# Letters

## Chernobyl Radiation Dose

Eliot Marshall (News & Comment, 8 May, p. 658) summarizes a report that I presented to the American Occupational Medical Association in Philadelphia. Despite my best efforts to the contrary, some confusion occurred about the difference between radioactivity and radiation dose. Marshall states that "the total amount ejected is comparable to, but slightly less than, the fallout from all atmospheric weapons tests." This reference to radioactive material is incorrect and is a problem that has arisen before. The total amount of radiocesium ejected in the atmospheric nuclear weapons tests was at least 10 or 20 times higher than the total amount of radiocesium released during the Chernobyl accident. Because of the remote location of weapons tests with respect to population, the overwhelming majority of the radioactive material was deposited in areas where there was little potential for human exposure and dose in a collective sense. Marshall should have referred to the amount of radiation *dose* solely attributed or attributable to cesium-137, not the amount of *radioactivity*. Just the amount of radiation dose absorbed by people was somewhat comparable because, in the case of the Chenobyl release, a much smaller amount was released in a more populated area. Actually the radiocesium *dose* from Chernobyl to the Northern Hemisphere in our latest calculations is about 60% of the cesium dose from weapons tests. Another point is that the total amount of radiation dose commitment to the population of the Northern Hemisphere from weapons tests includes many other radionuclides, and cesium alone constitutes perhaps a little less than half that total.

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## Learning Science

I find myself in boisterous agreement with F. H. Westheimer's cogent critique of so-called "core" curricula (Policy Forum, 5 June, p. 1165), even though my own college apparently does rather better about science requirements than the highly visible colleges and universities that Westheimer cites. It is truly appalling that a student can receive a B.A. degree from a serious college or university and not know *one single thing* about evolution, about mathematics, about principles of behavior, about genetics, or about simple physical laws, let alone molecular biology. Westheimer notes another appalling fact: the *science* faculty at Harvard voted for a core curriculum that "all but ignores science." He asks how this is possible and, in answer, avers that scientists and mathematicians do not want to teach science and mathematics to the "unwashed," presumably students who are majoring in sociology, history, English, philosophy, literature, and the like. As evidence of this, Westheimer says, "scientists frequently state that it is not possible to teach anyone who does not want to learn. That is true." Thus, to my point: as wretched as the scientific knowledge of our students is, the quality of instruction in science at many colleges and universities is probably equally wretched. Yet Westheimer seems willing to rely wholly on selection as a possible solution to the problem of scientific ignoramuses. Universities could select for their student bodies only those who are eager to learn science. Or, among the students now in our universities, there must be many who could learn science if that was what the faculty expected of them. Westheimer does not address the role of science faculty as teachers. This position leaves the job of arranging conditions so that students "want to learn" entirely to our students' precollege teachers. Universities then select from these products and their own science faculty is absolved of motivational responsibility. Surely this is a profound mistake. C. S. Slichter, a mathematician, put it as well as anyone: "It is not the teacher's task to teach interesting things, as the quacks proclaim, but to make interesting the things that must be taught" (*1*, p. 179).

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## "Progress" in Evolution

"I cannot, by the progresse of the Starres, Give guesse how neere to day." "Progress," in that statement by Brutus in Shakespeare's *Julius Caesar*, is indeed culturally laden, but not at all in the sense that Stephen Jay Gould *et al.* (Articles, 12 June, p. 1437) claim for the term. The *Oxford English Dictionary* (1933) gives a series of definitions for "progress," the first three of which concern various senses of motion, with no teleological or culturally offensive implications at all that I can see. The fourth definition gives the figurative sense of "advance to better and better conditions, continuous improvement." That is the sense in which "progress" has been used in evolutionary biology, but it still embodies nothing objectionable. Curiously, "improvement" was recently espoused by Gould (*1*) as a more objective, less offensive replacement for "progress."

Certainly, to make an a priori assumption that life progresses is indefensible. But it is equally indefensible to deny that increased mechanical efficiency or structural effectiveness for the conditions in which organisms live has not occurred or cannot be recognized. In the phylum with which I am most familiar (the Bryozoa, one of the eight abundantly fossilized invertebrate phyla), several progressive, long-term trends in the fossil record have been varyingly well demonstrated (*2*), in some instances within a clade and in others where a clade of mechanically better-suited forms replaces clade(s) with more ill-suited forms. These include trends in resistance to breakage (*3*), changes in growth patterns to delay interference between branches within a colony (*3*), replacement of encrusting species that lack frontal budding by competitively superior encrusters with frontal budding (*4*), and slow but inexorable rise to dominance of erect forms with the least mechanically awkward pattern of feeding currents (*5*). The Bryozoa are tightly constrained by their *Bauplan*, and many aspects of their morphology and ecology go nowhere (*6*). However, I know of no examples of trends within Bryozoa that operate in the opposite direction from those cited here. These trends support directionality in the history of life at least as well as real, but slight, asymmetry of clade diversity diagrams and also indicate that the history of life embodies improvement, mechanical enhancement, advancement, or any other synonym or circumlocution that one wishes to use to avoid the term "progress."

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