

Teaching about Evolution: Old Controversy, New Challenges

BY RODGER W. BYBEE

Receiving the first Education Award of the American Institute of Biological Sciences bestows a great honor on me. On this occasion I wish to extend my personal and professional gratitude. Beyond personal and professional recognition, this award from AIBS also brings honor and recognition to the Biological Sciences Curriculum Study (BSCS) and to the entire community of biology educators.

If it were not for BSCS I likely would not be receiving this award. More important, if it were not for AIBS, BSCS would not have had a major influence on biology education. It seems appropriate at this presentation of the first AIBS Education Award to make a few comments about biology education, in particular about the historical relationship between AIBS and BSCS, the old controversies about teaching evolution, and the new challenges to maintaining the integrity of science in education.

AIBS and the Biological Sciences Curriculum Study

The Biological Sciences Curriculum Study has a long and distinguished place in biology education. In more than four decades of work, the BSCS has had an unquestionable impact on American education. To date, domestic sales of the eight editions of *BSCS Green Version* total more than 2.6 million copies (the ninth edition will be released in 2002), with the seven editions of *BSCS Blue Version* at approximately 1.5 million (the eighth edition was published in the fall of 2000). *BSCS Yellow Version*, now out of print, sold more than 2 million copies. BSCS programs have been adapted in 25 different languages for use in more than 60 countries. Since its beginning, an estimated 20 million students have used BSCS biology curricula. This does not include other BSCS curricula for elementary, middle, and high schools and for college. Most would agree that this is a remarkable accomplishment, especially when one considers that producing *innovative* curriculum materials has been a central part of our mission. All of this would not have happened if it were not for the American Institute of Biological Sciences. Indeed, the origins of BSCS are clearly located in the history of AIBS.



RODGER W. BYBEE IS EXECUTIVE
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CURRICULUM STUDY

Two years before Sputnik, in 1955, AIBS established a Committee on Education and Recruitment. By 1956 a group of distinguished biologists on the education committee identified the need to reform high school biology. At the time, Bentley Glass was AIBS president, Hiden Cox was AIBS executive director, and Oswald Tippo was chair of the education committee. Discussion continued until the committee decided to establish a curriculum project. Arnold Grobman agreed to be the first director of BSCS. The year was 1958. Late in the same year AIBS received an initial grant from the National Science Foundation (NSF). The grant was for \$143,000. In January 1959 the University of Colorado at Boulder became the first home of BSCS.

In the late 1950s approximately 80 percent of high school students took biology. For each chemistry student, two took biology, and for each physics student, four took biology. For the majority of the American population the only science course ever taken was high school biology. The leading biology textbooks in the 1950s had scarcely changed since the early 1900s. Noticeably absent were discussions of evolution and

other topics such as human reproduction. One could not even find the word *evolution* in high school biology books. Such was the commercial and educational response to the Scopes trial. There is an interesting story about this in the history of BSCS. In Arnold Grobman's 1969 book *The Changing Classroom*, he comments that "at the early meetings of the BSCS Steering Committee, the question of whether evolution should be included in the BSCS courses was not discussed. It obviously was assumed by everyone present that evolution would be a major constituent of the BSCS course of study" (p. 204). After the preliminary editions were published, one member of the Steering Committee expressed an especially critical view. During a discussion of the proposed textbooks, Nobel prize winner H. J. Muller stood up, pounded the fist of one hand into the other and shouted, "One hundred years without evolution in our schools is enough." Let me review the history and context for such a remark from this noted biologist and the response by BSCS.

An old controversy: Evolution in the biology curriculum

In the early 20th century, American education witnessed the transition from single courses such as physiology, botany, and zoology to what we now recognize as general biology (Hurd 1961, Mayer 1986). This transition was assisted by a course of study developed in 1899 by the New York Board of Regents, but the appearance in 1907 of a textbook entitled *Elements of Biology* by George W. Hunter really situated biology in school science programs. Until the mid-1920s, evolution was "an established element within an otherwise innocuous life-science curriculum" (Pauly 1991, p. 663).

Although conflicts with creationists began when Darwin published *On the Origin of Species* in 1859, the Scopes trial seems a turning point for the controversy in American education. In 1925 students in Dayton, Tennessee, used *A Civic Biology*, another textbook authored by George W. Hunter. Four pages (out of 432) from that text provided the basis for the Scopes indictment and trial. To be clear, in the mid-1920s evolutionary facts and presentations were a minor element in biology education. In comparison, evolution had a much more prominent place in earlier courses on physiology, botany, and zoology (Pauly 1991). After the controversy surrounding the Scopes trial, the place of evolution in biology textbooks continued at a low, almost nonexistent level until the 1960s (Skoog 1979).

Evolution teaching was only a minor portion of textbooks—it antagonized certain vocal elements of the public, the facts and theory were historical, and most of the substance was geological. Thus compromise and omission seemed easy. From a teacher's perspective, it is easy to imagine that an evolutionary perspective could be downplayed while still teaching biology and nurturing high school biology as a part of American public education.

In his 1997 Pulitzer Prize-winning book, *Summer for the Gods: The Scopes Trial and America's Continuing Debate over Science and Religion*, Edward J. Larson explains how Cold

War fears that the United States had fallen behind the Soviet Union in technology helped change the role of science in American education. In 1958, Congress passed the National Defense Education Act, which poured money into science education, encouraging the National Science Foundation to fund the development of state-of-the-art science textbooks. "Freed from market considerations, a team of scientists and educators working under the auspices of the Biological Sciences Curriculum Study (BSCS) produced a series of new high school biology texts that stressed evolutionary concepts. Commercial publishers rushed to keep pace. Despite scattered protests by fundamentalists, school districts throughout the country adopted the BSCS textbooks—even in the three southern states with antievolution laws" (Larson 1997, p. 249).

It is in no sense an overstatement to say that the Biological Sciences Curriculum Study assumed responsibility for putting evolution back into high school biology. Larson's observation is supported by Robert Pennock in his 1999 book *Tower of Babel: The Evidence against the New Creationism*. Prior to publication of the three BSCS versions, the word *evolution* was not mentioned in high school biology textbooks. Although the textbooks might present underlying ideas such as change, organic development, or systematic presentation of phyla, evolution was not in any way a major theme. BSCS established "Change of Living Things through Time: Evolution" as the first of eight major themes for its programs (Mayer 1978). This theme was reaffirmed by BSCS in its 1993 publication *Developing Biological Literacy*. In addition to discussions of evolution in the three BSCS high school versions, BSCS produced a separate program in 1992, *Evolution: Inquiries into Biology and Earth Science*, with an accompanying videodisc. The newest program for high school biology, *BSCS Biology: A Human Approach* (1998), begins with chapters on evolution and emphasizes that theme throughout the book.

For over 40 years, BSCS has supported the issue of teaching about biological evolution. Thousands of BSCS teachers have had the courage to take a stand and continually counter attacks by creationists. In a very real sense, past directors of BSCS—Arnold Grobman, William Mayer, Jack Carter, Joseph McInerney—have maintained the integrity of science as creationists engage in disputes through textbook publishing, school programs, and public policies.

Wrestling Proteus to teach about evolution

Biologists recognize *proteus* as the species name for amoeba. Proteus, in Greek mythology, was a sea god who could change his form at will. He also possessed knowledge of the future, and, in order to obtain that knowledge, one had to wrestle with Proteus until his metamorphosis ceased. I am often reminded of that Greek myth because conflicts with creationists have continuously taken various forms, and one can predict they will persist because their protean changes have not ceased, and most likely will not.

The protean forms creationists have taken include state laws banning evolution, requirements to teach creationist science, equal time for creationism and evolution, disclaimers in textbooks, standards and assessments that omit evolution, laws that forbid purchase of instructional materials that present as factual information which has been proven false, and, most recently, intelligent design. Indeed, Proteus has many forms.

Although the forms of creationism have varied, the goal is always clear—the creationists wish to exclude evolution and to include their religious views in school science programs. This turns out to be a struggle over control of the science curriculum. Actions in Kansas, Oklahoma, Pennsylvania, Arkansas, Michigan, and Kentucky suggest that the controversy continues.

One of the newest challenges comes from Arkansas and takes the form of a House Bill that “would make it illegal for the state or any of its agencies to use state funds to purchase materials that contain false or fraudulent claims.” Although the bill failed, it would have barred the topic of evolution along with other topics such as radiometric dating and index fossils. This bill had as its justification the very processes of science—namely, that scientific methods attempt “to falsify ongoing or prior scientific work to ensure the validity and integrity of results.”

In Michigan, another proposed bill would prohibit standards from including “attitudes, beliefs, or value systems that are not essential in the legal, economic, and social structure of our society and to the personal and social responsibility of citizens in our society.” We have not wrestled Proteus to a final solution.

I simply have to question the capability, integrity, and ability of states to serve the educational interests of students, science teachers, and science when we see such political decisions. In assessing the current situation for teaching about evolution, one has to conclude that at the state and local levels, our wrestling match is continuing, often without a referee. A recent study found that in state science standards there is a regional tendency to ignore, lightly address, or euphemistically refer to the theory of evolution in standards documents (Lerner 1998). Such examples indicate a clear, and in my view compelling, need for use of the *National Science Education Standards* (NRC 1995) as the organizing content for state and local standards and assessments. The continuing struggle also signals the need for scientific organizations and scientists to become involved as advocates, resources, and partners with biology teachers, school districts, and state departments of education.

In a study of science teachers, Jeffrey Weld and Jill McNew (1999) found that the factors most strongly associated with teaching evolution in their classes were course work and independent study in the nature of philosophy and science, membership in a national organization, and use of the *National Science Education Standards* as a guide for their practice. Indeed, the *Standards* include content on evolution and the nature of science and provide guidance for all of us in the science education community.

New challenges

One of my major concerns (and point of departure for suggesting a new approach in this conflict) centers on the continuous misconceptions associated with terms and phrases such as “far from being proven scientifically,” “scientific evidence,” “teach evolution as a theory and not a fact,” and “evolution is just a theory.” Such misconceptions about science clarify the need for a biology education that includes developing an understanding of such ideas as the methods of inquiry; the role of evidence; the place of critique and skeptical review; the tentative nature of explanations; the connections between the current body of scientific knowledge and proposed explanations; the acceptance, modification, or rejection of alternative explanations; and the explanatory power of models and theories. My concern about this issue is deepened by the research on teachers’ and students’ understanding of the nature of science (Lederman 1992, Scharmann and Harris 1992, Solomon et al. 1996). In short, this research indicates that both teachers and students either lack understanding or have significant misconceptions about the nature of science.

One person, statement, or organization cannot solve all issues associated with those who propose alternatives to science in science classrooms, but one document can provide guidance for the content of school science programs and support for those who encounter the new protean forms of creationists. I am referring to the *National Science Education Standards* (NRC 1995).

There are, I believe, clear and compelling reasons to teach our students about scientific inquiry and the nature of science. And we can do this within the context of biological evolution. In fact, teaching about the nature of science necessitates teaching about theories such as biological evolution—something we do not do well in science education (Lerner 1998). The formulation, testing, and development of theories are among the central and most important activities of the scientific community, and we have every right to teach about the scientific development of a theory such as evolution, but for the most part we do not.

Teaching about the nature of science should be integrated with teaching about evolution. Inquiry and the nature of science are not entities separate from the development of scientific theories. One only has to read books such as *On the Origin of Species by Means of Natural Selection* (Darwin 1859), *One Long Argument* (Mayr 1991), or *Science as a Way of Knowing* (Moore 1993) to see the relationships between the scientific processes and the structure and development of a theory such as biological evolution. Although the view of teaching science presented here may seem an obvious element of education, students are seldom asked to reflect on the nature of current scientific knowledge and the means by which scientists come to know what they do about nature. We can confirm this observation by reviewing almost any commonly used science textbook.

Summary and conclusion

In 1958 AIBS formed the Biological Sciences Curriculum Study, a true and enduring innovation in American education that has set the standard for teaching about evolution. As one of several research-based curriculum groups created by grants from the National Science Foundation, BSCS became a leader in the development of curricula that allowed students to learn science through inquiry.

Among other numerous accomplishments, BSCS literally put evolution back in high school biology textbooks. With time, other commercial publishers included chapters on evolution. The recent AIBS review of high school programs indicates that evolution was present, accurate, and up to date in all of the books reviewed. In fact, some programs had particularly excellent presentations of biological evolution. Such evidence does not assure that leaders will teach the material.

Scientists and educators have expended considerable time and energy on the defensive, debating the highly organized, thoroughly funded, and extraordinarily articulate (if not scientifically accurate) protean positions of creationists. It is time to formulate an additional, offensive strategy, one that emphasizes improved teaching about evolution *and* the nature of science by the majority of biology teachers. The National Academy of Sciences contributed to this new approach when the National Research Council supported work on *Teaching about Evolution and the Nature of Science* (NAS 1998). The intention of this volume was to provide an update for biology teachers and to connect evolution and the nature of science. Philosophically, the document suggests a positive, constructive approach, as opposed to engaging in confrontation and debate over the numerous inconsistencies, logical errors, and scientific misconceptions of creationists. This NAS report signals the scientific community's support for teaching about evolution and the nature of science. Teachers should have the support of scientists, professional organizations of scientists, and those in the science education community as they assume new roles, strategies, and challenges for educating their students and maintaining the integrity of science in education.

I believe it is accurate to say that in the late 1950s most biologists assumed the new challenge of providing not only the best biology course possible but an exemplary science course. As we enter the 21st century, biologists, science educators, and biology teachers continue to have a remarkable opportunity and an extraordinary responsibility. Ours is an age for biology. We should seize this opportunity to strengthen the public's understanding of science in general and evolution in particular.

Just as a new medicine ultimately selects for its own demise, so too must the scientific, educational, and legal communities use various new strategies to counter creationists (AAAS 1996). Proteus will return in another form to continue the struggle. We can expect the conflict between creationists and science to continue and the battles most likely will involve school science programs and personnel. *National Science Education Standards* presents a new opportunity and a

constructive approach to teaching about evolution and the nature of science.

Many biology teachers see the continual confrontations with creationists as a cause for concern, if not outright conflict, between science educators and our detractors. This acknowledged, I encourage a perspective that responds to the conflict in a positive way. Biology educators can use the authority of the standards to support their position in opposition to those who want to introduce pseudo-science in science classrooms. *National Science Education Standards* reaffirms the centrality of evolution in biology. With the standards as a foundation and the support of the scientific community, BSCS intends to combine defending the integrity of science and meeting new challenges through development of innovative science programs, professional development of science teachers, and sustained research on curriculum reform.

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