Letters

Scientists' Freedom to Travel

In the light of past problems arising with international scientific meetings, the International Council of Scientific Unions (ICSU) passed in 1974 a Resolution on the Freedom of Circulation of Scientists. This resolution, and the accompanying Advice to Organizers of International Scientific Meetings, state that ICSU and any of the affiliated international scientific unions will withdraw their sponsorship of scientific meetings if bona fide scientists are not granted travel visas by at least 1 month ahead of each meeting.

With increasing alarm have we followed evidence that the letter and spirit of the ICSU resolution have been violated in the past few years. It may be sufficient to quote here two documented examples: the 1977 meeting on ferroelectricity, sponsored by the International Union of Pure and Applied Physics (*1*), and the 1978 meeting of the International Genetics Federation (information received from officers in America). We believe that any infraction of the ICSU resolution greatly weakens the fragile fabric of international cooperation in science which all of us have at heart. We therefore urge that *Science* continue to publicize information concerning the freedom of circulation of scientists, specifically to (i) inform the American scientific community on a regular basis of any violation of the ICSU resolution of 1974 whenever it is brought to their attention and (ii) report on actions taken by ICSU dealing with such violations.

The American scientific community will thus be able to arrive at an informed opinion as to what further steps may be necessary to safeguard the freedom of circulation of scientists.

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Composting Hazardous Wastes

It is true, as reported in the 1 June issue of *Science* (Research News, p. 930), that biological degradation of organic matter (including hazardous wastes) can be accelerated at elevated temperatures. Furthermore, as indicated, composting is a promising means of providing suitable temperatures. If the potential of this technology is to be realized, however, it is necessary to examine the widespread belief that, in composting, "hotter is better" (my expression). Indeed the high temperatures routinely attained at composting plants, for example in the range of 70° to 80°C (*1*), while often interpreted as an indication of successful operation, in fact severely restrict degradation.

At least three lines of evidence demonstrate that degradation is maximal at moderate thermophilic temperatures (approximately 55°C).

1) Composting is based on biological self-heating (*2*), the course of which is characterized by the expansion and subsequent collapse of an indigenous mesophilic population, followed by a repetition of similar events in a thermophilic population (*3*). This is manifested by two bursts of heat generation in sequence, and a corresponding two-step temperature ascent. The collapse of these populations is self-induced in that intolerable temperatures are soon reached. The first sign of mesophilic retrenchment is at approximately 40°C and, for thermophiles, at 55°C.

2) In trials involving composting materials equilibrated to a fixed temperature (or to a reasonably narrow range), degradation measured as heat output, production of carbon dioxide, and other objective criteria, is maximal at 52° to 63°C (*4–6*). Higher temperatures representative of routine operation have been shown to be moderately to severely inhibitory (*7*).

3) In trials involving equilibrated material the species diversity of cultivable bacteria decreased sharply above 60°C (*6, 8*). At 65° to 69°C only *Bacillus stearothermophilus* was recovered. The presence of diverse species implies metabolic diversity, a characteristic that is much to be desired in connection with the treatment of hazardous wastes.

Clearly, a feedback system, involving an interaction between population and temperature, is operative in composting. The feedback is positive early in the temperature ascent but becomes negative as the temperature tolerance limit is approached.

Extreme bacterial thermophiles are known (*9*). Theoretically these could be involved in composting increasing the optimal process temperature; however, evidence indicates that the composting ecosystem is the domain of moderate thermophiles.

Heat production, because it represents organic matter degradation, should be maximized in composting. Therefore, process optimization consists of removing heat to the extent that this is necessary to restrain any undue temperature ascent. However, the design being adopted by many communities (*1*), including New York City on a massive scale (*10*), maximizes heat retention and temperature. In this design, a clear distinction is not made between the roles of heat and temperature in composting. This is to the detriment of the process's underlying microbial ecosystem and the objective of degrading organic matter.

In addition to the degradation of organic matter, the destruction of pathogenic microorganisms is a composting objective. Recently a task group concluded that exposure to 55°C for 3 to 5 days satisfies this objective (*11*).

We have found that these principles concerning heat and temperature pertain to the degradation of crude oil added to composting refuse. Also, we have developed practicable means of controlling temperature in field-scale, static-pile composting. The advantages of doing so are being demonstrated in large-scale research trials at Camden, New Jersey.

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References and Notes

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7. For example, carbon dioxide production at 72°C was 5 percent of that at 56°C (*5*).
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