when other organochlorine compounds (endosulfan, lindane, simarin and captan) were applied as spray. In soil samples thought never to have been treated with any pesticide, 11 to 36 per cent DDT-accumulating bacteria were found.

The proportion of DDT-resistant bacteria in a population was estimated by a pour plate method: peptone agar containing various concentrations of DDT was mixed with a water or soil-suspension sample. The plates were incubated at 25° C. Daily colony counts showed striking differences in retardation and inhibition between two samples, of which one had been shown by autoradiography to contain 3 per cent DDT-accumulating bacteria, and the other 93 per cent (Table 1).

Table 1. DDT RESISTANCE IN TWO BACTERIAL POPULATIONS. SAMPLES ARE MIXED WITH PEPTONE AGAR CONTAINING VARIOUS CONCENTRATIONS OF DDT AND INCUBATED AT 25° C

Sample	Medium: peptone agar with DDT (p.p.m.)	Colony counts after 1–7 days expressed as percentages of the number counted after 7 days on plates with no DDT added: Days 1	2	3	4	5	7
Ditch water	0	7	38	78		92	100
3 per cent*	0·1	5	48	56		79	84
	1	6	36	74		89	91
	10	0	1	11		31	55
	25	0	0	0		0·5	0·5
Nursery soil	0	6	18	76	91	98	100
93 per cent*	25	0	2	12	15	16	16
	500	0	0·1	2	4	5	6
	1,000	0	0	0	0·1	0·4	0·5
	2,000	0	0	0	0	0	0

* Percentage of colonies in this population which showed blackening, as determined by the autoradiographic technique.

DDT-sensitive bacteria were detected by transferring peptone-grown colonies on to fresh plates with or without 1 p.p.m. DDT. Surprisingly, few colonies had failed to grow on these plates after three days. 5 p.p.m. DDT gradient agar plates, however, showed a definite inhibition zone. Pure cultures of the few strains which did not grow initially in the presence of 1 p.p.m. DDT could be induced to grow in two stages with 0·6 and 0·8 p.p.m. DDT.

Degradation of DDT by bacteria was investigated in pure cultures of strains selected from (*a*) strains which strongly accumulated DDT, detected by autoradiography, and (*b*) strains isolated from enrichment cultures in peptone water to which 2 per cent DDT had been added suspended in acetone. The bacteria were grown in peptone water with 1 p.p.m. ^{14}C-DDT on a rotary shaker at 25° C. After 20 h the cells were spun down, washed and extracted with methanol (once) and chloroform–methanol 1:1 (twice). The combined extract was put through a membrane filter, washed with 0·1 M KCl[5] and evaporated. The residue was dissolved in 5 ml. hexane and cleaned by extraction with dimethylformamide (DMF) (three times). Water was added to the combined DMF layer and DDT was left in the hexane[6]. The concentrated hexane was chromatographed on a silica gel plate with petroleum ether (40:60)–paraffin 4:1 (ref. 7). Radioactive spots were located by autoradiography and estimated with a Packard radiogram scanner. The membrane filter was also scanned for radioactivity. A recovery of 90–100 per cent was obtained from the filter and extracts combined.

One bacterial strain from group (*b*) accumulated almost 100 per cent of the radioactive material in the medium. By the methods described, 75 per cent was found in the extract and one third of this amount was chromatographically shown to have been converted into DDE. A slight amount of DDD was also present. The radioactive compounds left on the filter may be either strongly bound DDT or DDE, or unextractable degradation products.

The ubiquity of DDT—found even in Antarctic snow[8]—may explain the large proportion of DDT-resistant bacteria in all soil samples. On the other hand, its insolubility in water may explain the small proportion of DDT-resistant organisms in this ecosystem.

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[1] Henzell, R. F., and Lancaster, R. J., *J. Sci. Food Agric.*, **20**, 499 (1969).
[2] Kokke, R., Van Zuilekom, J. T., and Wikén, T. O., *Antonie van Leeuwenhoek*, **35**, 121 (1969).
[3] Van Kleeff, B. H. A., Kokke, R., and Nieuwdorp, P. J., *Antonie van Leeuwenhoek*, **35**, suppl.: *Yeast Symposium*, G9 (1969).
[4] Kokke, R., Van Kleeff, B. H. A., Nieuwdorp, P. J., and Van Zuilekom, J. T., *Aetes Symp. Int. Radioecol.*, **1**, 637 (Cadarache, 1969).
[5] Folch, J., Lees, M., and Sloane Stanley, G. H., *J. Biol. Chem.*, **226**, 497 (1957).
[6] Faubert Maunder, De M. J., Egan, H., Godly, E. W., Hammond, E. W., Roburn, J., and Thomson, J., *Analyst*, **89**, 168 (1964).
[7] Copius Peereboom, J. W., in *Dünnschicht-Chromatographie* (edit. by Stahl, E.), 613 (Springer-Verlag, Berlin, 1967).
[8] Peterle, T. J., *Nature*, **224**, 620 (1969).

Carbon Monoxide as a Basis for Primitive Life on Other Planets: a Comment

WOLFGANG[1] has made the interesting suggestion that photodissociation of carbon dioxide to CO + O may provide the necessary ingredients for a chemotrophic primary production process conducted by living creatures on other planets, analogous to the primary production function of photosynthesis on the Earth. Wolfgang cites *Bacillus oligocarbophilus* as a terrestrial precedent for biological oxidation of carbon monoxide; *Hydrogenomonas carboxydovorans*[2] is a more recently described example.

Wolfgang made his suggestion partly to emphasize the point that speculation on these matters ought not to be prejudiced towards some variant of terrestrial photosynthesis. One ought also to avoid being influenced by the prevalence of aerobic metabolism in the world around us. Wolfgang's suggestion begs many questions about the stability of the O in the particular environment being considered; such questions could be largely avoided if CO oxidation were anaerobic. CO oxidation can be coupled biologically to sulphate reduction[3] and Yagi[4–6] has shown that it couples readily to the reduction of sulphite in extracts of sulphate-reducing bacteria. I have obtained extracts of *Desulfovibrio* which conducted a rapid oxidation of carbon monoxide with sodium dithionite (normally regarded as a very strong reductant) as the oxidizing agent. Anaerobic carbon monoxide oxidation, coupled to a step in the sulphur cycle, might be intellectually a somewhat more satisfying speculation than aerobic oxidation because of the circumstantial evidence now accumulating that ecosystems based on sulphureta are present-day representatives of some of the earliest terrestrial biological systems[7–9].

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[1] Wolfgang, R., *Nature*, **225**, 876 (1970).
[2] Kistner, A., *Proc. Roy. Soc.*, C. (Amsterdam), **57**, 186 (1954).
[3] Stephenson, M., *Bacterial Metabolism*, third ed. (Longmans, London, 1949).
[4] Yagi, T., *Biochim. Biophys. Acta*, **30**, 194 (1958).
[5] Yagi, T., *J. Biochem., Tokyo*, **46**, 949 (1959).
[6] Yagi, T., and Tamiya, N., *Biochim. Biophys. Acta*, **65**, 508 (1962).
[7] Klein, R. M., and Cronquist, A., *Quart. Rev. Biol.*, **42**, 105 (1967).
[8] Peck, H. D., *Some Evolutionary Aspects of Inorganic Sulphur Metabolism; Lectures on Theoretical and Applied Aspects of Modern Microbiology* (University of Maryland, 1967).
[9] Postgate, J. R., *Proc. Roy. Soc.*, B, **171**, 67 (1968).