LETTERS

Science and Religion

I agree with W. H. Hildemann's view (Letters, 5 Mar., p. 1182) on the possible complementarity of "evolutionism" and "creationism" in personal philosophies, yet he misses a major point of evolutionary scientists, the American Civil Liberties Union, and Judge Overton relative to the immediate source of the controversy, Arkansas Act 590. That point is the nature of the difference between science and religion and the corollary about how science should be taught. Contrary to Hildemann's suggested textbook statement, scientists (when they are behaving scientifically—that is, not all the time) do not "believe in" anything except their ability to gather reasonably objective information about the universe. Rather, they tentatively accept propositions they are unable to reject using available information. Despite our increasing uncertainty about events at progressively greater removes in time, the origins of life and the origins of the universe can be and are being explored scientifically (see the Gordon Research Conferences announcement, 5 Mar., p. 1275). At some point, all persons come up against questions they are not prepared to treat scientifically, for reasons of knowledge, psychology, or taste. Then they use other modes, including religion.

When we teach science, however, our goal should be to specify correctly what the scientific approach is and to develop in our students the ability to recognize it, to use it in at least some areas of their lives, and to understand when it is being invoked inappropriately. If we are successful, they will be able to think scientifically about problems they did not consider in school.

Science and religion provide different ways of knowing. Scientific assessments of truth cannot be mixed with religious beliefs and remain scientific. Making *that* point in science classes would also assure those assuming otherwise that science is not "anti-God" because it cannot be used to address anything supernatural at all. As individuals we may mix scientific assessments of natural phenomena with supernatural beliefs into a happy whole, but one of the main lessons of Act 590 is how dangerous to freedom of inquiry it can be if we cannot tell the difference between the two.

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Hildemann suggests that elementary textbooks introduce the subject of evolution with a statement: "A few scientists believe in a relatively recent inception of the earth and living organisms by sudden creation of the universe, energy, and life from nothing." The suggestion is not new. An attorney for the defense in the recent trial of *McLean* v. *Arkansas Board of Education* made essentially the same suggestion in his cross-examination of a science teacher who was a witness for the prosecution (*1*). The attorney asked why a statement in the teacher's chemistry text, which attributed great age to fossil fuels, could not be modified by insertion of a sentence, "Some scientists, however, believe that fossil fuels are relatively young." The teacher replied that such a sentence could be inserted in mechanical compliance with the Balanced Treatment Act of Arkansas (ruled unconstitutional on 5 January 1982), but that, as a conscientious teacher, he could not do it because "balanced treatment" must mean "equal dignity," and that he would have to justify the insertion. He added that he could not do this because he had heard no valid evidence to support such a position.

Are we prepared to sacrifice the integrity of teachers on the altar of religious zeal?

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Science Advice

It seems somewhat foreboding that, of the panel of 13 scientists named to advise George A. Keyworth, director of the Office of Science and Technology Policy and science adviser to President Reagan, all are male, most of them are physicists, and none is identified with science in the humanities (News and Comment, 5 Mar., p. 1214). What an irony it is that this panel, the highest-level scientific advisory committee in the federal government, should be a pale shadow of the old President's Science Advisory Committee established by President Eisenhower and abolished by President Nixon.

As it is, the federal departments and their administrators, including the President, appear to be unaware that there is a combination of disciplines devoted to the scientific study of mankind; that anthropologists, ethnologists, sociologists, and psychologists analyze intergroup relationships and communication, perceive disharmony and harmony alike, and probe their genesis. These scientists at least know something about how groups of mankind live and relate to one another. If they are to be heard from, and consulted, they will have to command attention. If they succeed, and have counterparts abroad, it is just possible that the superpowers can work fast and efficiently to develop a realistic program for coexistence in this world before ignorance, suspicion, greed, and power combine to destroy much of civilization.

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Damascus Steel

The ironic thing about Thomas H. Maugh II's article "A metallurgical tale of irony" (Research News, 8 Jan., p. 153) is its reading of history: It should have emphasized the really important new process of treating steel to yield a microscopically uniform dispersion of micron-sized particles of iron carbide that confers "superplastic" properties on high-strength steel of very high carbon content.

This excellent achievement of the Stanford metallurgists is *not*, however, a rediscovery of the supposed secret of that beautiful and effective weapon, the Damascus sword. Giambattista della Porta wrote (*1*) in 1589 of the importance of temperature in treating *wootz*—"too much heat makes it crumble," and Joseph Moxon (*2*) in 1677 specifically cautioned against forging it above a blood-red heat. He remarked that "when it is wrought it takes the finest and keeps the strongest edge of any other steel. Workmen set an almost inestimable value on it, to make Punches . . . of." The more subtle explanation of its properties in terms of composition and structure was slower to develop. The French metallurgist Bréant published in 1823 (*3*) a most important paper in which, for the first time, the origin of the pattern was traced to the microconstituents that today we call cementite, austenite, and ferrite, and he showed how the texture changed with variations in composition, temperature, and mechanical deformation. He saw that a good structure originated in the very coarse duplex crystals formed by slow solidification from the liquid state, and this was contorted by subsequently

forging the blade at a low temperature. In April 1822, a sword forged from Bréant's steel by a Parisian cutler named Cardheilhac was displayed at a meeting of the Société d'Encouragement pour l'Industrie Nationale (*4*). Bréant's paper (*3*) was briefly withheld from publication for reasons of national security, but it eventually appeared in the *Bulletin* of the society. At least four English translations were published within the next 2 years. Bréant's work had many imitators, including the Russian Anossov, whose extensive but rather unimaginative work in turn inspired the critically important scientific studies of D. K. Tschernoff (Chernov) beginning in 1868. Another Russian, N. T. Belaiew, in 1914 pointed out (*5*) how important the study of the blades had been to the development of modern metallography. Far from being rediscovered in the 1980's, the "secret" of Damascus steel was well known in the 19th century. Its study was central to the development of understanding of the relation between the structure, properties, and treatment of complex materials and thus is a very real part of the prehistory of modern solid-state physics.

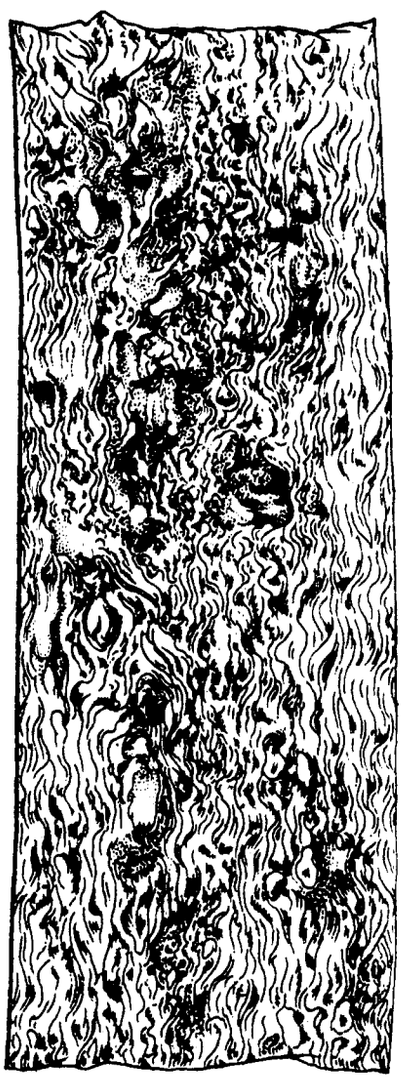

Fig. 1. Engraving showing the texture of a Damascus sword blade forged in 1821 from an ingot of crystallized steel made by J. R. Bréant in duplication of the true Oriental technique. [From (*3*)]

The duplex structure of true Damascus steel originated in the coarse crystallization of the cake of *wootz*. Some swords and all Damascus-textured gun barrels were made by a quite different technique, that of joining together by hammer-welding strips of steel of different composition, and folding, twisting, or otherwise deforming the mass to get the desired texture. Many blacksmiths are doing this in the United States today with appealing results. A few are working with the far more difficult crystallization process.

The history is treated at length in two of my publications (*6*) and most recently and comprehensively in a book by Jerzy Piaskowski (*7*).

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Effective Funding

In his editorial on peer review (1 Jan., p. 11), Allan H. Clark makes some serious overstatements in defense of the peer review system. Citing a recent study (*1*) which points out that chance enters significantly into decisions by the peer review system, he takes the position that, since uncertainty is inherent in any system, we must hold fast to peer review as it is presently used.

He asserts that the recognition of the chanciness aspect has "raised calls from many quarters for elimination of the peer review system"; may we ask who it was that called for such elimination? In the recent past eight articles and editorials have been published in *Science* (*2*) and five in *BioScience* (*3*) that have criticized the peer review system, and not one of them has suggested that peer review be dumped. Instead, they have suggested either setting up a part of the granting system in another mode or making modifications such as the use of signed reviews or of rebuttals by the investigator.

He asserts that "block grants . . . would foster mediocre research." Yet his own institution, Purdue University, became one of the most distinguished centers of plant physiology, plant pathology, animal physiology, and biochemistry in the 1950's and 1960's largely through block funding of the Agricultural Experiment Station.

He asserts that if 13 out of 20 reviewers are in favor of a given proposal, "the majority opinion will carry and the proposal will be funded." Anyone who has served on a peer review panel knows that this is not realistic. If one reviewer is strongly opposed to a proposal, it will often be rejected; if more than one is strongly opposed it almost certainly will be rejected, and the divisions of the National Science Foundation have established oversight committees with the particular intent to challenge program directors who recommend funding for proposals that have been given any serious objections.

There are many in the science community who feel that exclusive dependence on peer review for funding decisions is not only expensive in time but serves to favor reductionist proposals and proposals in popular or fad subject areas and tends to provide bias against more daring or innovative proposals. In short, peer reviews tend to strengthen authoritarian conservatism. Surely the history of block grant funding, such as in the agricultural experiment stations and in the Office of Naval Research, has yielded vivid proof that the peer review system is not the only way to provide for effective research support.

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