# 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.

MICHAEL W. FOX
*Executive Director,*
*Center for Respect of Life and Environment,*
*2100 L Street, NW,*
*Washington, DC 20037*

### 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.

MICHAEL I. SOBEL
*Brooklyn College*
*of the City University of New York,*
*Brooklyn, NY 11210,* and
*Center for Energy and Environmental Studies,*
*Princeton University,*
*Princeton, NJ 08544–5263*
HAROLD FEIVESON
*Center for Energy and Environmental Studies,*
*Princeton University*

REFERENCES

1. R. Radner, in *Stability and Strategic Defenses*, J. N. Barkenbus and M. Weinberg, Eds. (Washington Institute Press, Washington, DC, 1989), pp. 266–296; M. I. Sobel and H. Feiveson, in preparation.

### 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