Letters

Biotechnology: Society's Role

Daniel E. Koshland, Jr., in his editorial (p. 1233) for the 16 June issue "The new harvest: Genetically engineered species," transcends the scientific syllogisms of the lead articles in that issue when he concludes, "Whether society prefers to have wolves or dogs remains to be seen." "Society," that is, the public, has little say about the present and future applications of biotechnology. And is the choice either wolves *or* dogs? Must we remake every natural thing into our own image of perfection and utility?

While the multiple pleiotropic health problems of genetically engineered pigs (Articles, 16 June, p. 1281) are duly noted, we should also remember that the "engineering" of wolves into dogs by selective breeding has resulted in much animal suffering, especially in purebred dogs now afflicted with more than 200 genetic disorders.

Perhaps we should ask not whether society prefers to have wolves or dogs but rather whether we prefer to have a natural world or an industrialized biosphere. The preservation of wildlife and wildlands depends in part on the judicious application and containment of new biotechnologies. It is doubtful, in view of the high probability of the doubling of the human population within the next 40 years, that making pigs grow faster and stay lean and continuing to regard meat as a dietary staple will help preserve the diversity and integrity of the earth's biotic community.

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ICBM Modernization

John M. Deutch's article "The decision to modernize U.S. intercontinental ballistic missiles" (23 June, p. 1445) effectively argues that a road-mobile single-warhead Midgetman is preferable to the rail garrison ten-warhead MX on the grounds of survivability. Deutch devotes less attention to silo-based alternatives, but he does state that, in terms of survivability, the MX in the multiple-shelter "carryhard" system may be equivalent to a silo-based Midgetman. Specifically, a single MX missile movable among ten shelters is said to be equivalent to ten Midgetmen (with the implicit assumption that the survival probability for targets is the same for both systems). This claim is based on the fact that the mean number of surviving warheads, $<N_S>$, is the same for the MIRVed and unMIRVed systems; however, it fails to take into account the fact that the probability distribution for the number of surviving warheads is quite different for the two systems.

A more appropriate measure of survivability is the minimum number of surviving warheads at a given confidence level, C. This number, $N_{S,min}$, is simply related to $<N_S>$ (in the case of a Gaussian distribution) by $N_{S,min} = <N_S> - y[2n(1 - P)<N_S>]^{1/2}$, where n is the number of warheads per missile and P is the probability of survival of each target (*1*). The parameter y is related to the confidence level by $\text{erf}(y) = 2C - 1$.

To illustrate, with 500 warheads and $P = 0.1$, we have $<N_S> = 50$ for either system. But if we wish to have $N_{S,min} = 50$ at $C = 90\%$, we must deploy 594 warheads at $n = 1$, but 860 warheads at $n = 10$. The fact that the MIRVed system has a wider probability distribution adds 45% to its cost when measured in terms of dollars per minimum number of survivors.

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Eos Meeting

Eliot Marshall (News & Comment, 16 June, p. 128) describes our first Earth Observing System (Eos) meeting as an "inquisition." Was I perhaps at some other meeting?

In response to an Eos Announcement of Opportunity sent around the world, NASA received hundreds of proposals from interested scientists in all fields of earth science who want to play a major role in this mission. About 150 investigators were selected this past February. In March, we held our first "all hands" meeting at the Goddard Space Flight Center for the selected scientists to meet one another and exchange ideas for a few days, since they will be sharing data

with one another for the next two decades. About 500 scientists and their collaborators attended; the numbers were limited only by the size of our largest auditorium. I had numerous calls from attendees praising the favorable climate for freedom of expression and the openness of questioning.

Marshall focuses on some minor remarks about the need for support for graduate students in competition with funds for "satellite building." This need is not really in dispute. One needs to consider the complexities of the scientific issues and the ambitious step forward that is Eos. Of course training the next generation of students is important. In NASA we have recognized the need for new talent and advancing beyond the hardware issues that we do understand. We must now address the problems of understanding the earth as a planetary body if we are going to learn to predict this changing system. The primary goal of Eos is directed toward understanding the earth on the global scale; the data, not the hardware, are the hallmark of Eos.

Marshall does not report the key role in Eos to be played by the 28 interdisciplinary investigator teams that were selected for Eos. The interdisciplinary investigators have specifically been brought into Eos early, long before any hardware is built or flown, to aid in the scientific direction of Eos and to see that the unprecedented flow of Eos data will indeed become scientific information to be placed at the service, ultimately, of mankind. The interdisciplinary scientists will guide the development of the data and information system. They are expected to use all the data from the Eos instruments and to publish their results in the open literature. Their work is to lead to the development or improvement of theoretical models that will shed further light on the earth as a system. Eos interdisciplinary scientists come from a multitude of universities and national research organizations from around the western world.

All of us have come to recognize the urgency and importance of earth science in the next century, and we have little time for distraction. All of the ideas reported by Marshall are good: James Hansen's, Dixon Butler's, Francis Bretherton's, and those of the 500 who attended this meeting and the thousands who will use the Eos data. Our problem is sorting and establishing the priorities, finding out the missing pieces of the puzzle, deciding those we can afford, and encouraging participation by partners nationally and internationally who can help and contribute.

What did the meeting produce? More scientific insight, organization into scientific teams, and plans for developing our scientific strategy.

In the next century the nations of the world will depend on understanding this unique and fragile planet on which we live.

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Rabies Vaccine Trials

Marjorie Sun's articles (News & Comment, 30 June, p. 1535; 14 July, p. 126) report on the proposal of the Wistar Institute to conduct trials on South Carolina and Virginia islands of a new vaccine to orally immunize wildlife against rabies.

Although Wistar's approaches to the health authorities in South Carolina and Virginia were not significantly different, the resulting decisions of the health officials from the two states are in sharp contrast. In his letter of 5 July 1989 announcing that he had approved the proposed trial on Parramore Island, Virginia State Health Commissioner C. M. G. Buttery stated, "Virginia is proud to be a part of this first important step toward controlling wildlife rabies." The letter of 31 March 1989 of South Carolina