protein in related species, and newer interpretations such as continental drift and punctuated equilibrium. I then reviewed the Scopes trial of 1925 and spent a considerable amount of time reviewing the Arkansas "balanced treatment" trial of 1981. I had the class read Judge Overton's decision in full as it appeared in the March 1982 issue of the American Biology Teacher. His essay is well written, and I feel it should be considered required reading for anyone looking at this issue today.

My colleague from the religion department provided some important background on the bible scholarship done of the first two chapters of Genesis. The two chapters differ in their authorship, date written, and sequence of creation events. Studies show that several details in the Genesis I account have been borrowed from the older Babylonian creation story.

The library assignments were made during the course. One was a periodical assignment in which students were to compare and contrast four periodicals (Science, Science 85, Scientific American, and Science Digest) with respect to types of articles, departments, intended audiences, degree of technicality, and interest for them. The other library assignment was the individual research project presented in written and oral form toward the end of the semester.

This coming spring I will be teaching the course for the second time. I plan to add a couple of lab experiences to the course and to bring in more current issues and news items regarding science this time. In teaching the course, I have learned a great deal about the history, philosophy, methodology, personalities, and values of science that I had only partially understood and appreciated before. If anyone has additional suggestions for teaching such an interdisciplinary course, I would appreciate hearing the ideas.

**CONFRONTING THE CREATION SCIENCE/EVOLUTION ISSUE IN EDUCATION**

Malcolm P. Levin, Sangamon State University, Springfield, IL

**INTRODUCTION**

Understanding nature and exploring the universe have been cherished values since the beginnings of civilization. Often scientists were first "men of God." In that search for God, they studied the workings of nature and the universe. Today, scientists still seek an understanding of the universe and many still hold strong religious beliefs. Albert Einstein is often noted for his religiosity. When asked "Do you believe in God?" He responded, "Yes." I believe in

Spinoza's God, who reveals himself in the harmony of all being. What I see in nature is a magnificent structure that we can comprehend only very imperfectly and that must fill a thinking person with a feeling of 'humility'. This is a genuinely religious feeling that has nothing to do with mysticism.... My religiosity consists in a humble admiration of the infinitely superior spirit that reveals itself in the little that we, with our weak and transitory understanding can comprehend of reality (Ferris, 1982, p. 38).

In this elegant statement of Einstein's feelings about God and universe we find a
In this paper I will address three aspects of this important controversy. First, I intend to develop the hypothesis and present evidence to show that "creation science" is simply a mechanism devised by Christian fundamentalists to establish control over the thinking of individuals and to inculcate a world view in which all problems reduce to black and white, good and evil. Second, I will examine the impact of the "creation science" movement in my own community. Finally, I will offer suggestions on how we can reverse the scientific ignorance of the general public.

SECTION I

In his book, Exploring New Ethics for Survival, the biologist Garrett Hardin (1973) described a future event in the politics of the United States. In this scenario the political extremists from both the left and the right reach the conclusion that environmentalism is the common enemy and they join ranks to eliminate evil. There are parallels in the creation/evolution debate. I believe that the battle over the legitimacy of "creation science" is just the first step of a coalition of political and religious extremists whose common ground is an ill-defined religious fundamentalism. Their ultimate goal is to establish their world view as a guiding philosophy for, at the very least, the United States. In this instance, the common enemy is evolution because the theory of natural selection proposed by Darwin tangibly marked the beginning of materialism and relativism for the life sciences, especially for man. Consequently, evolution challenged and continues to challenge fundamentalist patterns of behavior. A key element in the opposition to evolution is that theory confronts, at least in the minds of fundamentalists, the special relationship between God and man. To put it in a biblical context, it impugns the notion of dominion over the earth and our creation in God's image. To fundamentalists, the theory of evolution negates a "fixed and knowable" world -- one in which the word of God inevitably leads to heaven, if not heaven on earth.

Evidence for this strong condemnation of fundamentalists and the creation science position comes from a variety of sources. In particular, many of the writings of the creation scientists espouse positions which delineate their values and their world view (Kitcher, 1982, pp. 186-202). Henry Morris, the Director of the Institute for Creation research and the editor of the book Scientific Creationism, makes his position clear in his numerous books and pamphlets. In The Remarkable Birth of the Planet Earth (Morris, 1972), the reader is told that "evolution is contrary to God's nature of love and mercy" (p. 73), that "evolution is incompatible with Christian ethics" (p. 74), and that "evolution produces anti-Christian results" (p. 75). In support of this last statement Morris declares that

Evolution is the root of atheism, of communism, nazism, behaviorism, racism, economic imperialism, militarism, libertinism, anarchism, and all manner of anti-Christian systems of belief and practice (p. 75).

His solution is "a solid faith in a personal, sovereign Creator," for "a good tree cannot bring forth evil fruit," and "neither can a corrupt tree bring forth good fruit" (Matthew 7:18). In the edition of Scientific Creationism (Morris, ed., 1974) written for the general public, as opposed to the edition written for public schools, the Institution for Creation Research states, "Evolutionist teaching is not only harmful sociologically, but it is false scientifically and historically." Thus, while Morris and others are arguing equal time for what they call science, they also make it clear that what is wrong with the science of evolution is more than just false science. Evolution, in their view, is sociologically, politically, and economically
evil as well as being godless.

As evidenced above, the fundamentalist position is one that sees the world only in black and white, or good and evil. Again, I believe that Morris (1972) makes this clear in the preface of his book, The Remarkable Birth of the Planet Earth, in which he states, "Belief in evolution is a necessary component of atheism, pantheism, and all other systems that reject the sovereign authority of an omnipotent personal God." And according to Morris, an evolutionary view of the world justifies "a long succession of evil systems," "animalistic attitudes and behavior by individuals," and "leads usually and logically to the rejection of the trustworthiness of the Bible, and, therefore, failure to appropriate its premises leading to salvation and eternal life." Thus, the acceptance of evolution makes man a purveyor of evil, and the acceptance of Bible and God makes man good. That there is no room for fence riders is apparent when Morris (1972, pp. 75-76) comments on "the semantic curiosity called progressive creation" and on theistic evolution. In this passage he tells us that these Christians are dishonoring God especially those who promote progressive creation. Further, a review of several of the creation science books (Gish, 1972; Gish, 1978; Kofahl and Segraves, 1975; Levitt, 1976) reveals that the authors hold the same absolutist position as Morris. Their books, however, are designed to bring together the "positive" aspects of creation science rather than develop a frontal attack on evolution. Kofahl and Segraves (1975) are especially careful to develop a positive thesis. Levitt (1976), on the other hand, lapses and falls back on the same arguments as Morris, telling the reader that evolution and communism are equivalent. Thus, the creationists' ideology is clear: there is one universal truth.

Thus far I have concentrated on the writings of the fundamentalists who have worked to develop the creation science model. I believe it is important, however, to connect the Institute for Creation Research (ICR) and their publications to the broader new right movement. The connections are there. Both the writings and public pronouncements of two leading television evangelists, the Reverend Jerry Falwell (1981) and Dr. Marion "Pat" Robertson (1984, pp. 28-33) link evolution and secular humanism. The Reverend Tim La Haye (1980) also makes this connection in his writings. These fundamentalist spokesmen sometimes work together to promote their world view. Jerry Falwell has been active in the effort to raise funds to assist in the scientific creationism movement (Kitcher, 1982, p. 165, Shear, 1983) and has promoted it by distributing copies of Morris' book, The Remarkable Birth of the Planet Earth. Moreover, in a written response to my request for an interview with Falwell, or a representative of the Moral Majority, regarding Falwell's policy position on creation science, I was told to contact Dr. Duane Gish at ICR.

Falwell (1981) makes several statements in his book Listen America? which are relevant to the argument that all issues can be analyzed from only two points of view, that of the anti-evolutionist and that of the evolutionist, or good and evil. At the end of his book he discusses the "Seven Principles that Made America Great." Principle six is particularly relevant. I quote the entire passage below:

The principle of god-centered education (Deuteronomy 6:4-9; Ephesians 4:4)

In recent years, the name of Almighty God has literally been removed from our public schools. Voluntary prayer has been banned. Creationism is no longer taught as a viable alternative to evolution which is now taught as a fact. As God was taken out of our schools, we saw moral permissiveness, academic deterioration,
and the drug epidemic creep in. In many cases, sex education classes in the public schools are nothing more than academic pornography. Secular humanism, rather than God-centered education, has resulted in decadence and deterioration (p. 241).

Here, Falwell makes a crucial link which defines the enemy clearly. Secular humanists and the God-less evolutionists are the common enemy. According to Falwell, the young people, age 25-40 years, "have been educated in a public school system that is permeated with secular humanism. They have been taught that the bible is just another book of literature. They have been taught that there are no absolutes in our world today" (p. 15). He pursues the dangers of secular humanism arguing that young Americans have grown up under a government influence that teaches socialism and welfarism and that the television has taught situation ethics and immorality. These influences, according to Falwell, lead to a loss of repect for life and to disrespect for the family as God established it. In short, when the leaders of fundamentalist right place the secular humanists and the evolutionists together, the definition of what is wrong with America becomes clearly defined for the fundamentalist audience.

Tim La Haye, one of the founders of the Moral Majority and an outspoken fundamentalist, has devoted an entire book, The Battle for the Mind, to warning Christians that the humanists are ready to destroy what America stands for. He is an important link in my thesis that the goals of those promoting creation science are more broadly conceived. Citing the humanists' Manifesto II, La Haye (1980, pp. 125-140) also asserts a one-voice position of evolutionists and humanists. La Haye's logic and peculiar world view lead him to divide the world into two religions: those with a biblical base - Judaism and Christianity and those with a pagan base - Confucianism, Buddhism, Muhammadanism, Babylonian Mysticism, and Humanism. La Haye, along with Henry Norris, was a founder of Christian Heritage College in 1970. Norris served as its vice-president and professor of apologetics from 1978-80 (Conway and Siegelman, 1982, p. 361; Numbers, 1982, p. 543). While I make this connection, I also want to point out that Norris and other members of ICR have made an effort to play down this relationship, to keep their activities separate, and to remain apart from the political and legislative activities. Norris and the Institute see their role as scientists whose task it is to disseminate the facts of creation science (Conway and Siegelman, 1982, pp. 119-128). The references to humanism, however, and its inseparability from an evolutionary perspective are found in most of the creationist books and articles that I have examined. Examples include Evolution, The Fossils Say No! (Gish, 1978, p. 25), What's All This Monkey Business? (Kester, 1981), Introducing Scientific Creationism into the Public Schools (Morris, 1975), Creation: A Scientist's Choice (Zola, 1976), and The Creation Explanation (Kofahl and Segraves, 1975). Based on the foregoing discussion, the relationship between the anti-evolution and anti-humanist perspective should be clear. Fundamentalists see the sciences, as they relate to evolution, and the philosophy of humanism as one and the same. Thus, biologists that use evolution as a unifying principle, are viewed in the only way possible by fundamentalists; we are all secular humanists.

At the beginning of this paper I stated that it is my intent to show that the thrust of equal time for creation science is only the first piece of a broader move to reshape American values along the values of the fundamentalist right. Although the notion of thinking about the ethics of decision making from a humanist perspective is an anathema to fundamentalists as should be apparent from the discussion up to this point, I believe it is worthwhile to present portions of a code of behavior developed for our youth by the Moral Majority of North Carolina. The guidelines for behavior
that are listed below are designed to discourage thinking, to limit the interchange of ideas between teachers and students, to restrict students' personal growth and development, and to generally isolate students from the world around them. The list of 25 don'ts eliminates discussions of the future, future social arrangements or governments, values, and boy-girl and parent-child relationships. Also, students are not to enroll in social studies classes, not to discuss values, not to write an autobiography, not keep journals of their opinions, activities, and feelings, and not to engage in classroom discussions which begin: "what if ...?, Do you suppose...?, Do you think?, "and "what might happen if ...?" Editorial, Voice of Youth Advocates, (1981). Thus, the position of the fundamentalist right is very clear. They want all Americans to do as they are told and to behave alike.

One final point is relevant to this analysis of the goals and objectives of the creation scientists and the fundamentalist right. They have adopted a position of "the ends justify the means." A review of their attack on biological evolution and what science is and does reveals both a distortion of modern biology and the natural sciences and a distortion of the writings of the scientists who have tried to broaden our understanding of the natural world. Morris, Gish, Kofahl, Seagraves and other creationists have consistently taken passages out of context to show their readers that even the evolutionist doesn't believe in evolution. Kitcher (1982) and Ruse (1982) have been more than fair in their analysis of the creationists in suggesting that perhaps they don't realize how they have twisted science. I would not be so generous. As absolutists, Morris and his colleagues know that they have truth on their side. They are for Bible and God; we represent Satan. The creation scientists and the fundamentalist right will not swerve from the path in their effort to turn America around. From my perspective they are but one short step from totalitarianism. They rail about the atheism and amorality of communism but I believe they would substitute a theistic republic which would have only the aura of democracy. Everyone will have one world view or will be afraid to express any other perspective.

SECTION II

I will now turn to the second part of this paper, a discussion of the impact of creation science and its advocates in the public schools of my own community. I present this section because it illustrates what can happen in your community. The events that transpired and the knowledge that I gained tell us much about the nature of this conflict and also suggest what our role as biologists and scientists should be. Finally I believe this discussion leads logically to my recommendations and suggestions in the last part of this paper.

In November, 1980, the Ball-Chatham School District received a grant from the regional educational service center, a unit of the State of Illinois' public educational system. The grant provided for the development of a district-wide Citizen's curriculum Advisory Council (CAC) "to examine all areas of the Ball-Chatham school curriculum and make recommendations for change if, in their view, change was warrant-
ed." In February, 1981, a twenty person council representing a cross section of the community was established. The Council elected officers and organized twelve subcommittees to review the various curricular areas as well as the adequacy of such entities as the libraries and the guidance and counseling services. In addition, a subcommittee was established to develop a survey instrument to determine public opinion on aspects of the curriculum and school services. The Council then requested volunteers from among its membership to chair the subcommittees and asked for recom-
mandations from the council for community people to staff them. As a result of this process, the local fundamentalist minister who chaired the Council became the self-selected chair of the science curriculum subcommittee. The science subcommittee was subsequently established with two of its 7 members, including the chairman, coming from the membership fundamentalist churches. (There are at least 2 in the district.) There were no scientists, no individuals with a science background, and no science teachers on the subcommittee other than myself.

In the weeks that followed the establishment of the subcommittee, its activities were carefully orchestrated by the chairperson in order to exclude me from the meetings, to challenge any teaching using an evolutionary perspective in the curriculum, and to promote equal time for creation science in any classroom setting where evolution was taught or implied. (The efforts to exclude me were not apparent to the subcommittee.) At the same time, the minister used his pulpit to deliver a series of sermons which informed his congregation that false science, heresy, was being taught in the local public schools. Further, in support of his position, he voluntarily provided me with a tape of two of these sermons. He also devoted two evenings, one during a regular committee meeting time, to show me the pedagogic value of the two model approach to the teaching of evolution.¹ His discussions with me included the presentation of a slide and tape show prepared by ICR and a critique of the humanists' Manifesto II. The slide and tape production, "Creationism and Evolution: A Comparison of Two Scientific Models," was also shown to the subcommittee during an earlier session. In short, he had done his homework from a fundamentalist's perspective; he had argued the connection between evolutionists and humanists.

By now, the reader may be wondering what happened to the review of the science curriculum by the subcommittee, what information was sought in the survey instrument, and what recommendations were placed before the Curriculum Advisory Council. A synopsis of these events follows.

My limited observations of the subcommittee's work suggested that the group intended to solicit little information from the schools on the status of the science curriculum. Further, the subcommittee seemed perfectly willing to let the chairman proceed to challenge evolution and to promote "creation science." Various members of the committee held at least one meeting with appropriate faculty and administrators from each of the schools in the district. The reports were perfunctory. In at least one instance the subcommittee member had misplaced his notes and gave his best recollection of the information gathered. Because I had been unable to meet with the subcommittee when the various members assumed their responsibilities, I was asked to review the science texts. It is my opinion that the only acceptable meeting time was chosen by the chairperson to exclude me from the process. Consequently, I rescheduled the remaining sessions of the only class I taught in the Spring of 1981. This allowed me to attend the last 2 of the approximately 6 meetings of the subcommittee. A draft report was prepared by the chairperson and presented at the last meeting. It consisted of eight short paragraphs and was only 1-1/4 pages in length.² Four paragraphs summarized the science curriculum, the remaining four dealt with the creation/evolution controversy. The latter half of the draft report noted the conflict with religious beliefs as a result of teaching evolution, recognized the newness of "scientific creationism," and recommended that a creation scientist from ICR's Midwest Center provide workshops for the teachers. This section also recommended "that books supporting scientific creationism be placed in the school libraries and be made available to teachers at all levels." Moreover, these recommendations were prepared without any formal or informal approval by the committee and prior to the availability of the results of the survey.
With regard to the survey instrument, the subcommittee submitted five statements which were to have graded responses from strongly agree to insufficient information. The first two statements dealt with the teaching of evolution, the scientific evidences against evolution, and the scientific evidences for creation. My objections to the ambiguity of these two statements were presented to the chairperson, but unfortunately, I was not present at this subcommittee meeting. The five statements were subsequently submitted to the CAC. After considerable debate by the task force concerning the ambiguity of the creation/evolution statements, they became part of the survey instrument because of the forcefulness of the minister (White, 1983). The statements ultimately occupied the first and second positions of the science section. With this summary of events, I now will turn to my response to the efforts of the minister.

My naivete caused me to see the problem as one of education. Initially, my efforts were aimed at dissuading the minister from pressing the issue because it was clear the "creation science" was bad science. Then it became apparent that I would have to argue that "creation science" had no place in the science curriculum, that it was not only bad science but also that it was religion. Further, I would have to delineate the issues for the subcommittee, and it would be necessary to bring the issues to a vote.

Given my first inclinations, the solution to the problem was to discuss the merits of the creation science model with the minister. We examined the Second Law and the great flood. At each point I explained that one corrupts the scientific method when one selects bits and pieces of evidence to fit a hypothesis and discards the main body of facts. I argued that neither the creationists' interpretation of the Second Law nor their evidence for the great flood was consistent with the larger body of scientific knowledge. We ultimately examined each of the pieces of definition of creation science that became law in Arkansas in 1981. From our discussions it was apparent that I had not been persuasive and that he would pursue making creation science a major part of the recommendations of the report.

As a result of the foregoing, I contacted a member of the Advisory Council, the wife of a protestant minister. I explained that I felt the creation science model was simply a narrow view of our Judeo-Christian heritage and clearly religious in nature. I asked if she was aware of any books by theologians that reconciled the conflicts between science and religion. My search led me to a book entitled The Christian View of Science and Scripture by Bernard Ramm (1954). Ramm, an evangelical Christian, has written a number of books dealing with apologetics and biblical interpretation. He holds both degrees in theology and advanced degrees in the philosophy of science. I believed that his views would be an appropriate way to approach a committee discussion of creation science. My purpose was to show that even within the fundamentalist churches there was no one voice on the meaning of Bible and that some religious scholars saw no conflict between science and religion. Consequently, the teaching of evolutionary theory was not heresy.

Why I determined to argue creation science and evolution in this manner has a great deal to do with my feelings about religious freedom and my own personal values about how one should treat his fellowman. I believe that one must respect, and must not infringe upon, the religious beliefs of others. While I could not accept the position of the chairperson, I believed, and still believe, that it was unethical to systematically attack an individual's faith to win a scientific position. In retrospect, I concede that I may have been in error to hold that degree of respect for those who know only one cosmological view and hold with only one truth. Nevertheless,
I resisted the temptation to attack Biblical inerrancy, the basis of this minister's faith. Consequently, I searched for this common ground between Christian beliefs and science. I wanted to show the minister and the committee that the teaching of the theory of evolution and Christian beliefs need not conflict. To my surprise, the result of my presentation of Ramm's thesis, that there is no conflict between science and Christianity, was answered by the minister quickly and tersely. I paraphrase the response - "I have read Ramm and he is wrong; I reject him." Thus, I was faced with seeking a solution of other methods.

The next step was one which many writers in philosophy, religion, and science have taken to eliminate contradictions in these areas of knowledge. I prepared a brief report examining the nature of knowledge in religion and in science showing that the former was based on faith and that the latter derived theory and law through experience and experimentation. Therefore, there are fundamental differences in how we know what we know in these two realms. I argued that science and religion are two mutually exclusive ways of understanding the world. Thus, one is left with the conclusion that creation science has no place in the classroom because it is not science. It does not meet the basic criteria of the scientific method.

The presentation of this report to the subcommittee was punctuated with charges that I had not addressed the "facts" of creation science. In addition, the subcommittee was told that the teaching of theory of evolution taught children that their parents and their ministers were liars. Before the "debate" drew to a close, the minister resorted to name calling and declared that I was a secular humanist. In a final effort to gain support for his position, he told the subcommittee that he would give up his faith if he was wrong.

As a result of the position paper that I prepared for the subcommittee, the report submitted to the Citizens' Advisory Council was extensively revised. In its final form the subcommittee's report recommended that "the theory of the evolutionary development of man from lower forms of life ... be examined only on the high school level." I readily acceded to this statement because it was apparent that evolution per se was being taught only at the high school level and that the descent of man was only incidental to the biology curriculum. Unfortunately, the survey instrument suggested that this was not an unreasonable recommendation. Less than 4 percent of the respondents felt that the statements on creation and evolution were unanswerable because of insufficient information while approximately 75 percent appeared to support equal time for creation science. I believe we should be cautious in our interpretation of these data, however, because the statements were, as indicated earlier, ambiguous and because the meanings of various phrases are subject to interpretation.

The conflict did not end, however, when the report was filed with the advisory council. The chairperson of the subcommittee made a unilateral decision to attach 11 pages of supplementary materials on the teaching of creation science including extensive lists of creation science resources and where these materials could be obtained. Again, I found myself negotiating what I believed to be an acceptable appendix to the report. I reached a compromise which I felt expressed the will of the subcommittee.

Up to this point I have presented an extensive review of the events that took place in my own community. A brief analysis of what I learned is appropriate at this juncture.

First, what happened in my community could happen in yours. The steps taken by
the minister are outlined in Introducing Scientific Creationism into the Public Schools by Henry Morris (1975) which includes instructions to church members regarding the issue.

Second, I do not believe that the subcommittee on which I served is unique or unusual. Their knowledge of science and the scientific method, certainly of epistemology is limited. Therefore, one will have to carefully lead them through the arguments if you expect to keep the fuzzy thinking of creation scientists out of the classroom. Further, if the members of this subcommittee are typical, the scientist will have to "carry the ball" in the face of indifference. No one offered support during these discussions. It was the opinion of the subcommittee that the only reason for excluding creation science was that I had persuaded them that it was religion and that the U.S. Supreme Court was very clear as to what was permissible in the public schools. In general, the subcommittee was sympathetic to the minister's cause by virtue of the fact that ministers are community leaders.

Third, I do not believe you can expect to be treated with the sense of fairness that one expects from persons professing a Judeo-Christian heritage. Attempts to respond to the issues within the context of the minister's tradition failed. Approaching the issue from an epistemological perspective resulted in only name-calling and what was seen as a challenge to my adversary's faith.

Fourth, you should expect to have to explain the results of acquiescing to creation science to members of your community. Most do not perceive creation science as a threat to science or as the infringement of the separation of church and state which it clearly is. They certainly do not regard it as part of a broader set of values espoused by fundamentalists and the Moral Majority. In the final analysis, many are not sympathetic to the total absence of prayer from schools, and this is likely to underlie any such discussions.

Finally, while one may successfully defend secular science in your school district, the activities of fundamentalists and creation scientists have met with considerable success in the area of textbook publishing (Hastings, 1983). Because of state board of education action in Texas, you may find that biology and other science texts in your schools make no mention of evolution or give it only a brief or weak treatment. Thus, evolution may not be a part of the science curriculum unless special efforts are made to put in as a supplement. This problem is addressed in the last section of the paper.
SECTION III

In the introduction to this paper, I argued that the creation science/evolution controversy is a widespread problem for the scientific community. Further, the basis of the problem is not because the arguments of the fundamentalist right are either correct or persuasive but because we as educators have failed to communicate to the public what science is and what scientists do. In Sections I and II, I analyzed the efforts of the fundamentalists, identified the breadth of their goals, and critiqued their effort in my own community. I believe the evidence is sufficiently persuasive to conclude that the public will continue to be challenged by individuals, or groups, seeking equal time for creation science in public education in the future. In this final portion of the paper, I examine some potential solutions to the problem of scientific illiteracy. I approach the solutions at two levels. First, what can we do as teachers of the biological sciences in colleges and universities, and second what can be done to correct the problem at the secondary level?

If we have failed to communicate the nature of science to the public as I and other scientists and educators have argued and as the behavior of the citizens of the community, in which I live, suggests, then what is it about our curricula that results in scientific illiteracy? Biology curricula at most institutions of higher education require coursework in genetics, evolution, cell biology or physiology, and anatomy or embryology. These courses are generally taught by presenting a great deal of experimental data. Descriptive courses are not the rule. Additionally, biology departments offer a variety of organismal and integrative courses vertebrate biology and ecology, for example. These courses are both experimental and descriptive. Further, logic and critical thinking are implicit, if not explicit, universal components of course work within biology, as well as typical baccalaureate curricula. If this is an accurate description of biology curricula and of liberal arts curricula in general, then what is the cause of our failure? I believe that the problems result from acts of omission, that is, we do not clearly and specifically address the levels of organization of knowledge. We do not teach scientific methodology in a manner that shows the hierarchical nature of knowledge, or that shows how one moves from hypotheses to theories, and to laws. Similarly we do not actively convey the idea that one can conduct good science by working from both the specific to the general or from the general to the specific. In parts of higher education curricula my criticisms are now being adequately addressed, but I suspect this is the exception, not the rule.

The solutions are inherent in the criticisms; there are a variety of ways to solve the problem, however. At the college or university level I believe we need to place a course, or perhaps several courses, in the curricula which are required of all undergraduates not majoring in the natural sciences. One example comes to mind. More than 15 years ago, the University of California at Berkeley developed, and required of all non-biology majors, a course which subsequently was published as a textbook entitled Heredity Evolution and Society (Lerner, 1968). The book examines fundamental aspects of biology as they related to social issues. The only reservation that I have about this book is that it lacks a section devoted to the philosophy of science. The concepts are implicit in the book, but I would argue for a section which clearly spells out the nature of science and the scientific endeavor. Such a curricular requirement could do much for improving the scientific literacy of our college graduates.

Within biology departments, I believe we should address the problem by adopting a course in the philosophy and history of science. I would even argue for its inclusion in the other natural sciences. The course need not add to our biology requirements if
the college or university can meet the curricular needs in the philosophy or history departments. Alternatively, faculty could address the nature of science by supplementing existing courses. Both genetics and evolution lend themselves to the examination of scientific method and the nature of science. Perhaps we should also examine the historical setting at the time of Darwin in evolution courses. The controversy between creationists and the biological sciences has not changed. Arguments by contemporary religious leaders, theologians, and scientists who oppose evolutionary theory are identical to those arguments which beset Darwin in the 1860s and 1870s. Courses on evolution are a particularly appropriate setting for this topic.

Other areas of our biology curriculum also provide reasonable entrees to the nature of science and to evolutionary models as a unifying principle of biology. Organismal courses, such as entomology, herpetology, invertebrate zoology, mammalogy, ornithology and others, are appropriate places to build on the natural relationships and discontinuities of life from an evolutionary perspective. Incorporating a few lectures on the nature of taxonomy would do a great deal for strengthening the student's understanding of how science works and would clarify the efforts of taxonomists and phylogenists who use natural or evolutionary schemes of classification. Mayr's discussion of species concepts (1963) provides convincing evidence for such a pedagogic approach. Finally, one can address the nature of science and the question of evolutionary relationships in such courses as vertebrate anatomy and physiology, or cooperative vertebrate physiology. There are valid reasons for using the particular laboratory animals that we use and these can be traced to evolutionary relationships and methods in science. Thus, I believe that solutions within biology are simply a matter of determining where in a curriculum the nature of science is most appropriately addressed and that depends on the department and the philosophy of its faculty.

Solutions will be much more difficult for secondary education where the problems are different. First, as noted in the previous section, creation scientists have already made significant inroads in curbing the teaching of evolution as a part of the biology curriculum. The success is, in part, the result of a decision by the Texas State Board of Education which has brought about substantial modifications to biology textbooks at the secondary level (Moyer, 1983). The strength of the Texas decision lies in the fact that publishing houses must be able to sell their books in the Texas system or face financial difficulties. Thus, requirements by Texas as to how evolution must be handled have led to both a reduced and a modified treatment. Second, since most curricula in secondary schools are limited to teaching what is in the texts, it follows that evolution has been de-emphasized as the unifying principle of biology. The consequences are simply a result of the economic realities faced by publishers and of the manner in which the curriculum is handled in secondary education. Thus, what one should do to maintain or to reestablish a reasonable treatment of evolution will depend largely on the community in which one lives. In many localities the adequacy of science and mathematics curricula are likely to be examined and re-evaluated as the result of recent national studies showing a declining quality in our high school graduates. I believe that college science faculty should act as resource people in their school districts. In offering assistance, we should remember that while we have command of, or are experts in, a particular science, the teachers know more about how to present the material. While many teachers are only minimally qualified in the sciences, no useful purpose will be served by emphasizing this.

What about the textbooks? Should the changes in textbooks with regard to evolution be a key issue when providing assistance? I think not. While the treatment of evolutionary theory has been reduced in many textbooks, the books are still
satisfactory. In contrast to questioning the quality of the textbooks based on their treatment of evolutionary theory, it may be more useful to focus on how the scientific method is stated in the texts and taught in the classroom. Improving an understanding of the nature of science in the short term seems more likely to underline the importance and usefulness of evolutionary models in the sciences and in understanding the world around us. In general, I do not believe a direct confrontation and demands for broadening the treatment of evolution will help to solve the problem. On the other hand, I would certainly argue that we should provide assistance to teachers who wish to develop lesson plans that expand the material on evolution in biology courses.

I have left the most difficult aspect of this problem for my final recommendations. What should your role be in the event that creation scientists challenge the teaching of evolution in your community’s schools? Given my limited experience, I believe the solution lies in preventing the problem from arising in the first place. I have already recommended that we offer assistance to local schools, that we serve as resource people. I believe that this action could prevent the problems that I encountered in my own district. In the event that a strong offense does not prevent the creation scientists from seeking equal time, you should be prepared to develop a position paper to clarify the issues. It is important to defuse the efforts of the creation scientists early. Otherwise, everyone’s time and effort is diverted and the primary goals of getting on with the business of education takes a back seat. In my own community, the citizens never really evaluated the science curriculum because of such a diversion.

In conclusion, at least one professional teachers’ organization has developed a source book (Wisconsin Education Association Council, 1982) and several scientific societies (WEAC, 1982) have passed resolutions and issued position statements which clearly identify the religious nature of creation science. All emphatically reject it as a model worthy of equal time. I recommend these materials as useful resources in dealing with the creation science/evolution controversy. Finally, the recommendations in this section are by no means the result of an exhaustive review of the literature. They are quite simply my initial thoughts on the problem and a few suggestions on how to proceed.

Endnotes:

1. The session held at the time of a regular committee meeting occurred because no other committee members attended. I assume the meeting was planned and that it was merely coincidence that the minister and I ended up debating each other.

2. Reports to the Citizens’ Curriculum Advisory Council varied considerably in length. The mean length was 5.25 pages for the 12 subcommittees. The range was 0.5-40 pages. The median was 1.5 pages. If the same data were analyzed omitting the library service report (40 pages) the mean falls to 2.09 pages, range .5-5.5.

3. The subcommittees were asked to submit a minimum of 5 statements for the survey instrument. The Advisory Council indicated a preference for 10 in order that statements could be selected with regard to their general value in the curriculum study. One member of the Advisory Council has suggested that limiting the statements to 5 was a deliberate maneuver by the minister to insure that the creation/evolution issue went before the community.

4. The statements regarding creation science and evolution are as follows:
a) "If the theory of evolution is taught or implied, then the scientific evidence opposing the theory must also be taught."

b) "Scientific evidences for creation should be taught in conjunction with the evidences for evolution."

5. Obviously the minister also saw the problem as one of education. However, he was approaching the issue from a position of absolute truth and knowledge while I was attempting to examine the problem using logic, not faith, and recognizing the tentativeness of science.

6. This minister, as well as Morris and other fundamentalists, frequently refer to John 3:16 as a key reference to the concept of Biblical inerrancy.

Literature Cited:


