *Beagle* diary, entry for September 7, 1833

[I]n my own mind I am convinced that a horse coexisted with the Megatherium & Mastodon: How strange that man after an immense epoch should repeople the country with the same genus. — I believe all Historians are agreed that the Spaniards found no Horse in S. America. —

—Darwin's geological diary: Pampas, 1833

When I found in La Plata the tooth of a horse embedded with the remains of Mastodon, Megatherium, Toxodon, and other extinct monsters...I was filled with astonishment; for seeing that the horse, since its introduction by the Spaniards into South America, has run wild over the whole country and has increased in numbers at an unparalleled rate, I asked myself what could so recently have exterminated the former horse under conditions of life apparently so favourable. But how utterly groundless was my astonishment! Professor Owen soon perceived that the tooth, though so like that of the existing horse, belonged to an extinct species.

—Darwin, *On the Origin of Species*, 1859

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Photo: Sarah Bradford-Denison

*Children exploring DNA at NCSE's 2018
Science Booster Club Summer Camp in Iowa City, Iowa*

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