subjects. She was a scientist studying scientists, a meta-scientist if you will. She had to make decisions about what she thought she was doing. The fact that she spends a lot of time explaining the relevant science implies that she thinks it matters. If it can influence her, it can influence other scientists as well. This problem confronts all students of science. How we study science implies something about what we take science to be.

As Segerstråle sees it, the significant difference between Wilson and Lewontin was in their attitude towards science. Wilson was willing to take chances, to come up with new ideas and to pursue them even if they seemed implausible or overly ambitious. He admits that his early efforts to biologize all of the social sciences, not to mention the humanities, might seem too simplistic. But he says the beginnings of general theories come out of such oversimplifications. Lewontin, in contrast, possibly because he thinks that such things as social class can influence science, holds a hard-nosed attitude to science — new theories must be clearly formulated and backed up with significant amounts of data.

Accurate though her explanation of the differences between Wilson and Lewontin might be, Segerstråle pays insufficient attention to one crucial aspect of the sociopolitical context of the time — the Vietnam War. Many Americans felt helpless during this time. They were faced with a lot of problems, not the least of which was a cruel, stupid war about which there was so little they could do. They could sign petitions, march in protest and burn draft cards, but that was about it. Early in her discussion, Segerstråle remarks that the sociobiology controversy was not between the left and right. "The actual dividing line went, rather, between a particular type of New Left activist on the one hand and traditional liberals and democrats on the other." The key term is "activist". The battle waged against sociobiology was part of this activism.

I must also mention the most famous incident of all. In 1978, at a meeting of the American Association for the Advancement of Science, both Segerstråle and I attended a session on sociobiology at which Wilson was to present a paper. As he began his presentation, a dozen or so members of the International Committee Against Racism marched up onto the stage, chanting: "Racist Wilson you can't hide, we charge you with genocide!" A woman then poured water over Wilson's head. How much water is a matter of conjecture. Usually we are told it was a pitcher of water. Segerstråle remembers a jug. I am sure that it was a small paper cup. One bit of evidence that supports my memory of the incident is that Wilson was able to mop up the water with a single handkerchief. Such are the problems of eye-witness reports. ■

David L. Hull is in the Department of Philosophy, Northwestern University, Evanston, Illinois 60608, USA.

The climate of fashion

Artist Lucy Orta's *Refuge Wear. Collective Survival Sac — 2 Persons. With Transformable Rucksack.* From a brief pictorial overview, *Art & Fashion* by Florence Müller (Thames & Hudson, £12.95).

Dowsing the human volcano

Something New Under the Sun: An Environmental History of the Twentieth-Century World
by J. R. McNeill
Allen Lane/W. W. Norton: 2000. 421/448 pp. £20/$29.95

Paul Crutzen

Looking back at mankind's impact on the environment during the twentieth century, with J. R. McNeill, professor of history at Georgetown University, as a guide, one is both impressed and depressed. To take a few examples from this highly informative book: the world population grew by a factor of four to around 6,000 million; the urban population increased 13-fold; industrial output increased 40 times and energy use 16 times. In the twentieth century, according to McNeill's estimate, humans used ten times more energy than during the whole of the rest of the millennium. Water use increased by a factor of seven, and the methane-producing cattle population paralleled the increase in the human population; on average, one cow per family supplies humans with dairy products and meat. The fish catch grew 35 times; and emissions of carbon dioxide and sulphur dioxide grew by a factor of more than ten.

The Earth's carbon, nitrogen and sulphur cycles are now strongly perturbed by agricultural and industrial activities. The global release of sulphur on the continents as a result of the burning of coal and oil — the "human volcano" — is an order of magnitude larger than all natural inputs combined. The supply of nitrogen to the environment from fertilizer application and from fossil-fuel burning is of a similar magnitude to total global biological nitrogen fixation.

The environmental impacts on the atmosphere are well known: unhealthy air to breathe in industrial cities, acid rain, photochemical smog, and increases in the greenhouse gases carbon dioxide, nitrous oxide and methane. Even the apparently benign chlorofluorocarbons have turned out to be an environmental menace, delivering chlorine to the stratosphere, where it acts as a catalyst in ozone destruction. The result has been the creation of the 'ozone hole' over the Antarctic, a region previously considered to be least vulnerable to such effects.

Many of the human effects on the environment are long term. The average residence times of chlorofluorocarbons, carbon dioxide and nitrous oxide in the atmosphere are 100 years or more, and some of their effects, such as global warming and the resulting sea-level rise, may linger for "centuries to millennia". The effects of human contaminants such as nitrate and lead on soil and groundwater could last even longer.

McNeill's book contains hundreds of examples of environmental assaults by humans on atmosphere, hydrosphere, pedosphere and biosphere, in all parts of the world, during the last century. All are described clearly and lucidly.

But the book is more than a mere summing up of human damage to the environment; it looks for links between the history of the planet and that of its peoples. McNeill doesn't see only the negative effects of the developments of the twentieth century. The engine, the source of the environmental problems, also contributed to the liberation of some 25% of the world's population from hard labour, opening up for them possibilities for better education and the pleasures of free time. But all this comes at a considerable price, and the big question is whether such developments can be made sustainable and, even more importantly, whether the other 75% of the human population can reach the same standards of living without the total destruction of the Earth's environmental base.

McNeill does not try to give answers and inspires readers to make up their own minds. However, in the final page of his book he gives some important advice: "Modern history written as if the life-support systems of the planet were stable, present only in the background of human affairs, is not only incomplete, but is misleading. Ecology that neglects the complexity of social forces and dynamics of historical change is equally limited. Both history and ecology are, as fields of knowledge go, supremely integrative. They merely need to integrate with one another."

I am very impressed with the book, and strongly recommend it to policy-makers and to historically and environmentally interested readers. It should serve well as teaching material at universities and even high schools. It is an important, beautifully written book.

Paul Crutzen is at the Max-Planck-Institute of Chemistry, PF3060, 55020 Mainz, Germany.

Icy displays from before time

Comet Science: The Study of Remnants from the Birth of the Solar System
by Jacques Crovisier & Thérèse Encrenaz
Cambridge University Press: 2000. 173 pp. £37.50, $54.95 (hbk); £14.95, $19.95(pbk)

Dale P. Cruikshank

As recently as 20 years ago, the most challenging part about getting new observations of a comet was the process of making some sense of them. This was particularly true for the photographic images that characterized a century of comet studies. We could see little more than signs of a comet's motion and the behaviour of its tail and the 'coma' of dust and gas as it approached, and then receded from, the Sun. We were given only vague clues to the composition, size and origin of the intriguing solid lump that lay inside the opaque comatic fog enshrouding the heart of the matter, the nucleus.

But now comet science is plunging ahead with an exuberance born of a chain of lucky chances, both in space and here on the home planet. Some of the dizzying delight of comet specialists occurs in the glare of the public view, as with the spectacular apparitions of comets Hyakutake (1996) and Hale–Bopp (1997). But most of the deepening and honing of our understanding of these icy bodies takes place in the dimly lit world of the astronomer, who dispatches spacecraft to selected comets, while probing back on Earth with ever larger and more sensitive telescopes.

Spectacular apparitions: but comets may also reveal much about the origins of life.

The story of these events is told in a clear, succinct and authoritative narrative in *Comet Science*, written by two French astronomers who have each contributed mightily to the modern understanding of comets. The authors trace the history of observations of comets and their role in the development of science since the time of the Greeks. But the bulk of the book focuses on the revelations of comet behaviour, composition and origin from the *in situ* studies accomplished by several multinational space missions, starting with Comet Halley in 1986 and going on to cover observations of Comet Hale–Bopp, the great summer-sky spectacle of 1997. Included along the way is the gravitational demolition of Comet Shoemaker– Levy 9 by Jupiter and the subsequent collision of the 20-odd icy fragments with the giant planet in 1994.

Although the missions to Halley had the obvious advantage of a close-up look and direct analysis of dust in the coma, traditional telescopic work has benefited enormously from the development of new and powerful instrumentation. Perhaps the most stunning advances have come from the application of radio astronomical techniques to comet studies. After a century of speculation on the identity of the parent molecules spawning all those complex photographic spectral lines and bands (from the daughter molecules), the parent molecules have finally come into view. Not only are water, carbon dioxide, carbon monoxide, methanol, isocyanoacetylene and a host of new molecules detectable, but the distribution of the isotopes of hydrogen, carbon, oxygen and nitrogen that comprise them have become decipherable. In the isotopes lie clues to the ultimate origin of comet material.

Comet Science not only lays out the factual information we have about comets, but clearly describes the context in which we now regard these icy "remnants from the birth of the Solar System". Parallel advances, from theoretical and laboratory studies, in understanding the chemistry of the ice and dust in the interstellar medium that floats around and clumps up in regions separating the stars show that some cometary material originated before the Solar System began to form. Mineral grains in thin, dusty clouds in deep space acquire icy coatings that are chemically processed by ambient stellar ultraviolet light, marking the beginnings of the complex carbon chemistry that, transported in the comets that have hit Earth, seeded our planet, as well as uncounted others, with some of the raw materials of life.

Comets are routinely observed from space by the Hubble Space Telescope, which offers views unachievable from Earth, and much new information about the nature of water in comets was revealed by observations of