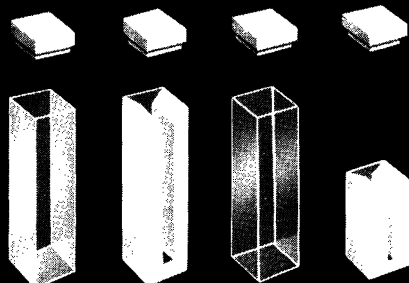


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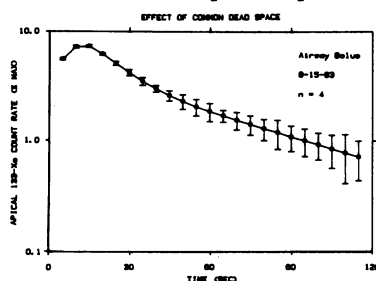


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researchers—and what secretarial help they can muster—from an expensive, time-absorbing, and largely thankless task that distracts from serious communications. In the spirit of personal statements coming before institutional ones, I have adopted a policy of accommodating postcard requests only from scholars working in countries where journal availability is low.

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### Biotechnology and the Biosphere

There may be another dimension to the case of the ice-nucleating bacterium *Pseudomonas syringae* that was not mentioned in Gina Kolata's article "How safe are engineered organisms?" (Research News, 5 July, p. 34). According to Russell Schnell (1) of the National Oceanic and Atmospheric Administration Laboratory in Boulder, Colorado, *Pseudomonas syringae* enhances rainfall. It seems that the lipoprotein coats of this and other species of bacteria found on plants and in detritus when shed and wafted up into the clouds form ideal nuclei for ice formation that is absolutely necessary for rain to fall. Furthermore, contrary to what was previously thought, recent studies show that particles without organic materials derived from bacteria and plants (that is, "clean dust") are useless as nuclei for the formation of raindrops (raising the possibility that the Sahel drought could be prolonged by the absence of organic nuclei).

If *Pseudomonas syringae* does indeed have a beneficial role in enhancing rainfall, then the ecologist's concern about possible secondary or indirect effects of releases of genetically altered organisms is vindicated—incredibly, at the very first major controversy over release of engineered organisms. To the agriculturist the ice-nucleating bacteria are viewed only as pests, something to destroy or at least neutralize. But before such action is taken we should try to find out if the organisms in question have other functions that are of redeeming value. Reduction in rainfall due to lack of ice-nucleating capacity could be a lot worse than crop loss due to frost. At least we ought to consider such possibilities and assess indirect as well as direct impacts before we conclude that the alteration is "benign" (as inferred for current proposals in Kolata's article). Essentially, this is

the position of the ecologist when it comes to proposals for genetic alteration in open systems; it is not an "alarmist" position but just commonsense caution when one is dealing with complex environmental systems that are poorly understood.

Since microorganisms play major roles in maintaining earth's life-support systems, we need to be especially careful about tinkering with decomposition and other recycling processes. Unlike the life-support system of a spacecraft, which is mechanical and man-made, the biosphere is bioregenerative and self-regulating. Since we did not build it we don't know much about how it really works, and we have shown little interest in studying it at the necessary large scale until recently, when malfunctions have begun to appear due to human impacts. The case of the ice-nucleating bacteria is an excellent example of the need for a more holistic assessment that allows for consideration of roles and functions other than the one that seems undesirable.

What is needed now is a reasonable procedure for assessment at the ecosystem level that leans to the side of caution when there are a lot of unknowns. Accordingly, there is urgent need for increased support for research in environmental microbiology (that is, microbial ecology) and ecosystem science.

One consequence of the industrialization of agriculture is that food tends to become a market commodity rather than something to nourish us (that is, a life-support necessity). While a strong market economy is necessary for efficient food production, enthusiasm for biotechnology should not lead us to treat all organisms merely as "commodities" to be manipulated for short-term economic gain when there are nonmarket values and long-term consequences to be considered.

It is high time we became concerned with the health of the biosphere. A new technology for benefit-cost assessment could balance in an objective manner the short-term economic (market) benefits and the long-term costs in terms of damage to nonmarket goods and services that might be affected by proposed alterations. Advances in biotechnology should be accompanied by advances in the technology of ecosystem impact assessment if we are to minimize mistakes and disappointments.

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#### References

1. S. Weisburd and J. Raloff, *Science News* 127, 282 (1985).