Pyenson understands the approaches to relativity of a whole succession of commentators from Einstein's early collaborator Jakob Laub, to Born and Weyl, the latter an extreme exponent.

In a discussion of Minkowski and the special theory, Pyenson notes that, as a student, Einstein had found him boring as a teacher, because of the lack of physical content in his lectures, and that, later, Minkowski judged Einstein as mathematically limited. A recurrent theme here is

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Genius matured — Einstein, aged 37, in his Berlin study in 1916. The photograph is reproduced from one of the introductory chapters in Jamie Sayen's Einstein in America: The Scientist's Conscience in the Age of Hitler and Hiroshima. Publisher is Crown, New York, price is \$17.95.

that the tension between pure mathematics and theoretical physics was a constant feature of the scientific atmosphere in which relativity emerged. Similarly, the members of the famous 1905 Göttingen seminar on the electron theory were unable to perceive what was new in special relativity, and to resolve the impasse in the electron theory which interested them for its intrinsic and abstract characteristics rather than as a problem in physics. Einstein was opposed to this approach to physics which began with pure mathematical constructions rather than with physical problems.

Pyenson takes the question one step further by examining the relationship of mathematics and physics in secondary-school education in order to explain how pressure "from below" may shape the attitudes of research scientists. In this view,

students in traditional *Gymnasien* learned mathematics from people who were the products of university seminars in pure mathematics and who stifled generations of students with abstractions. When engineers and others revolted against this approach in the 1890s, a new instrumentalist viewpoint emerged, especially in the *Realenstalten* which prepared students for practical careers in technology and industry and which also, after 1900, produced the majority of physicists. The new instrumentalism, epitomized by Felix Klein, was a middle position between the older view of mathematics as a mere tool and the emergent neo-Leibnizian current espousing pre-established harmony. Einstein's education at the Cantonal school of Aarau was closer in spirit and content to the programme of the *Realenstalten* than to the classical *Gymnasium* curriculum which he had found so restricting.

It is not quite clear in Pyenson's exposition just how the pedagogical revolution was achieved. The secondary-school mathematics teachers (here characterized as the *sans-culottes* of this revolution)

were themselves the products of training in pure mathematics. The engineers wanted to break the hold of the universities (and thus of the pure mathematicians) on the training of school teachers and backed educational reforms designed to bring this about. Klein's role was to co-opt the *sans-culottes* by bringing the instrumentalist, problem-solving approach into the university. The complex social dynamics at play here require further delineation.

In his recent book *Revolution in Science*, I. B. Cohen stresses the significance of the conversion of "revolutions on paper" to true scientific revolutions; the social processes whereby working scientists are converted to a new theory are crucial to the analysis of this transition. Pyenson's contribution is precisely the exploration of factors in the German educational system which pre-conditioned a range of responses to relativity. □

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Marking change

Arthur J. Boucot

Fossils and Climate. Edited by P. J. Brenchley. Wiley: 1984. Pp. 352. £27, \$49.95.

I ENJOYED reading this book, and wish I could have attended the symposium on which it is based. As is usual with such volumes, the 15 contributions differ in both quality and originality, but in general the standard is very high.

For me, the outstanding chapters are Janis's on the use of fossil ungulate communities in the Cenozoic to better understand floral communities of the past, as well as climate, and Rögl and Steininger's synthesis of the Paratethyan story ("Pontian Cockles" brought up to date). This latter contribution is clearly the culmination of some decades of labour by scientists from many nations, and will be of great value to both geologists and palaeontologists, as well as evolutionists. Not far behind is Rosen's account of just what might control reef coral distributions, both past and present. Rosen discusses our present understanding of the subject, much of which is based on his own research, and evaluates critically the various explanations which have been put forward (one hopes that he will next tackle the Cenozoic record to complement this work). Also included is a helpful commentary on the thorny problem of defining biogeographical provinces.

In addition to these particularly original contributions, there are several less innovative but still very worthwhile chapters. In this category are Shackleton's

account of the use of oxygen isotope evidence in the study of Cenozoic climatic change, Creber and Chaloner on growth rings in fossil wood, Hallam on the use of marine invertebrates for interpreting past climates, Brenchley on the relation between the terminal Ordovician extinction event and climatic events (contemporary glaciation), and Dickins on the story of Gondwana in the Late Palaeozoic.

In the palaeobotanical area, Boulter reviews the drawbacks of using European Palaeogene botanical evidence in estimating temperatures; these are clearly important problems, of which I had been ignorant. Boulter doesn't provide us with a pleasing answer, however, possibly because one isn't available. Here, too, Batten reviews the confusing (for me) status of late Cretaceous pollen biogeography and its implications.

The book, of course, hardly lives up to its title, but it would be unreasonable to have expected this from a handful of papers prepared for an international symposium. Especially notable is the absence of any discussion of meteorological modelling of the past (CLIMAP, as well as work on the Cretaceous such as that by Barron or Lloyd), but the bibliographies at the end of each of the papers are reasonably comprehensive and do provide a lead into the broader literature on fossils and climate. Libraries specializing in geology and biogeography should purchase this book, while life scientists would do well at least to skim the papers which deal with the aspects of evolution involving climatic change and biogeography. □

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