The Fertilizer-Ozone Connection

Deborah Shapley's article (News and Comment, 18 Feb., p. 658) is not fair to some people and is 9 months late. The article is based on a paper I gave at the April 1976 meeting of the American Geophysical Union in Washington, D.C. Eight other papers on the same subject were presented at the symposium. Most of these papers consisted of original contributions, whereas mine was only a review of the work of others. Also, my paper is now one part of an undigested, unapproved, preliminary report being prepared by the Panel on Nitrates of the National Academy of Sciences–National Research Council, which apparently was "leaked" to Shapley. I think it is ludicrous that my 9-month-old review paper was rushed into print as if it were a hot news item.

Shapley's article appears to give me credit for discovering that nitrogen fertilizers (manufactured and managed legumes) may conspicuously reduce stratospheric ozone, but this is an injustice to the actual discoverers and developers of the case. That man-induced fixed nitrogen might reduce stratospheric ozone was implicit in 1971, after the publication of three papers (*1*) showing that nitric oxide is chemically formed in the stratosphere from soil-produced, inert nitrous oxide and two others (*2*) showing that nitric oxides catalytically reduce ozone. An illustration of how well this was recognized then is a quotation attributed to a spokesman for an aircraft company early in 1972: "Blame the farmers; don't blame us."

In 1971 so little was known about the natural amount and distribution of nitrogen oxides in the stratosphere that it was not timely to pursue the fertilizer problem. However, in the period 1972 to 1975, the Climatic Impact Assessment Program obtained enough measurements of stratospheric oxides and learned enough about the sensitivity of stratospheric ozone to nitrogen oxides that it became appropriate to consider the problem. Although it is difficult to assign priorities, it is my impression that Crutzen (*3*) first took up the subject again, and McElroy (*4*) was the first to deeply probe the complicated biological bases for the problem.

Shapley says the problem has been "hampered by vigorous disputes," but any "vigorous disputes" I know of are evidence of the vitality of the subject and have tended to speed up work on the problem and get new people (*5*) (including soil scientists) interested in it.

In the discussion of possible partial answers, Shapley apparently misunderstood what I said in a telephone interview. Although recycling of fixed nitrogen could reduce the amount of manufactured nitrogen fertilizer, organic farming in terms of cultivated legumes also represents added nitrogen fixation.

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Radioactive Wastes

The article by Luther J. Carter on radioactive wastes (News and Comment, 18 Feb., p. 661) is full of numbers but devoid of information that gives an understanding of what they mean. It constantly mentions millions of gallons and tens of thousands of tons of waste from the entire nuclear industry over the next 25 years and creates the impression that we are being inundated by vast quantities of this waste. If that's the game, why not mention the trillion gallons (10 million tons) of carbon dioxide, the 10 billion gallons (150,000 tons) of sulfur dioxide, or the 100 million gallons (1 million tons) of solids produced by SO_2 scrubbers that are the wastes from a single coal-fired power plant in 1 year? An understandable figure for the high-level wastes is 2 cubic meters per year from a nuclear power plant, an amount that could be stored under a typical dining room table. The electric power produced by such a plant is worth $200 million per year, so one could spend $2 million in handling this small quantity before increasing the cost of electricity by as much as 1 percent.

Carter says this material must be isolated "for what, in the human perspective, must be forever," but after 500 years, the amount one would have to eat (after conversion to edible form) to give a good probability of injury is about a half-pound. (In the case of military

waste, about which the above statement was made, one would have to eat 10 pounds.) That makes it less dangerous than many natural rocks (for example, cinnabar) and clearly less dangerous than pesticides and herbicides we keep in our homes and spread on the ground in farmland. Why don't they have to be isolated forever?

The principal hazard scenario for the waste is that it may be contacted by groundwater, leached into solution, and eventually get into food and water supplies; but this process includes many inherent time delays which essentially guarantee that nothing will get out for at least 500 years (*1*). Also, the waste accumulated by a million years of all-nuclear power in the United States would cause less than one fatality per year (*1*). Compare this with the 10,000 fatalities per year from sulfur dioxide due to coal burning.

Carter states in one place and implies throughout that these wastes have a great potential danger, but he gives no indication that it is orders of magnitude less than the potential danger from many other poisonous substances our society constantly deals with (*1*). Also the radioactivity in the waste is many orders of magnitude less than natural radioactivity in the earth at depths shallower than that of the waste burial.

Carter implies that the low-level transuranic waste is also a serious problem, but it is really trivial, and even the most haphazard deep burial would surely suffice. The British simply dump it in the ocean with no ill effects. Until recently, the United States handled it with haphazard shallow burial, and any reasonable analysis shows that there are no ill effects. For example, if all the transuranics thus buried were to leak out and get into rivers, or to become distributed through soil uniformly between the surface and their burial depth, not a single fatality would ever be expected to result.

The statement about friction between the Atomic Energy Commission (AEC) and the National Academy of Sciences (NAS) committee on radioactive waste disposal is somewhat misleading. With the exception of a brief misunderstanding in 1966, the relations between the NAS committee and AEC-ERDA (the Energy Research and Development Administration) have been most cordial for over 20 years. Several thousand copies of the so-called "suppressed" report were distributed by AEC.

The statement that "there have been no known human casualties" from leaking waste storage tanks at ERDA's Savannah River and Hanford installations implies that there may well be some. The leaking material is 40 feet below the surface, which gives a gamma-ray attenuation of something like 10^{-50} for the approximately 10^{24} gamma rays that have been emitted, so there is only 1 chance in 10^{26} that a single gamma ray has ever reached the surface. Compare this with the thousands of gamma rays with which natural radiation bombards each of us every second.

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Cancer Data

Most death certificates do not reflect incontrovertible evidence of cancer when compared to evidence established by autopsy, biopsy, or surgical resection of a malignant tumor as an index of cancer epidemiology (*1*). Reliance upon mortality figures based on death certificates in which autopsy results are reported in establishing the epidemiology of cancer raises serious questions about the validity of subsequent lengthy and costly studies on environmental carcinogens by the Environmental Protection Agency (EPA) (Editorial, 4 Feb., p. 443) or by others.

As a practicing general pathologist I am well acquainted with the low autopsy rate in most hospitals in the United States, and particularly in rural counties. Knowing the frequency with which occult cancers may be encountered at autopsy, the difficulty in deciding whether cancer is the cause of, or even related to, death, and the casual way in which death certificates are filled out by many physicians whether or not an autopsy has been performed adds further skepticism about the epidemiologic value of cancer mortality figures based on death certificate data.

Far more reliable, albeit perhaps a harder initial task, would be a random sampling in every possible county of autopsy and surgical pathology records over a specific time period. Virtually all biopsied, resected, and occult cancers would be found, as well as the patient's age at the time cancer is recognized. Few cancers go unrecognized before death even though they may not cause death. Further, many cancers are successfully treated or recur after a latent period long enough so that death from other