oretical discussions. It would be unfair not to mention that the "ponderomotive force" calculations presented by Hora continue to be the subject of lively discussion at meetings on laser-plasma interactions.

Obviously, there is great interest now in the analysis and experimental verification of high-temperature plasmas produced by laser pulses on solid deuterium targets. The answer to the question concerning the conditions necessary for the production of significant numbers of neutrons may lie in the tailoring of the pulse which is mentioned in Hora's paper "Experimental results of free targets," in which he refers to the pioneering work of Lubin at the University of Rochester on tailored pulses. One cannot criticize the book for its lack of information on neutron experiments, because the very first experiments demonstrating significant numbers of neutrons were barely at the reporting stage in 1969. At least the French experiments are mentioned by Floux in the appendix.

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Quaternary Geology

The Late Cenozoic Glacial Ages. KARL K. TUREKIAN, Ed. Yale University Press, New Haven, Conn., 1971. xii, 606 pp., illus. $20. Silliman Foundation Lectures.

Any scientist wishing to learn the "new look" of Quaternary geology must spend several hours with this collection of 21 papers. These are up-to-date distillations of what one might glean from over 1000 journal references given at chapter endings. But there are some new ideas and methods, too. The common aim is to interpret the significant climatic fluctuations—especially glacial-interglacial contrasts—from sea floor deposits, microorganisms, sea level deposits, glacier "oxygen" stratigraphy, pollen, mammals, or lake sediments representing the last 10 million years. The focus is on the great scientific advances of the last decade; 82 percent of the references are dated 1960 or later. There is no reference to the "classical" Kansan stage, nor indeed is there any description, table, or critical review of glacial drift, loesses, or paleosols from the central United States, let alone from Europe. This is not a book about glaciations as such, although two of the best contributions—Denton's excellent summary of Antarctic ice fluctuations and McDonald's "Deglaciation of eastern Canada"—deal with particular examples.

The dominant theme is the role of the oceans in the cyclic pattern of climate (12 chapters). A description of a new micropaleontological statistical approach to climate by Imbrie and Kipp is the longest account. The four summary studies of sea floor deposits are the latest views of well-known teams: Emiliani; Wollin, Erikson, and Ewing; and Hunkins and others (under Arctic sea ice). Broecker gives welcome evidence in support of the long-used projection of sedimentation rates on the ocean floor. Late Pleistocene eustatic sea level fluctuations are presented by Bloom in a neat new calculation of the nature of deglaciation from late glacial sea levels. Two chapters concern the precision and interpretation of oxygen isotope curves in ice in Greenland and the variations in late Pleistocene carbon-14 determinations by the Dansgaard team and Stuiver. Two very good long articles by van der Hammen and by Wright provide careful, up-to-the-moment interpretations of the pollen record in Europe and America. I find Wright's time-distribution chart of former forests (fig. 9) most helpful in teaching. Mammal stratigraphy is a less precise climatic tool, as Kowalski says, and is the only subject treated in the book that is not tied precisely to the latest isotopic dating. The two summaries of mammal evolution (mostly European) make the subject more meaningful than previous long lists. Two long summary papers about the cradles of man and civilization (East Africa by Bishop and the Near East by Farrand) demolish the simple idea of "pluvials" correlated with glacials. Ewing concludes with an all-too-short updating and defense of his and Donn's theory of the causes of glaciation.

Of course one can point to a few weaknesses. I deplore the paucity of cross references among articles; of course this is hard for an editor to achieve after 34 authors have scattered. The long, detailed tables of data (pp. 147–81) could hardly be read by anyone. The heavy titles of some of Wright's diagrams, the reduction of a few pollen spectra to the point of illegibility, and the hand printing of Farrand's fig. 8 detract from the finish of the volume. For all that, 606 pages with plenty of plates is a bargain at $20 today.

The occasion for this symposium and volume was the retirement of Richard Foster Flint, Henry Barnard Davis Professor of Geology at Yale. And Flint well deserves a stimulating volume like this after a life full of inquiry in all corners of the earth. This book is not, however, exclusively a product of Yale thinking by the many students of the Quaternary whom Flint has sent out; it is a collection of many points of view. Above all there are many new ideas to be tested in the future: basin and range orogeny as a result of westward migration of the North American plate, identity of Brørup, Bølling, and Allerød climatic reversals from oxygen isotopes in deep ice cores, fully quantified paleoclimatic curves from a pelagic ecosystem essentially unchanged during the Pleistocene, and interpretations of back-melting versus later downwastage of the last glacial ice margins from comparisons of well-dated sea level and ice margin positions. One gains two distinct impressions: (i) that the glacial-interglacial climates varied from place to place in a complex way if mean annual temperatures could vary by a scant 4°C over the broad Pacific but by 7°C or more over the Atlantic and 13°C on the Greenland ice top, and (ii) that glacial refrigerations go much farther back in time (at least 4 million years) than we conceived a decade ago and are much more numerous than the standard total of four or five. You must read it to believe it.

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The Decline of a Theory

The Caloric Theory of Gases from Lavoisier to Regnault. ROBERT FOX. Clarendon (Oxford University Press), New York, 1971. xvi, 378 pp. $16.

Before 1850 most physicists and chemists held as a working assumption the view that gases were composed of stationary particles, kept apart by repulsive forces. These forces were accounted for by the putative