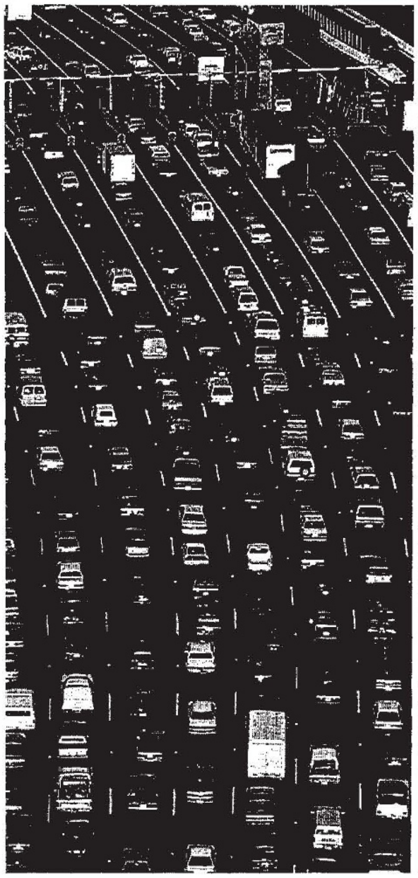
in my medical-student days.

It is difficult to find fault with this eccentric and lively account of the circulation. If I have any quarrel at all with Vogel it is in his apparent lack of regard for the red blood cell which, he suggests, is not a proper cell because it does not have a nucleus. But surely a cell that travels many hundreds of miles in conditions of unbelievable turbulence, is dragged through capillaries half its dimension and then crammed together with its fellows in the osmotic backwaters of the spleen, maintains itself and its haemoglobin against all the odds in this unfriendly environment yet is able to adapt its function to prevailing oxygen requirements, and suffers the final indignity of being eaten by a macrophage, is worthy of a little more respect (and space). But this is a personal bias.

Like all good storytellers, Vogel leaves a few intriguing questions hanging in the air. How, for example, does he know that the systolic blood pressure of an energetic octopus is about 80 mmHg, and who is it (or perhaps was it) that discovered why arboreal snakes do not faint when they climb trees?

The true mark of a really good popular science book is that it is as interesting to the expert as it is to the general audience to whom it is addressed. I strongly recommend this book to anybody who teaches the physiology of the circulatory system, and to cardiologists and all those who live in fear of them. □

David Weatherall is at the Institute of Molecular Medicine, University of Oxford, John Radcliffe Hospital, Oxford OX3 9DU, UK.



Rush-hour traffic creeping across the Bay Bridge, San Francisco. Sixty per cent of the oil burned in the United States each day is consumed by cars and trucks, adding hundreds of thousands of tons of CO_2 to the global greenhouse. The picture is taken from *Global Warming: Understanding the Forecast* by Andrew Revkin, published by the American Museum of Natural History Environmental Defense Fund. $29.95, £20.

Understanding historical climate

William F. Ruddiman

Climate Since AD 1500. Edited by Raymond S. Bradley and Philip D. Jones. *Routledge: 1992. Pp. 679. £85.*

WHAT can the climate changes of the past 500 years tell us about the future? To address this important question, the authors of this volume have assembled many different records of past global climate change and reviewed the limitations on interpreting these data. The result is a most valuable compilation.

Three kinds of data are examined, all from the continents or their margins. Historical data include recent instrumental recordings and a wide variety of earlier observations. Coverage before 1880 is adequate for portions of the northern continents, but there are large gaps in the data for North Africa and Asia, and little information for the Southern Hemisphere. Dendroclimatological data come from studies of annual tree-ring width and variations in density for many trees at each site and borings within each tree. In recent years, there has been fairly wide geographical coverage in the continents of the Northern Hemisphere and pioneering investigations in the Southern Hemisphere. Climate can also be reconstructed from ice cores. Glacial ice varies greatly in its physical and chemical composition, and the chronologies developed from annual layering can be verified against historically recorded volcanic eruptions.

But several factors limit the use of these methods. Historical records are often semiquantitative and are subject to complex observer biases. Also, the diverse array of recorded parameters (rain in east Asia, sea ice in North America) makes comparison difficult. Dendroclimatology studies are limited by, for example, the difficulty of allowing for long-term growth trends and, in some regions, having to calibrate and verify against only brief historical records of climate. For ice cores, the causes of variations are often not well understood (for example, the relative roles of air temperature and water-vapour source in changes in oxygen isotope ratios).

An underlying concern of the volume is the relevance of the changes in climate during the past 500 years to present and future climate, particularly those changes caused by greenhouse gases. If scientists could identify significant patterns of climate change over this period and link them unambiguously to known forcing functions, it should be possible to recognize some of the 'natural variability' in the climate system and to detect more accurately the magnitude of man-made changes, both in the past and future.

The baseline for calculating this century's global warming happens to fall in the relatively cool late 1800s, when instrumental recording became sufficiently broad for climatologists to attempt estimates of global temperature. Yet the many indicators of climate given in this volume point to substantially warmer temperatures in earlier times, such as the 1700s. If these warmer temperatures (or some average) were used as the baseline, the inferred warming in this century would be greatly reduced. This would aggravate the existing problem of explaining why warming this century is less than expected from observed increases in trace gases.

Answers to this broader question are not yet at hand. The challenge of synthesizing the data in this volume into a coherent view of global or even regional climate change is daunting, in part because different indicators are sensitive to different climate indices and seasons (for example, summer precipitation and winter temperature). In addition, geographical coverage for the continents is still limited, and most ocean regions will never yield annual climate indicators. Climatic forcing functions are also not yet well understood, including solar variability (for which no unambiguous evidence exists of a climatic effect), volcanic eruptions (the climatic effects of which are here given surprisingly lukewarm support; a stronger case has been made elsewhere by Steven Porter) and El Niño oscillations.

Nevertheless, this volume succeeds admirably in bringing together many of the multifaceted data from which future progress can proceed. □

William F. Ruddiman is in the Department of Environmental Sciences, University of Virginia, Charlottesville, Virginia 22903, USA.