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

presence of the imponderable fluid *caloric*—the matter of heat. This prevailing view of the gaseous state had two supporting pillars: the orthodox Newtonian view that the particles were stationary and that the required repulsive forces existed between them, and second, the caloric theory itself, which was rooted in the doctrines of fire of such natural philosophers as Boerhaave and Cleghorn and which was formed and championed by Lavoisier and Laplace. Fox gives a detailed account of the evolution of the calorist theories and pays particular attention to the zenith of their strength and popularity in the works of such giants of Continental physics and chemistry as Laplace, Carnot, and Avogadro.

Fox's account increases in drama and in pace when the groundworks are completed; the decline and fall of the caloric theory of gases are the meat of the issue. He sees the rather long decay of the caloric view as linked inseparably with the faltering of the influence of Laplace and the Laplacian hypothetico-mechanical style of science on French physics. The assault was led by Fourier and by such younger men as Dulong, Arago, Petit, and Fresnel; Fox sees them (with the possible exception of Fourier) as attempting to find a middle way between Laplacian orthodoxy and an ultimately sterile positivism, the latter a symptom of the interregnum created by the increasing weakness of the former. The author concludes that the disintegration of this brilliant group of younger physicists after 1830 may well have been responsible for France's loss of scientific leadership in the middle and late 19th century.

This book would have been immeasurably improved by a fuller treatment of what Fox terms "Laplacian physics," the decline of which plays so important a part at the dénouement. But Fox has written an engaging book, demonstrating in it that he is neither daunted by the "big issues" nor fearful of touching upon problems which can be dealt with in an only partially satisfactory way.

One of these larger issues, however, is raised only obliquely. Fox maintains that the caloric theory went out with a whimper and not with a bang; contrary to T. S. Kuhn's view of scientific revolutions, no "crisis" situation existed here, and no satisfactory "paradigm" was yet readily available to replace the theory. It is perhaps unfortunate that Fox did not see fit to face this issue squarely, for it still after all bears examination. Certainly, Joule's experiments on the interconvertibility of heat and mechanical motion in the 1840's appear to have given a severe shock, at least to the calorist views of William Thomson.

Unquestionably, *The Caloric Theory of Gases* is a readable and often compelling book, one in which historians of science will find considerable matter to debate and scientists may discover much that is stimulating and surprising.

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Structural Chemistry

Conformational Analysis. Scope and Present Limitations. A symposium, Brussels, Sept. 1969. G. CHIURDOGLU, Ed. Academic Press, New York, 1971. xii, 280 pp., illus. $15. Organic Chemistry, vol. 21.

This book is not a systematic treatise on conformational analysis but consists of the short invited papers presented at a symposium held under the auspices of the International Union of Pure and Applied Chemistry in 1969.

With this reservation understood, the book has much to recommend it. The topics it treats are quite broadly representative, ranging from five-membered rings (Altona) through six-membered (Reisse; Stolow; Garbisch, Hawkins, and McKay), seven-membered (von Bredow, Friebolin, and Kabuss), and eight-membered rings (Anet) to ten-membered ones (Westen); from carbocycles to heterocycles (Anteunis on oxygen and sulfur heterocycles; Lyle, Thomas, and Walsh, Fodor, Mandava, Frehel, and Cooper, and McKenna on nitrogen heterocycles); and from sugars (Onodera) to steroids (Bucourt). There are also chapters on solvolytic cyclization (Felkin), on *ab initio* calculations (Lehn), on the conformation of molecules containing atoms from groups V–VIII of the periodic system (Musher), on catenanes and molecules with knots (Schill), and on carbonium ions (Schleyer). Excluded from the symposium were papers on the conformation of biopolymers or synthetic polymers; the closest one gets to these topics is in a discussion on cyclodepsipeptides (Ivanov and Ovchinnikov) and in a chapter on optical rotation in branched paraffins (Pucci, Aghetto, Luisi, and Pino).

As one might expect in a collection of papers presented at a meeting, the length, the quality, and even the language of the contributions vary widely —although only one contribution is in a foreign language (German), one or two others are in "that international language of Science: broken English." Several of the chapters duplicate more extensive reviews by the same authors that have appeared elsewhere; one of the authors has actually published an entire book on the topic of his chapter in the same Organic Chemistry monograph series to which the present collection belongs.

This reviewer has reservations concerning the desirability of collections of the present type—at the very least, contributors to a symposium who have recently reviewed their work in other places should be excused from duplicating such reviews in abbreviated form—but given the objective of this collection he must commend the editor for achieving it handsomely. All 20 contributors to the symposium submitted manuscripts; publication in the form of an attractively printed and sturdily bound book with clear tables and neat diagrams was achieved in only about 15 months; the book is carefully edited, is largely free of errors, and has adequate author and subject indexes. (In contrast, the ten plenary lectures given at the symposium, published as articles in *Pure and Applied Chemistry*, took almost two years to appear.)

This collection is a high-priority item for institutional libraries serving chemistry departments. In addition it is recommended for individual chemists working on conformational problems; several of the chapters, notably that by Altona on pseudorotation in five-membered rings, those by Garbisch *et al.* and Reisse on the evaluation of thermodynamic parameters in conformational equilibria, and, above all, the beautifully clear and instructive contribution by Lehn on the status of *ab initio* calculations are of more than ephemeral interest.

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