

Sending smoke signals

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A Path Where No Man Thought: Nuclear Winter and the End of the Arms Race. By Carl Sagan and Richard Turco. *Random/Century*: 1991. Pp.499. \$27.95, £20.

WHAT have we here? A short book written for a general audience by two of the originators of the 'nuclear winter' theory. In it they describe the horrible environmental consequences of an all-out nuclear war, prescribe ways to mitigate these (not surprisingly by eliminating most nuclear weapons) and then suggest how we might reach that happier situation.

Sagan and Turco are two of the five authors of the *Science* paper published in 1983 that first developed the theory that smoke from many burning cities after a massive nuclear attack might alter climate on a global scale and reduce average world temperatures by as much as 20 °C. The effects on man and beast would be devastating. The theory was based on an analysis by Paul Crutzen and John Birks, published in 1982 in *Ambio*, that suggested that fires generated in a nuclear war could produce sufficient smoke to have substantial effects on the climate. Others have since refined the analysis: the general conclusion now is that the climatic effects are not likely to be as severe as first depicted and that a more apt description of them might be nuclear 'autumn' rather than winter. (Sagan and Turco 'lightly' acknowledge these later analyses.) But experts still concede that if the industrial world should go up in smoke, serious climatic consequences would be likely.

Nuclear-winter analyses are fraught with uncertainty. Just what would an all-out nuclear war be like? Would cities be heavily targeted and, if so, what would be the nature of the consequent fires? How much and what kind of smoke would be generated and how would it be distributed? How much of the solar radiation normally striking the Earth's surface would be absorbed by this smoke and for how long? And then just what would the climatic consequences be? For example, there is an uncertainty of a factor of 50 in the exponent when calculating the average reduction in sunlight, meaning that the effect on sunlight absorption could be anything from inconsequential to one that results in complete blocking, at least for a while.

It is indeed surprising that over a 40-year period of detailed analyses of the many consequences of nuclear war, the long-term climatic effects of the massive fires that might result were not adequately taken into account. So Sagan

and Turco, with their nuclear-winter colleagues, deserve great credit for analysing and drawing attention to the possibility of another horrendous outcome.

But in the language of game theory, neither hawks nor doves ever imagined anything but horrendous consequences — the differences lie in their strategies for avoiding a nuclear war altogether. The hawks believe that to assure deterrence, a vast and complex nuclear arsenal with a wide spectrum of capabilities is needed to convince the enemy that it will lose in every possible nuclear encounter. Doves believe that enough nuclear weapons only to threaten nuclear devastation are needed. It is not a gap in the repertory of imagined and unimaginable consequences that has limited efforts to deal with the threat of nuclear war. Nonetheless, as Sagan and Turco point out, nuclear winter, on the scale that they indicate, would extend the worst of conceivable man-made horrors

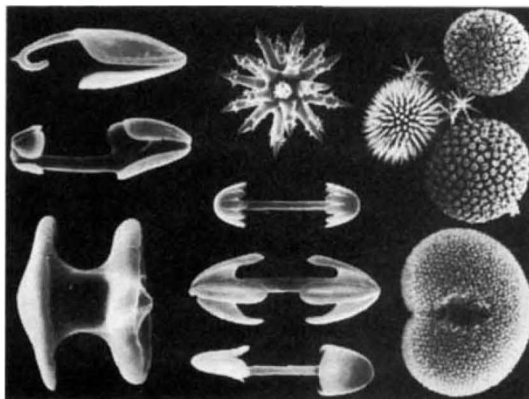
to parts of the world that are not close, either politically or geographically, to the nuclear combatants.

Sagan and Turco begin by describing nuclear winter and the basis of the theory. Then they briefly outline the other consequences of nuclear war: the production of toxic gases from fires, radioactive fallout and ozone depletion. The authors look at all the issues 'through a glass darkly', but the horrors of an all-out nuclear war hardly need a blacker perspective. They do, however, agree that it "seems highly unlikely, that even intentionally, we could destroy all life on Earth", concluding that some insects and grasses would surely survive. (Thank God.) Sagan and Turco then go on to contend that cities and oil-storage sites would be targeted in a nuclear war; if this were not so, nuclear winter would probably not occur.

The rest of the book (more than half) deals with nuclear policy rather than science. Nuclear deterrence is discussed generally: the possible self-deterrent effects of nuclear winter and its effect on noncombatants. Finally, the authors make proposals for reducing the world's nuclear arsenals below the current insane number that we have and below what they believe could cause nuclear winter. Except for being set in the con-

Absorbing creatures

Most people know that sponges come from the bottom of the ocean and make performing one's ablutions more pleasurable. Fewer are aware that they harbour antibiotic and anticancer substances. But how many could decide whether sponges are plants or animals? In fact they are multicellular, typically marine animals that usually occur in complex sessile colonies. Because they are built on a different plan from the Metazoa (for instance, they lack a nervous system), sponges are grouped separately from all other multicellular animals as Porifera, and are presumed to have arisen from unicellular ancestors independently. Their porous body is supported by a fibrous framework reinforced with a mineral skeleton of calcareous or, as shown here, siliceous spicules (top, $\times\sim 1,250$). Water carrying food and oxygen is drawn into chambers lined with choanocytes (bottom, $\times\sim 4,500$). Each of these cells has a flagellum for water propulsion, and a collar of microvilli for ultrafiltration of



food particles. The electron micrographs shown here are two of over 100 in the *Atlas of Sponge Morphology* edited by L. De Vos *et al.* With its narrative and line drawings, the volume provides an alluring and masterful guide to the anatomy, physiology and reproduction of sponges, as well as to the remarkable number of microsymbionts that they shelter. Published by Smithsonian Institution Press, price is \$41.95, £27.25. **PT**