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GUEST EDITORIAL

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Déjà Vu All Over Again: Climate as a Second Front for Biology Teachers

What is accepted by the scientific community on the basis of overwhelming evidence, yet opposed by a vocal minority on ideological grounds, and therefore the target of attempts to undermine its presentation in the science classrooms of the public schools? If your answer was *evolution*, help yourself to a gold star. After all, in the 90 years since the Scopes Trial, the teaching of evolution has been the leading source of controversy in American science education. But if your answer was *anthropogenic climate change*, you, too, can give yourself a gold star. Like evolution, anthropogenic (human-caused) climate change offers challenges – but also opportunities – to biology teachers.

The facts are clear. Global temperature has increased rapidly and significantly over the past 150 years, and human activity, especially the burning of fossil fuels, has been, and is, a major cause of the rise in temperature. The resulting changes to the climate will have (indeed are already having) disruptive – potentially disastrous – effects on human societies and the natural world. The multiple, independent, and converging lines of evidence for anthropogenic climate change have been acknowledged as convincing by the scientific community, including the National Academy of Sciences and the Royal Society (2014) and the American Association for the Advancement of Science (AAAS, 2014).

Owing to the disruptive, widespread, and interconnected effects of the rise in global temperature, climate science is increasingly acknowledged as not only scientifically but also practically important, with consequences for public health, economic development, and global politics. Correspondingly, after decades of neglect, climate science is increasingly prominent in science education in the United States. The *Next Generation Science Standards* (NGSS), for example, present global climate change as one of four sub-ideas in the core idea of Earth and Human Activity in earth and space sciences at both the middle school and high school levels (NGSS Lead States, 2013).

But a backlash against the inclusion of climate science – and anthropogenic climate change in particular – in the science classroom is under way. For example, when West Virginia became the thirteenth state to adopt the NGSS in December 2014, it was discovered that beforehand a member of the state board of education successfully called for changes that downplayed climate change (Quinn, 2014). Nationally, according to a survey of 555 K–12 teachers who teach climate change, 36% were pressured to teach "both sides" of a supposed scientific controversy, and 5% were required to do so (Johnson & Holzer, 2011).

Systemic considerations as well as ideological opposition stand in the way of teaching climate change. Climate science is not yet ensconced in the American science education system. In high school, the typical science progression is still frequently a march from biology through chemistry to physics, with a comparative neglect of earth, atmospheric, and ocean sciences. Evidence of the neglect is provided by Parker et al. (2015), who find that, with regard to knowledge of the carbon-transforming processes central to climate science, "only 10% of high school students typically have a level of understanding commensurate with that called for" by the NGSS.

As a result, biology teachers themselves often feel unprepared to teach about climate change. They often have not had the chance to learn the relevant science or assimilate the relevant pedagogy, which have been historically neglected in both preservice teacher education and in-service professional development. Yet the onus of preparing today's young people to join a society facing a rapidly changing climate falls on these teachers. Students who pursue higher education will have further chances, but for the half of all students who do not, high school biology is likely to be the last best hope they have of learning about climate change in a formal learning environment.

Incorporating climate change within a crowded biology curriculum is a challenge, to be sure, but it is not insurmountable. The biology classroom abounds in opportunities – from agriculture to zoology – to present climate science. Scientific resources on climate change are increasingly available, as are pedagogical resources that present innovative approaches to overcoming the distinctive obstacles to effective teaching about climate change. (Mark McCaffrey's recent *Climate Smart & Energy Wise* [2014] offers a useful review.) And the lessons learned from teaching evolution in the face of creationism are often applicable in teaching climate change in the face of climate change denial.

True, the motivations behind these two forms of science denial are different: creationism is driven largely by religious fundamentalism, whereas climate change denial is motivated largely by economic interests and political ideology. But the rhetorical strategies are eerily similar. The three pillars of science denial – questioning the science as shaky, just a theory, controversial; challenging the science as driven by radical ideological motivations and leading to undesirable social consequences; and appealing to fairness to argue that the (supposed) controversy over the science deserves to be aired in the science classroom – clearly support the edifices of climate change denial and creationism alike.

So it is helpful in teaching climate change, as with evolution, for biology teachers to impart a solid understanding of the nature of science as a preliminary, so that students will understand and appreciate the significance of the scientific consensus.

Carter and Wiles (2014) report findings supporting "the hypothesis that a better understanding of the modern model of science may lead to changes in attitudes towards politically contentious ideas that are not scientifically contentious," including evolution and anthropogenic climate change. A variety of sources – including Bramschreiber and Westmoreland (2015) – provide classroom exercises aimed at facilitating such changes.

Similarly, in considering ways of teaching climate change, as with evolution, it is important for biology teachers to resist any pressure – or temptation – to present what is in fact a matter of scientific consensus as a topic of current scientific debate. Anthropogenic climate change and evolution, as we have emphasized elsewhere (Berbeco et al., 2014), "are politically or religiously controversial, provoking headlines and arousing passions. But they are not scientifically controversial." To repeat our admonition, "Misrepresenting a socially controversial scientific topic as scientifically controversial is committing the deadliest sin in science education: misrepresenting the science."

In wanting to teach anthropogenic climate change in a scientifically accurate and pedagogically appropriate way in your biology classroom, you are not alone. As with evolution, scientific organizations around the world and science education associations across the country are unequivocally on your side (and the National Center for Science Education stands ready to assist, especially if you encounter resistance). And you'll be on the side of the future. According to a recent survey (Leiserowitz et al., 2011), no less than 70% of American teens want to know more about climate change. Biology teachers should be ready, willing, and able to help.

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