(estimated at 40–150 yr)[3], and concern centres on the rapid increases in concentration observed for these compounds over the past several years. Natural CH_3Cl on the other hand, has a short lifetime (estimated at 0.37 yr) and should already be present at a steady level, at least on an annual average basis.

The lack of relevance of the natural content of stratospheric chlorine to these anthropogenic concerns, however, has an even more fundamental basis. All calculations to date indicate a progressive, roughly linear effect of added stratospheric chlorine on the depletion of the average ozone concentration, at least for changes of less than 10%. Consequently, the expected depletion in ozone from the continuing addition of anthropogenic chlorine is almost independent of whether the natural ozone level used as the baseline for comparison involves a 0%, 1%, or 5% component in its overall destruction from ClO_x of natural origin.

Ozone removal by stratospheric chemical processes predominantly involves the recombination of O_3 and O through NO_x catalysis, with lesser contributions from HO_x catalysis and direct reaction. Johnston (unpublished) has estimated that other processes could account for the additional, natural removal of as much as 15% of the ozone content, without affecting the consistency in present calculations of the balance between ozone formation and destruction; this additional destruction (15%) is the equivalent of about 6,000 parts per 10^{12} of stratospheric chlorine. Volatile organic halocarbon contributions of natural origin—chiefly, the recently discovered atmospheric CH_3Cl—total only about 1,000 parts per 10^{12}, while average stratospheric contributions from inorganic sources (sea salt, volcanoes) are much smaller than those from organic sources. The discovery of $\geq$ 5,000 parts per 10^{12} of additional, natural, stratospheric chlorine now seems very unlikely.

These considerations of the anthropogenic against the natural ClO_x catalysis of ozone depletion parallel those made earlier for anthropogenic against natural NO_x catalysis. The detailed findings of the US Climatic Impact Assessment Program have shown that the addition of substantial quantities of anthropogenic NO_x would cause the extensive depletion of average ozone levels, despite the fact that these ozone levels are at present controlled chiefly by the reactions of natural NO_x.

Lovelock[1] has also argued that molecules such as CCl_2F_2 and CCl_3F are much more stable in the stratosphere than CH_3Cl. Present measurements and calculations suggest that is not the case. The tropospheric stability of CH_3Cl is certainly far less than that of CCl_2F_2 and CCl_3F because of the vulnerability of the former to attack by tropospheric OH radicals. In the stratosphere, however, with lower temperatures and lower OH concentrations, photolysis by solar ultraviolet radiation generally proceeds at a faster rate for CCl_3F (and at a comparable rate for CCl_2F_2) than the rate of attack of OH on CH_3Cl at the significant stratospheric altitudes.

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LOVELOCK REPLIES—Future generations will owe a debt to Molina and Rowland and to other scientists who have warned of the hazards to ozone by depletion by odd chlorine and odd nitrogen. I do not question their concern nor in broad outline their aeronomic models. There seems to be little doubt that in the long term the unrestrained release of fluorochlorocarbons to the atmosphere could have damaging and long lasting consequences.

Where I differ is on what constitutes a hazardous level of these compounds, and when it will be reached. At present the input of chlorine to the stratosphere from fluorochlorocarbons is small compared with that from CH_3Cl and CCl_4. Furthermore, the atmospheric concentrations of the fluorochlorocarbons is no longer rising rapidly, possibly in part a consequence of the public recognition of the problem. The concentration of CCl_3F, for example, is still less than 10^{-10} per volume, perhaps one tenth that of CH_3Cl.

I concede that my remarks on the rapidity of the destruction of CH_3Cl in the stratosphere may be wrong. But if the mean global concentration is taken as 10^{-9} by volume then it would be responsible for the depletion of 1.6% of the stratospheric ozone. This is twice that of the combined effects of the two fluorochlorocarbons CCl_3F and CCl_2F_2.

It is known that N_2O varies very substantially in concentration[1,2] but measurements of CH_3Cl have only been made during the past 10 months. It is much too soon to conclude that its aerial concentration is constant. If 'slash and burn' agriculture proves to be a major source then CH_3Cl concentration may vary in proportion with this activity.

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Matters arising

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Latent tumour metastases

THE report by Eccles and Alexander[1] illustrates in an experimental system a phenomenon which is a familiar one with human tumours, which I have referred to as occult residual cancer[2,3]. sometimes the sudden appearance of frank metastases years after the apparent complete local removal of the primary tumour can be related to some particular event, as for example the sudden appearance of metastatic melanoma in a patient who subsequently developed a carcinoma of the breast and was treated by mastectomy and X-ray therapy[4]. A remarkable feature in this patient was that initially the melanoma metastases were confined to the area irradiated, though they subsequently became generalised. In other patients no cause can be discerned. This is exemplified by a patient[5] who received a renal allograft after developing carcinoma first in one and then in the other of his own kidneys. When the second kidney was removed the tumour was found to be invading the renal vein and the prognosis was thought to be very poor. In spite of immunosuppression—or perhaps because of it for the azathioprine he received may have had an antitumour effect—he remained apparently tumour free for almost 7 yr, and then suddenly developed metastatic renal carcinoma first in his lungs and then elsewhere.

The clinical importance of this phenomenon is clear, but it has proved difficult to investigate because of the lack of a suitable experimental model. Fortunately Eccles and Alexander have now made good this deficiency.

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