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DeSantis DREAM Lab discovers ancient and modern worlds through the study of mammals, past and present

Photos courtesy DeSantis DREAM lab

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Dear NCSE Supporters,

Floods in California. Cold snaps in Texas. Tornadoes in Mississippi. There was no shortage of extreme weather events in the past year. Indeed, what used to qualify as unusual weather is increasingly happening with maddening regularity.

These extreme weather events provide local, personal, and deeply compelling opportunities to talk to students about climate change in their own communities. What makes them especially useful in the classroom is that there is no black-and-white answer to the question: "Was this event caused by climate change?" And whenever a question requires asking more questions, seeking out credible evidence, and using scientific reasoning to reach an answer, that's a fantastic science teaching opportunity. In this issue, you'll find a reprint of an article on teaching about extreme weather (p. 4) that I recently wrote as part of a collaboration with the National Science Teaching Association.

Of course, at NCSE, we want all students to grow up to be confident scientific thinkers. But we also know that tomorrow's scientists are sitting in today's classrooms, and you just never know what will inspire one of those students to pursue a career in science. In this issue's profile of Larisa DeSantis (p. 3), you'll read that she was fascinated by paleontology early, but had no idea that it could be a career, especially for a girl. But her interest never faded and eventually she followed that passion and became a research scientist who works hard to serve as a living inspiration to students of all ages. Read about her work with our teacher support program and her presentation at NCSE's Evolution Seminar at the 2022 National Association of Biology Teachers conference (p. 12).

Meanwhile, NCSE continues to monitor state legislation. It's been a busy year already. State legislatures across the country have proposed bills that use longstanding tactics to undermine climate change or evolution education; we've even seen the term "intelligent design" make an unwelcome reappearance, in West Virginia legislation that proceeded uncomfortably far before finally dying. You can follow our work to block these efforts at our website's "What We're Monitoring" section.

And finally, I have a bittersweet announcement. I have informed NCSE's board of directors that I intend to retire at the end of 2023. That will mark 10 years for me at NCSE, a decade during which the organization stayed true to its roots but also expanded into more direct efforts to support and equip teachers and to provide state-of-the-art research about U.S. evolution and climate change teaching practices. I have had the pleasure of working with Glenn Branch, Nina Hollenberg, and Stuart Fogg, all of whom were on the staff when I arrived, and have been fortunate to have been in a position to help recruit the rest of our amazing staff, all of whom I know my successor will enjoy working with. Be on the lookout for a job announcement in mid-April 2023—and think about whether there is anyone in your network who might be interested in leading this incredible organization.

Ann Reid is executive director of NCSE. reid@ncse.ngo

Larisa DeSantis: Changing the Face of Science One Outreach Experience at a Time

Growing up, Larisa DeSantis didn't think she was going to be a paleontologist. Though she lived near the La Brea Tar Pits in the heart of Los Angeles, and visited there often, DeSantis did not see female fossil hunters represented among scientists in popular culture. There were no role models in her field of vision—women who were vertebrate paleontologists at prestigious universities with National Science Foundation grants, their own research labs, and TEDx talks to their credit.

As a child, DeSantis asked her mother why she became a teacher. Her mother, she recalls, responded by saying, "Well, I faint at the sight of blood so I couldn't be a nurse. I can't type so I couldn't be a secretary. So this is why I became a teacher." At the time, DeSantis didn't grasp the implications of her mother's words. Later, though, she realized that she could not let those kinds of pernicious limitations persist, particularly in the field she is so passionate about.

> "Why as scientists do we do what we do, if not to share it and let other people learn from what we're learning?"

As a result, DeSantis has devoted a great deal of her professional life as a aleontologist to engaging in public outreach. Of course DeSantis believes that everyone should understand evolution and its profound relevance to everyday life—an important reason to educate the public. Moreover, she wants to help others feel the joy she experiences when wrestling with the questions engendered by fossils and the lives of ancient animals. "Why as scientists do we do what we do," she asks, "if not to share it and let other people learn from what we're learning?" But what is ultimately driving her to engage in public outreach, she says, is to help diversify a stubbornly undiverse profession. She wants to ensure that girls today see science as a career path. She wants to help change the face of science.

DeSantis's outreach is diverse and long-standing. Recently, she presented at the Tennessee Women in Science, Technology, Engineering & Research (TWISTER) conference for high school girls. She has discussed saber-toothed cats with Odis ("a puppet with a thirst for knowledge and adventure") at Paleofest 2020. She has participated in a National Fossil Day event called "Ask a Vanderbilt Paleontologist." And going further back, her first—and, she says, one of her most fun—jobs was "driving a 38-foot-long Winnebago that was a moveable museum with dinosaur exhibits in New York City. I kind of look like Ms. Frizzle anyway," she says, laughing. "This was not long after 9/11, so many of the schools had limited field trips. We would go to the different boroughs, bring our exhibits, and work with the teachers and do lessons with the students."

With such a commitment to science outreach, DeSantis was happy to help when asked by NCSE to give a presentation at the November 2022 National Association of Biology Teachers conference, which she reprised virtually as part of a Darwin Day 2023 celebration. (See "Chewing on Change: The Tales Teeth Tell Us," p. 12). The two-part talk included a portion led by Teacher Ambassador Jennifer Broo devoted to the exploration of an NCSE lesson set, Good is Good Enough. DeSantis, for her part, opened by focusing on an important aspect of her research interest: studying the fossilized teeth of ancient mammals to determine past climatological conditions.

At the DeSantis DREAM (Dietary Reconstructions and Ecological Assessments of Mammals) Lab at Vanderbilt University, her team uses their study of teeth to ascertain diet. "People often ask why do you care about diet?" DeSantis says. "It's because diet is such a huge part of how an animal interacts with their environment. Diet essentially influences where an animal lives."

"Think of a koala eating eucalyptus. Well, it needs a eucalyptus tree to live in to be able to eat that resource. Diet can also affect how an animal moves across its landscape. Think about wildebeest migrating in response to where the lush grasses are. And then it can also affect an animal's morphology and ability to take down prey. Think of a cheetah able to hunt its various prey items. And it can also affect things like reproduction."

Studying fossilized teeth can also help determine how arid an animal's environment was and potentially provide some indication of relative temperature. DeSantis and her team use other information as well, such as ice core data, to provide a more complete picture. DeSantis can then determine how animals responded to ancient climate change, potential reasons why they went extinct, and the long-term consequences of both climate change and large animal extinctions on a diversity of plants and animals.

These findings can then be used to better understand the impact of climate change today. They begin to answer some of the fundamental questions that drove DeSantis to first study environmental management alongside paleontology: How did ancient mammals respond to climate change? What are the cautionary lessons we can take away? Why did some animals survive and not others? And what are things we can learn about those survivors?

Her NCSE-affiliated presentation did not represent DeSantis's first collaboration with the organization. Just over a decade ago, she spearheaded an effort—with support from NCSE—to block a Tennessee bill that threatened to undermine the teaching of evolution and climate change. Dubbed the "monkey bill," it called for teachers to present the "scientific strengths and scientific weaknesses" of topics that arouse "debate and disputation," such as biological evolution and global warming. As DeSantis said at the time, the legislation brings "the political controversy into the classroom, where there is no scientific controversy."

Though the bill ultimately became law—and remains on the books today—DeSantis is proud that she and her husband, a high school science teacher, were able to garner more than 5,000 signatures on a petition opposing the bill. Having spent a good portion of her adult life in the southeast—in Gainesville at the University of Florida, where she earned her doctorate, and now in Nashville, Tennessee, at Vanderbilt University—DeSantis knows firsthand the societal challenges that can exist when it comes to evolution and evolution education.

All the more reason to engage in outreach and public education, she says.

It's a perfect opportunity to help the public understand and embrace questions about our planet's history and evolution. And who knows? Perhaps among hem is the next Larisa DeSantis.

Paul Oh is NCSE's Director of Communications. oh@ncse.ngo

CLIMATE CHANGE CAUSES EXTREME WEATHER EVENTS:

I will never forget one day in spring 1974 when my father returned home from a trip to Xenia, Ohio. Dad was in the insurance business, and I was used to hearing cautionary tales about people who injured themselves while setting off home fireworks, riding motorcycles without helmets, or cleaning out their gutters while standing on rickety ladders. But this was different. Dad heard about a lot of destruction in his line of work, but what he saw in Xenia left him practically speechless. The entire downtown was destroyed, and 33 people had been killed. It was by far the worst disaster he'd ever personally witnessed, or ever would again.

The evidence is now clear that climate change is contributing to increased hurricane intensity; more large wildfires; more frequent, severe, and pervasive droughts; and more frequent and intense heat waves

The tornado that struck Xenia on April 3, 1974, was part of what came to be called the 1974 Super Outbreak. At least 148 tornadoes were confirmed across 13 U.S. states and one Canadian province. Thirty of those tornadoes were level EF4 (winds of 267 to 322 kilometers per hour [kph]) or EF5 (winds of more than 322 kph). The total death toll was 319. For 37 years, the 1974 Super Outbreak held the record of most tornadoes in a single 24-hour period, until the 2011 Super Outbreak, which involved an astonishing 360 confirmed tornadoes, 15 of which were EF4 or EF5 in strength. Since 2011, two more super outbreaks have occurred, one each in 2020 and 2021, each containing more than 100 tornadoes within a 24-hour period.

Note: This article originally appeared at the National Science Teaching Association's website and is part of a new series, Climate Change Education Corner, that features helpful information, insights, and resources for science educators about climate science and climate change education. This project is a joint collaboration between NSTA and NCSE.

Photo by NASA

YES, NO, OR WRONG QUESTION?

Hmmm. Three super outbreaks in 11 years, after a 37-year gap? Does that mean climate change is making tornadoes worse? That sounds like a question for science!

And it is! But it turns out that it is not a straightforward question to answer. And one reason is that you might choose from a lot of different parameters to assess whether one tornado, or one tornado season, is worse than another. Do you measure the number of tornadoes, in which case the Super Outbreaks are the worst events? Or do you measure the number of deaths? Or the amount of economic damage? Or wind speed, atmospheric pressure, or length of time on the ground? Depending on which of these measures you choose, you might get different answers to your question of whether tornado activity is growing worse over time in a way that points to climate change as a contributing factor.

You could do a similar exercise with hurricanes, tornadoes' larger equatorial cousins. Is climate change making hurricanes worse? Well, that depends on whether you define worse in terms of the number of hurricanes, their size or their intensity, their destructiveness of lives or property, the amount of rainfall they bring, the distance they travel over land, the amount of time they spend over any given place—well, you get the picture. As if those weren't enough possible choices, sometimes new parameters present themselves. For example, several recent hurricanes have intensified with unexpected quickness; can that characteristic be linked to climate change?

The interaction of climate change with extreme weather is complicated and probabilistic (by which I mean that the best you can do is give a probability range for the impact of climate change, not a "yes" or "no"), and that makes the topic particularly amenable to bad faith arguments and misconceptions. Those who aim to downplay climate change, or discourage policies that would reduce fossil fuel use, will often emphasize that many uncertainties remain about how climate change affects different kinds of extreme events. And, yes, there are uncertainties. But that doesn't mean we don't know anything at all. This Heritage Foundation interview with one of its own economists is an excellent example of traveling in a more or less straight line from uncertainties about the impacts of climate change on hurricanes to the conclusion that reducing carbon emissions would do more harm than good. (Teachers, if you discuss this interview with your students, be prepared to help them examine the rhetorical devices the economist uses to reach his conclusions. The National Center for Science Education (NCSE) uses the FLICC [Fake Experts, Logical Fallacies, Impossible Expectations, Conspiracy Theories, Cherry Picking] model developed by John Cook to inoculate students against potentially deceptive argumentation.)

But even those who lack a professional interest in downplaying the role of climate change in worsening extreme weather events can have misconceptions. One survivor of Hurricane Florence, the second major hurricane to inundate North Carolina with 500-year floods within two years of one another, explained, "We live on the coast. It's cyclical. We may get two or three in a year, then go four or five years with nothing." Another said, "Really the Earth goes through cycles. So it's just we're on that particular cycle where we're grabbing more storms." That's not how 500-year floods are supposed to work: If you get significantly more than one every 500 years, something has changed.

So if the relationship between extreme weather and climate change is so complicated—and as a result, so confusing—why should we nevertheless be willing to tackle the question in the science classroom? I can think of two reasons.

First, extreme weather really gets students' attention, especially when it affects them, their families, and their communities, and the first question they might ask is whether climate change is responsible. (Of course, you should be pleased if they ask it!) And they certainly deserve the best answer we can supply.

Second, the more we know about how climate change may affect extreme weather, the better prepared we can be. If we can predict whether, for example, hurricanes are likely to move more quickly or slowly, carry more or less rain, have faster or slower wind speeds, or begin earlier and continue later in the year, we will be able to

make wiser land-use, building code, and emergency planning decisions. And the same goes for wildfires, tornadoes, droughts, and other catastrophes. These are the kinds of decisions that today's students will have to make regularly in tomorrow's warmer world.

Fortunately, if there's one thing scientists love, it's a challenge, so developing a way to untangle the connections between extreme weather events and climate change is right up scientists' alley. A relatively new area of climate science research called extreme event attribution seeks to develop transparent and reproducible methods to determine the role of climate change in extreme events. In a very simple nutshell, what scientists do is compare different models of the climate over time—some that include the increases in greenhouse gases since the 1850s and some that do not. Because of natural variation in climate, all of these models would be expected to predict, for example, heavier rainfall or heat waves or exceptionally big hurricanes in some, but not all, years. If the models that exclude increased greenhouse gas emissions show less frequent or less intense extreme weather events, scientists can conclude that these emissions had a role in increasing their probability.

Because of the demands of scientific rigor, attribution analyses of a given extreme weather event often are not published for many months afterward. But they eventually are published, and the evidence is now clear that climate change is contributing to increased hurricane intensity; more large wildfires; more frequent, severe, and pervasive droughts; and more frequent and intense heat waves.

While these general trends are clear, people tend to want to know whether any particular extreme event was caused by climate change. And waiting for peer-reviewed research to be published risks (horrors!) missing the news cycle. Wouldn't it be better if scientists could provide reliable feedback about the role of climate change in an extreme weather event while people are still talking about it? Responding to the perceived need for more rapid feedback, an international collaboration of attribution experts formed the World Weather Attribution initiative (WWAI). The WWAI website is well worth bookmarking: Not only does it provide timely and thorough information, but it is also a model of scientific transparency. As any good math teacher often requests, it shows its work.

What do I mean by that? Well, what kinds of questions might you ask about how such a project does its work? Here are a few that spring to mind: How do they decide which events to evaluate? How exactly do they determine whether climate change contributed to a particular event, and if so, by how much? Do they consider the role of other causes? If they use models to make these attributions (and of course, they do), which ones do they choose and why? WWAI answers all of these questions and more, briefly on its overview page and exhaustively in a series of peer-reviewed publications.

You won't find every extreme weather event on the WWAI website. Although the science of extreme event attribution is advancing rapidly, the process of evaluating an event is still labor-intensive, and there simply aren't enough data to reach any definitive conclusions about the role of climate change in every individual event. But looking at the events that have been evaluated is instructive—and sobering. Climate change was determined to have made early season heat waves in India and Pakistan 30 times more likely, and to have added four billion dollars to the damage caused by a typhoon in Japan. In other cases, the role of climate change was harder to discern. In a drought in East Africa, for example, climate change probably contributed to higher temperatures, but couldn't be linked to changes in rainfall patterns. And in still other cases, like severe flooding in Vietnam in October 2020, climate change was found to have only a limited role in the heavy rainfall events that triggered the floods. The fact that the WWAI doesn't implicate climate change in every event is, to my mind, an indicator of scientific integrity.

What's the takeaway message? It's that with a little preparation by the teacher, a science classroom can be a hospitable place for students to address questions about whether, in what sense, and to what extent the evidence shows that climate change causes extreme weather events. Indeed, NCSE has a set of activities designed to help your students explore this topic and correct any misconceptions they might have about the relationship between extreme events and climate change.

In 1974, the super outbreak of tornadoes that destroyed Xenia was perceived to be a horrendous but essentially random event. Even now, the relationship between climate change and tornadoes remains one of the most challenging of the many varieties of extreme weather events to tease apart. But the increasing severity and frequency of extreme events from fire to flood to drought to heat waves is becoming more predictable. And while that's hard news to absorb, it at least means that instead of feeling helpless, students can begin to think about what they can do in their own communities to prepare for and reduce the risks posed by local extreme events.

Ann Reid is executive director of NCSE. reid@ncse.ngo

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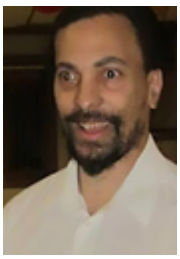


Darwin's Reach: 21st Century Applications of Evolutionary Biology (CRC Press, 2022), by **Norman A. Johnson** of the University of Massachusetts, Amherst, was published. According to the publisher:

The application of evolutionary biology addresses a wide range of practical problems in medicine, agriculture, the environment, and society. Such cutting-edge applications are emerging due to recent advances in DNA sequencing, new gene editing tools, and computational methods. This book is about applied evolution—the application of the principles of and information about evolutionary biology to diverse practical matters. Although applied evolution has existed, unrecognized, for a very long time, today's version has a much wider scope. Evolutionary medicine has formed into its own discipline. Evolutionary approaches have long been employed in agriculture and in conservation biology. But Darwin's reach now extends beyond just these three fields. It now also includes forensic biology and the law. Ideas from evolutionary biology can be used to inform policy regarding foreign affairs and national security. Applied evolution is not only interdisciplinary, but also multidisciplinary. Consequently, this book is for experts in one field who are interested in expanding their evolutionary horizons. It is also for students, at the undergraduate and graduate levels. One of the public relations challenges faced by evolutionary biology is that most people do not see it being all that relevant to their daily lives. Even many who accept evolution do not grasp how far Darwin's reach extends. This book will change that perception.

Mary Jane West-Eberhard of the Smithsonian Tropical Research Institute was awarded the Linnean Medal for Zoology for 2021 by the Linnean Society. According to the society's citation, she "has used her studies of natural history to alter, amend, and expand our understanding of the natural world. She is an entomologist studying the complex societies, behaviours and phenotypes of social wasps. [She] performed the first field test of kin selection, demonstrating that such selection was not based on high degrees of relatedness, thus reconceiving the evolution of sociality. … Her work has led to advances in developmental plasticity and evolution; her work with alternative phenotypes has shown that plasticity can lead to novel traits and then to genetic divergence and speciation."

WHAT WE'RE UP AGAINST
Advice from the Peanut Gallery

As Iowa State University prepared to launch a new bachelor of science in climate science degree in the fall of 2022, Nancy Boettger, a member of Iowa's Board of Regents, which oversees the state's three public universities, observed that "Climate change is a very politically charged topic," and urged administrators to "go the extra mile to protect freedom of speech or opinions that differ on this politically charged topic." Boettger offered to share "non-PC" materials about climate change with the university, although she admitted she hadn't "studied them a lot." The materials later reportedly proved to be two booklets published by the climate-change-denying Heartland Institute. The Cedar Rapids *Gazette* noted that the Heartland Institute "has drawn vocal criticism, including from the National Center for Science Education," and quoted a few sentences from NCSE's response to the Heartland Institute's 2017 mailing of unsolicited climate change material to teachers across the country.

—*GLENN BRANCH*

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.ngo.

CALIFORNIA

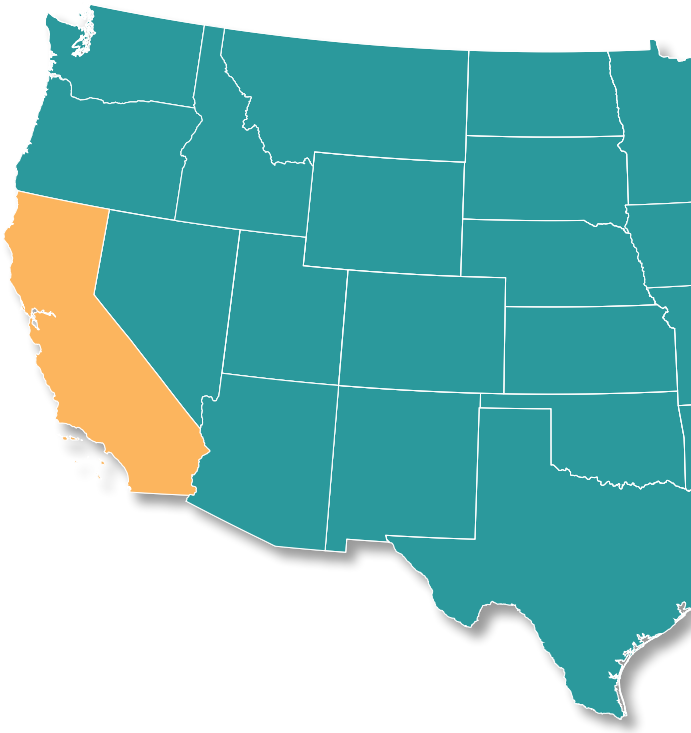
California's Assembly Bill 1939, introduced on February 10, 2022, would, if enacted, have required the California course of study to emphasize the causes and effects of climate change as soon as possible, no later than the 2023–2024 school year. Additionally, starting with the 2027–2028 school year, at least one of the two science courses required for graduation from high school would have been required to include material on the causes and effects of climate change. The latter provision was removed from the bill before it passed the Assembly on May 5, 2022. The bill subsequently died in the Senate Education Committee on July 1, 2022, when a deadline for bills to pass committee expired. The bill was introduced by Luz Rivas (D–District 39), Lisa Calderon (D–District 57), and Chris Ward (D–District 78); seven of their colleagues in the House and four of their colleagues in the Senate are listed as coauthors. In 2020, as NCSE previously reported, Rivas was the sole sponsor of the similar Assembly Bill 1922, which eventually died in committee.

NEW YORK

When the 2021–2022 session of the New York legislature ended on June 2, 2022, no fewer than eight climate change education bills died in committee.

- Assembly Bill 617 and Senate Bill 4683 would have established a climate change education grant program "to award grants to eligible applicants to support climate change education grant programs for young people or to provide optional teacher training or professional development programs relevant to the advance of climate change literacy in young people."
- Senate Bill 596 would have required the state commissioner of education to offer "recommendations to the board of regents relating to the adoption of instruction in climate science in senior high schools," including "the effect and impact of greenhouse gasses" and New York's commitment to reducing greenhouse gas emissions.
- Senate Bill 654 would have required the state commissioner of education to "create and require climate change instruction within the current established science curriculum" for grades one through twelve of New York's public schools. Correspondingly, school authorities would have been required to support the instruction.
- Assembly Bill 2325 and Senate Bill 1081 would have required the state commissioner of education to "establish a model environmental curriculum on climate change to be taught in all public elementary and secondary schools," included in the standards of instruction for not only science but also history, social studies, health, and mathematics.
- Assembly Bill 3468 would have required the state commissioner of education to "create and establish a comprehensive and accurate climate change and sustainability curriculum which shall be taught in grades kindergarten through twelve in all public and charter schools." Local districts would have been expected to use the curriculum or a substantially similar curriculum.
- Senate Bill 4781 would have required the state commissioner of education to "make recommendations to the board of regents relating to adjusting curricula for social studies, economics, geography, and government classes in New York schools to include requirements for climate change education."

At the end of the 2019–2020 legislative session, five climate change education bills introduced in the New York legislature likewise died in committee.



INDIA

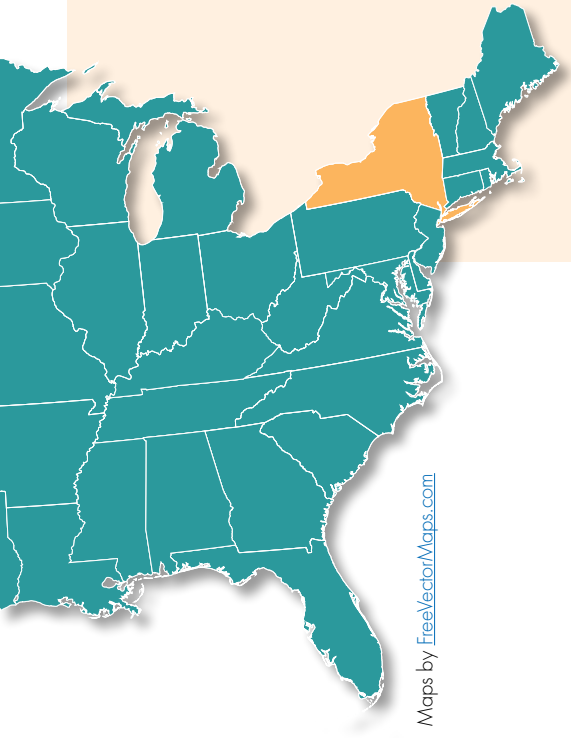
A decision to remove climate change material from the Indian national curriculum and model textbooks was reversed in July 2022 owing to protests from teachers. The National Council of Educational Research and Training had announced the removal of a chapter on the greenhouse effect from the class 11 geography syllabus, information about the Indian monsoon from the grade 9 syllabus, and a chapter on weather, climate, weather systems, and water from the class 7 syllabus, ostensibly in order to trim the curriculum to accommodate the disruptions caused by the COVID-19 pandemic. A group called Teachers Against the Climate Crisis urged NCERT to reconsider its decision, writing, "Students need to understand the complexity of the climate crisis if they are to respond and engage intelligently with it. In recent years, this engagement has typically begun in the classroom. It is essential therefore that schools continue to present students ... with information about climate change and related issues that is accurate, up-to-date, rational, and relevant." The minister of education, Dharmendra Pradhan, subsequently announced that the removed material would be restored.

UNITED KINGDOM, NORTHERN IRELAND

A museum in Belfast was forced to reply to a vexatious demand apparently from a foe of evolution. After a February 2022 freedom-of-information request for "the empirical evidence and hard science used to support the … endorsement of the origins of the human species and the evolution of life" on the part of the Ulster Museum was unanswered, the Information Commissioner's Office issued a decision ruling that the National Museums Northern Ireland, of which the Ulster Museum is a member, was not in compliance and required it to respond to the request within 35 days. Failure could be considered contempt of court. The decision was issued on July 26, 2022; asked by the Sunday Independent whether a response had been supplied, the museum offered no comment. Within a week, however, it was reported that the museum complied with the request.

UNITED KINGDOM

A climate education bill that would require "matters relating to climate change and sustainability to be integrated throughout the curriculum in primary and secondary schools and included in vocational training courses," introduced in Parliament on November 23, 2021, by Nadia Whittome (Labour–Nottingham East), died before receiving a second reading in the House of Commons. According to the BBC, although children study climate change in-depth in geography and science courses, the 18-year-old campaigner Scarlett Westbrook, who drafted the bill, argued that climate change is "about people, it's about economics, politics, history and arts—and we need to learn that too."



Maps by FreeVectorMaps.com

NCSE Executive Director Ann Reid was elected as a Fellow of the American Association for the Advancement of Science, as announced in a January 31, 2023, press release, in recognition of her "distinguished work in promoting the public understanding of science and in defending the integrity of science education." Becoming a AAAS Fellow is among the highest distinctions in the scientific community.

Adam Laats

Adam Laats is Professor of Education and History at Binghamton University (SUNY) and a recipient of NCSE's Friend of Darwin award for 2022. His books include *Creationism USA*, published by Oxford University Press in 2020 (and reviewed in *RNCSE* 2021; 41:4), and *Fundamentalist U: Keeping the Faith in American Higher Education*, published by Oxford University Press in 2018. The interview has been edited for length and clarity.

Glenn Branch: You taught in middle and high schools for a decade before entering academia. How have your experiences as a teacher influenced your scholarly work?

Adam Laats: My work as a classroom teacher had a decisive influence on my historical research. In both my Master of Arts in Teaching degree—to begin teaching—and my PhD work, I read a lot about progressive ideas in education. But when I began teaching, in St. Louis and Milwaukee, it seemed pretty obvious that real-world schools tended to be fairly conservative places. It wasn't just in one school or one community, but in lots of schools, lots of places. I don't mean "conservative" necessarily in a partisan or ideological sense, but in terms of what they taught and how they taught it. I wanted to know why.

GB: Your research is focused on religiously and politically conservative campaigns to reform public education. How did you become interested in these campaigns?

AL: I'm not from any kind of religious or conservative background. And in fact, my core interest is not in conservatism itself, but rather in the big questions about school: Who decides what goes on in public schools? How is it decided? How can we make schools "better" if we can't agree on what is "good"? When I started my graduate work in history at the University of Wisconsin 20 years ago, it quickly became clear to me that the existing studies were lopsided. We knew a lot about one side of school culture wars, historically, but very little about the other. So I set out to find out more about what conservatives have thought and done about schools in the USA.

GB: You've written two and a half books just on creationism. Have you received any notable feedback from creationists?

AL: I'm optimistic about our creationism culture wars, and my email inbox is one of the reasons why. Over the years, I have received so much email from ardent creationists that I created a separate "cre-mail" folder to hold it. Almost without exception, the correspondence has been extremely polite, even friendly, in spite of the fact that the writers had a strong disagreement with something I'd said about creationism. For the most part, the people who take the time to write to me want to explain their vision of creationism to me. And for the most part, their explanations help solidify my opinion that our fights about creationism are not really about science or theology themselves. Because the arguments I receive—the ones that lay out a careful biblical case for creationism—have absolutely no chance to convert me or convince me. It's a two-way street: while no argument from biblical principles will convince me, in most cases no argument from mainstream science will convince them. In the end, in my opinion, this is further evidence that the conflicts over creationism will not be resolved in the obvious way, that is, by one side convincing the other to accept mainstream science or creationism. Rather, the fights are instead often two different sides simply speaking past one another. Recognizing this discrepancy is the first step

toward seeking a middle ground that can support the teaching of evolution.

GB: You've devoted a lot of effort to writing for the public, with op-eds and commentaries in venues like* The Washington Post. *Why is it so important for the public to understand past controversies over public education?

AL: It's not only that those who don't know the past are doomed to repeat it. I think it is far more important and straightforward than that. Today's fights over public schools—about issues such as Critical Race Theory, LGBTQ+-friendly books, and anti-COVID-19 measures—only make sense as the latest outbreak of a chronic condition. Here's the analogy that works for me: Public schools are America's family dinner table, and the fights that periodically erupt there are episodes of long-running resentments and disagreements about what schools should be doing. If we don't discuss current battles in context, they will be almost impossible to understand, just as we can't understand family feuds without knowing the full backstory.

GB: What's your next project?

AL: The question that drives my work is this: Who decides what schools will do? For a full century, now, in my opinion, the battles over creationism and evolution education have been the best way to understand America's profound disagreement about what America means and what students need to know about it. But long before the 1920s, public schools were born in conflict. In the first decades of the 1800s, two very different visions of "public education" confronted one another in America's cities. Elites wanted to create two tracks of schools. "Public schools," in their vision, would be tuition-free schools for poor children. White and Black, boy and girl, the hope of elite reformers in the early 1800s was to get every American child into a school—a "public" school. But children themselves had different ideas. Low-income children and their families refused to accept schools only for the poor. They thought "public" schools should instead be for the entire public. Their push for a unified kind of public education wasn't wholly laudable or wholly modern. White activists always meant only the entire white public, even as Black pundits fought for truly integrated public schools. The movement that captured and eventually resolved this tension was the Lancasterian crusade, named for a narcissistic, abusive, deluded London reformer named Joseph Lancaster. I'm trying to figure out the mystery at the heart of the story. Namely, how did a woeful school-reform failure end up becoming a dramatic success? How did the flop of the Lancasterian movement become the birth of modern public-school systems?

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CHEWING ON CHANGE: THE TALES TEETH TELL US

Wombat-like animals the size of a rhinoceros. Dire wolves. Sabertooth cats. Giant kangaroos. These were just some of the marvelous megafauna Larisa DeSantis, a vertebrate paleontologist at Vanderbilt University, discussed as part of a recent NCSE and National Association of Biology Teachers online event entitled "Chewing on Change: The Tales Teeth Tell Us." (For more on DeSantis, see p. 3)

Held in honor of Darwin Day 2023, which commemorates the birth of naturalist Charles Darwin, the event was a reprise, and then some, of a face-to-face talk given by DeSantis at the NABT conference in November 2022 as part of the annual NCSE-sponsored Evolution Symposium.

DeSantis, who leads the DREAM Lab at Vanderbilt University, uses paleontology to investigate how mammalian communities have evolved over time in response to climate change throughout the world. Her talk featured information about how modern methods can yield a better understanding of the dietary behavior of dire wolves, American lions, and sabertooth cats, and also of why these animals went extinct. She also spoke about the evolution of marsupial predators, suggesting that understanding how these organisms lived and died can help us to better conserve extant predator species.

Accompanying both the conference symposium and online event was an education session facilitated by NCSE Teacher Ambassador Jennifer Broo and NCSE Director of Teacher Support Lin Andrews.

In their session, Broo and Andrews shared the lesson set Broo developed for NCSE: Good is Good Enough?. This lesson set uses a technique called NGSS storylining to help students explore the evolutionary history of the horse, using the variation between modern and extinct species of horses as an anchoring phenomenon. Broo explained the lesson set helps students to realize that populations, not individuals, change over time, helping to overturn the misconception of evolution as proceeding in a linear fashion.

Evolution Symposium at the NABT Conference

As for the past three years, the Darwin Day event had its roots in the NABT face-to-face conference. In November 2022, as DeSantis and Broo presented their Evolution Symposium talks in person, teachers had the opportunity to engage in the different hands-on activities included in the Good is Good Enough? lesson set. Whether teachers attended the symposium in person or virtually, they learned not only about ongoing research in the field of evolution but also about connected resources for teachers.

NCSE is committed to the continuing education of science teachers, and participating in events such as the annual Darwin Day webinar is a key part of that commitment.

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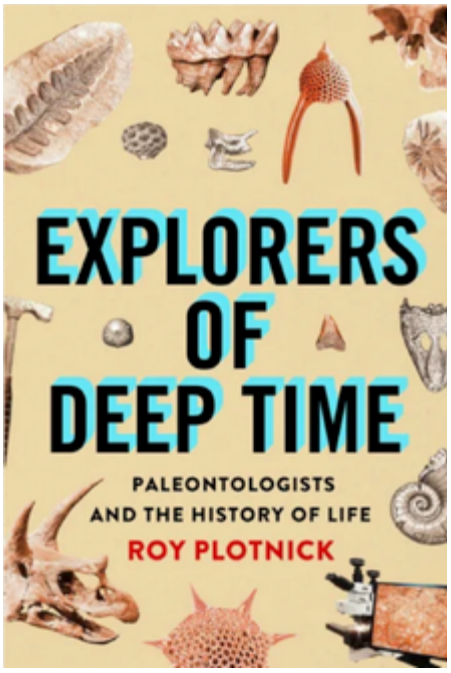


Explorers of Deep Time: Paleontologists and the History of Life

author: Roy Plotnick
publisher: Columbia University Press, 2022
reviewed by: Christine Janis

Explorers of Deep Time is an informative, entertaining, and charming book by Roy Plotnick, a doyen of North American paleontology. The book explains and reveals the practice of paleontology—a multidimensional and eclectic discipline, far from the archaic popular notion of just fossil collecting—and introduces many of today's paleontologists, around half of whom featured here are women.

There are a lot of personal stories in this book, but no ego parading: as Plotnick titles one of his chapters, "I'm Not Ross (or Indiana Jones)." In his recounting, Plotnick not only covers paleontology's current successes but also provides a glimpse into how much the science has changed over the past half century: "Paleontologists have more fun than other scientists!" This sense of fun, wonder, and a life in science well-spent pervades the book, which is in general well-written and easy to read.

Plotnick not only covers paleontology's current successes but also provides a glimpse into how much the science has changed over the past half century.

The book is divided into four sections. Section I, "Deep Time," provides a broad overview of the nature and importance of paleontology today. Only paleontology can pose the "best questions" as to what has happened over the course of Earth's history. Also considered are the different types of scientific disciplines involving paleontology (geobiology, molecular paleontology, etc.), and the opportunities for paleontological employment today (which include museums and government agencies as well as academic departments).

Section II, "Exploring Deep Time," showcases the discipline of paleontology today and discusses how things have changed over the past half century. We are told about the joys of fieldwork (and the contribution of new inventions like GPS), and the importance of museums for both educating the public and providing scientific resources for researchers. We then discover how the tools of paleontology have changed from a field hammer and a pair of calipers to today's panoply of high-tech equipment for visualizing materials and statistical techniques for analyzing data. The "Paleobiological Revolution" of the late twentieth century is described, with the advent of online databases and personal computers to access them and analyze data. A consider-

ation of the "Big Five" extinctions in Earth's history concludes with the importance of the new field of conservation paleontology in helping prevent a sixth extinction. Finally, the importance of studying living animals for understanding extinct ones is addressed, considering issues such as phylogenetics and biomechanics.

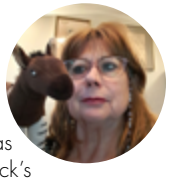
Section III, "Explorers of Deep Time," addresses various stages in the life of a paleontologist, from picking undergraduate studies and graduate advisors, through doing a post-doc and obtaining a more permanent position (including the stresses of getting tenure if employed as an academic), to the issues of publishing in journals, the joys and expenses of attending scientific conferences, and the frustration trying to obtain grants. While paleontology is still not highly ethnically diverse, over the past half century the field has progressed from containing very few women to now approaching 50% (but still mostly at junior levels).

Plotnick recounts a tale from a colleague when she was a graduate student at Harvard in the 1970s, facing the hostile environment of walls of a male students' office plastered with *Playboy* pinups. But sometimes "girls" fight back: one morning, the students found those pinups replaced with similar pictures of naked men from *Blueboy* magazine. Almost 50 years later the truth can now be told—that was my doing.

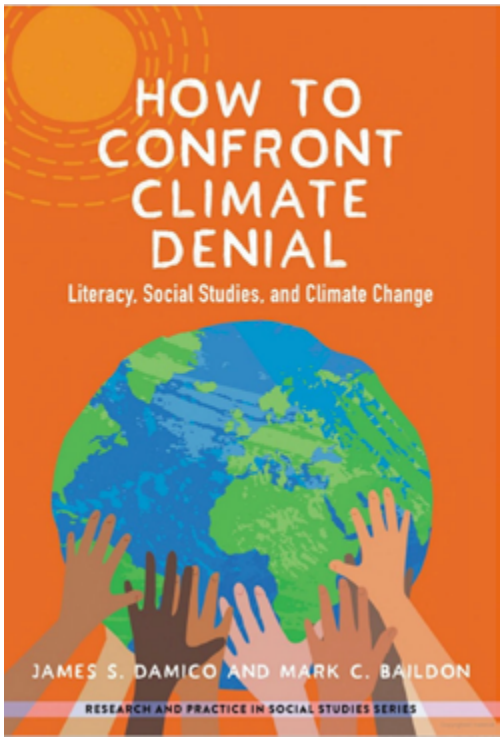
Section IV, "Deep Time and the Broad World," covers various relevant topics not yet considered: the issue of commercial collection of fossils and collectors' conflicts with scientists; the importance of amateur and avocational paleontologists; education and outreach, and how paleontology can be a great hook for STEM subjects; controversies between evolution and creationism (now extending to climate science), including the role of NCSE in these battles; the importance of artwork, both for scientific illustration and for popular reconstructions of extinct animals; and, penultimately, a consideration of paleontology and paleontologists outside the United States. The final chapter, "SWOT-ing at Paleontology," sums up by considering the Strengths, Weaknesses, Opportunities, and Threats of the field, pleading for the diverse paleontological community to present a united front to address these issues.

While I greatly enjoyed this excellent book, I was a little concerned about the lack of coverage of vertebrates apart from dinosaurs (and then, mainly issues of dinosaur popularity). For example, in the discussion of Australian paleontology there is no mention of the amazing Miocene ecosystems (mainly vertebrates) preserved at Riversleigh World Heritage Area.

I see the book's lasting value as a historical treatise of change in science over the past half century, but maybe that's because it echoes my own history and experiences! It would certainly be a most interesting book for anybody wanting to know about the science, perhaps especially for students who are thinking of entering the field, since overall it emphasizes the fun and collegiality of the world of paleontology as well as its trials and tribulations.



Christine Janis is a vertebrate paleontologist of similar vintage to Roy Plotnick. Originally from England, she spent most of her career in the United States, and was also married (second wife) to Plotnick's doctoral advisor, Jack Sepkoski. She's now back in the UK as an Honorary Professor at the University of Bristol, doing her best to be retired. She is the proud owner of the only *Hypohippus* (a browsing equid from about 15 million years ago) plush toy in existence. christine_janis@brown.edu



Climate science and climate change are inextricably intertwined, but teaching about climate change involves much more than teaching about the science. When confronted by denial, science teachers can point to the scientific data, but they are often not well-equipped to go beyond the evidence to address the social and psychological reasons that denial persists despite evidence to the contrary. Social studies classes offer a space for teaching about where denial comes from and how to address denialist claims. Two issues have delayed a systematic effort to address climate change denial within social studies classes, however: the lack of clear social studies standards for climate change, such as were made available to science teachers though the Next Generation Science Standards, and a lack of a clear justification for why climate change denial is a subject in its own right for the social sciences to deal with explicitly.

How to Confront Climate Denial: Literacy, Social Studies, and Climate Change

authors: James S. Damico and Mark C. Baildon

publisher: Teachers College Press

reviewed by: Brad Hoge

James Damico and Mark Baildon tackle both issues head-on in *How to Confront Climate Denial: Literacy, Social Studies, and Climate Change*. This book is intended primarily for high school social studies teachers. It provides an exhaustive argument that addressing climate change denial is not only a pressing social issue but also integral to a strong social studies curriculum. In addition, it presents a clear case for the immediacy of the need to include a treatment of climate change denial into the social studies curriculum of secondary classrooms, even offering a structure and examples for doing so.

The first half of the book makes the case for a social studies-specific approach to combating climate denial. It builds this case on three premises. First, that climate denial permeates society through propaganda driven by historical, societal, and corporate identities; thus it is a societal problem rather than a scientific one. Damico and Baildon describe these social identities as "stories we live by." Originating from our connections to place, communities, and purpose, these stories become propaganda when twisted to serve purposes contrary to our best interests. Second, that such propaganda utilizes logical and rhetorical fallacies to connect false identities to the stories we adopt as we form our sense of self. Third, that these fallacies feed political engines that force us to take sides in the face of overwhelming complexity of information.

Damico and Baildon show how these dynamics work, analyzing them within the FLICC model of science denial (fake experts, logical fallacies, impossible expectations, cherry picking, conspiracy theories) developed by John Cook. They effectively show how these strategies are used by both industry and politicians by citing numerous sources including the writings of Michael Mann, NCSE's Glenn Branch, Naomi Oreskes, Robin Kimmerer, and Katharine Hayhoe, in addition to Cook. They also show, in chapters 4 and 5, how climate denial propaganda is amplified by uncritical media, seeking to present "both sides of the argument" to ensure fairness. Their thorough treatment clearly demonstrates the ways that science denial techniques are used in propaganda, leading people to confuse dysfunctional stories to live by with their identities, cementing misconceptions into political affiliations.

How to Confront Climate Denial *provides a convincing case for the need of a new approach to teaching social studies to combat climate denialism.*

Readers looking for effective curricular strategies may feel that too much of the book is spent in analyzing climate denial propaganda. But the depth and detail are important to provide full context for social studies teachers, who may not have been embroiled in climate denialism and may still harbor skepticism of the full impact of the propaganda.

Damico and Baildon's careful explanation for the need for new curricula guides the reader comfortably into strategies for solutions. These strategies are presented in two stages. First, they recommend, students should be taught not only how to read texts critically, but also to approach critical reading from multiple vantage points, using each to pull the others into more demanding critiques that expose denial strategies, what they call "agnostic encounters." Second, they recommend helping students to build new stories to live by that honor critical thinking through dialogue and agreement developed through the process of reflective reasoning. Damico and Baildon explain this two-stage process using the structure of the curriculum, the arguments supporting its construction, and examples that demonstrate various ways the process could unfold.

Overall, *How to Confront Climate Denial* provides a convincing case for the need of a new approach to teaching social studies to combat climate denialism and a sound approach for doing so in social studies classrooms.

Brad Hoge is a high school science teacher in San Mateo, California, and NCSE's former Director of Teacher Support. bhoge@nuevaschool.org

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