butterfly conservation in temperate regions, the local extinction of a butterfly population may be considered only a trivial loss in many conservation circles; however, such an event should be treated very seriously as an indicator of long-term habitat deterioration. I was quite impressed by the amount of information on population structure, habitat requirements, extinction rates, and recolonization events that has been amassed on rare butterflies in the United Kingdom, and Thomas's chapter should be read by all conservation biologists, irrespective of their particular taxon of interest.

In summary, the editors have given us a book on butterfly biology that is exciting, informative, useful, and attractive. It clearly belongs on the bookshelf of anyone who uses butterflies as experimental organisms, and parts of it can be read with benefit by anyone interested in the general topics covered. This volume is a fitting tribute to Ford, and it amply justifies Henry Walter Bates's observation made in 1864 in *The Naturalist on the River Amazon*: "As the laws of Nature must be the same for all beings, the conclusions furnished by this group of insects must be applicable to the whole organic world; therefore, the study of butterflies—creatures selected as the types of airiness and frivolity—instead of being despised, will some day be valued as one of the most important branches of biological science."

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A 19th-Century Astronomer

James E. Keeler. Pioneer American Astrophysicist and the Early Development of American Astrophysics. DONALD E. OSTERBROCK. Cambridge University Press, New York, 1984. xii, 411 pp., illus. $39.50.

James Keeler (1857–1900) was widely regarded as the leading American astronomical spectroscopist of his generation. Born to a family of modest circumstances and growing up in communities devoid of scientific or cultural resources, Keeler might have become a mechanic or an instrument maker had he been a few years older. Luckily for him, and for science, he came of age at a time when America was ready to educate and employ scientists. In 1877, through a series of coincidences, Keeler was able to matriculate at Johns Hopkins, newly established as America's first advanced research university. Following graduation he went to work with Samuel Pierpont Langley at the Allegheny Observatory, where he acquired practical experience manipulating telescopes, spectroscopes, cameras, and bolometers. In 1883 he went to Germany for further study of physics and mathematics.

James E. Keeler at the time service switchboard at Lick Observatory, 1886. [From *James E. Keeler*; reproduced by permission of the Mary Lea Shane Archives, Lick Observatory]

Keeler's professional career, which lasted but 16 years, was spent alternating between the Allegheny and Lick observatories. Dedicated in 1862, the Allegheny Observatory had been founded by a group of Pittsburgh businessmen largely as a cultural adornment for their city. They sought the largest telescope their money could buy (a 13-inch refractor) and the most handsome building, but provided few resources for salaries, publications, and all the other necessary expenses of a scientific institution. To fund his researches Langley adopted the expedient of selling observatory time to local railroads concerned with establishing standard time signals. By the 1880's much of the equipment at Allegheny was antiquated, and the expansion of heavy industry in the area was proving a hindrance to good seeing. The Lick Observatory, by contrast, was new, well situated, well endowed, and designed for research. Keeler, who was chosen director of the Allegheny Observatory in 1891, became director of the Lick Observatory in 1898. He did excellent work in both places, both as a scientist and as an administrator. Together with George Ellery Hale, he was a founder of the *Astrophysical Journal*. Crowning his scientific achievements were his spectroscopic proof that the rings of Saturn are composed of particles and his photographic discovery of the abundance of spiral nebulae.

An astronomer by profession and himself a former director of the Lick Observatory, the author of this biography displays remarkable sympathy for his subject and tells his story with charm and grace. Keeler's strength was as an observer. He had a good sense of what projects might yield good results, and he knew how to squeeze the most from his instruments. In Osterbrock's words, he "tended to distrust far-ranging conceptual schemes, and to emphasize the complexities shown by the observations themselves" (p. 138). The same observation might be made of this biography. Osterbrock's interpretation of Keeler's work in terms of the science of his time and larger issues in the politics or sociology of science is weak. He has, however, scoured some 25 archives, unearthed just about every piece of paper to, from, and about Keeler, and organized the material systematically. This is narrative history in the grand tradition, leaving us to draw our own conclusions.

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The Dynamics of Climate

Climate Processes and Climate Sensitivity. JAMES E. HANSEN and TARO TAKAHASHI, Eds. American Geophysical Union, Washington, D.C., 1984. viii, 368 pp., illus. $28. Geophysical Monograph 29. Maurice Ewing Volume 5. From a symposium, Palisades, N.Y., Oct. 1982.

In an attempt to add to our understanding of the internal climate feedback mechanisms this book of proceedings presents 30 papers describing climate interactions in all parts of the climate system. Organized into six sections—Atmosphere and Ocean Dynamics, Hydrologic Cycle and Clouds, Albedo and Radiation Processes, Cryospheric Processes, Ice Cores and Glacial History, and Ocean Chemistry—the papers provide a sampling of current work on the subject. That the book is not completely comprehensive is testimony to the explo-

sion of research on this subject in the past ten years.

Some of the papers are interesting samples of the authors' work that lead the reader to extensive results published elsewhere. Others are comprehensive works themselves. One example of the latter is a paper by Hansen, Lacis, Rind, Russell, Stone, Fung, Ruedy, and Lerner, which is by far the longest paper in the volume. It presents results of extensive experiments in which a general circulation model of the atmosphere was used to test the relative importance of many feedback mechanisms. In addition, it presents new theoretical work that adds greatly to our understanding of the transient response, the rate of change of climate in response to, say, increasing atmospheric carbon dioxide. The two next longest papers in the book, by Rind and Barry *et al.*, also use the general circulation model to test feedbacks. These three papers illustrate the utility of theoretical computer models for the study of a system that is not amenable to actual physical experiments.

Some of the other papers present analyses of data on past climate change. Such analysis is another important technique for the study of feedbacks. With actual data, however, it is much more difficult, and impossible in many cases, to isolate the important feedback mechanisms and test their relative importance, since all are acting at once.

The book is a necessity for anyone actively engaged in or contemplating research on climate change.

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Early Towns of Europe

Farms, Villages, and Cities. Commerce and Urban Origins in Late Prehistoric Europe. PETER S. WELLS. Cornell University Press, Ithaca, N.Y., 1984. 271 pp., illus. $32.50; paper, $14.95.

The author of this book draws on the wealth of archeological publications on the late prehistory of central Europe (approximately 1000 B.C. to A.D. 1000) to formulate his main thesis, that exchange and commerce were decisive factors in the establishment of the early towns of Europe beyond the Mediterranean world.

During the Roman Empire (A.D. 0 to 400) classical societies were also in existence north of the Alps, and these influenced deeply the medieval development of the area of study. Wells rightly stresses the continuity between the Iron Age and subsequent periods but devotes only 20 pages of the book to the first millennium A.D. This is clearly the weakest part of the work. The archeological material of that period, much of which is from richly furnished graves, lends itself to consideration of social hierarchies and of contacts between princes and magnates. Though it is more difficult to understand the economic basis of the lifeways of the major groups of society, information on the subsistence economy is actually very rich for the first millennium A.D., though less easily accessible. A study of this material might have led the author to consider more seriously factors other than commerce in the development especially of those towns that continued after A.D. 1000. In particular, local marketing, craft production, religious institutions, and administration come into focus for such successful centers, most of which, unlike the Iron Age towns, have survived till present times.

The author's specialty is the early Iron Age, about 800 to 400 B.C., and this and the following phase are treated in much detail. Against a late Bronze Age background a thorough presentation is given of the interesting archeological material, arranged according to major themes such as manufacturing or distribution of wealth. The author painstakingly translates the information into a text that reads quite well though full of scholarly terms and references to localities of finds. We also hear of things more meaningful to the unprepared reader, like the princely town-fortress of Heuneburg in southern Germany, which traded with the Greek colony at Marseille. In a chapter on the later development an account of the impressive Celtic town of Manching, also in southern Germany, is presented. This site traded with Roman Italy in the dynamic period just before the legions marched into the region. Wells stresses the intermediate phase of raiding and migrations that took the Celts, for instance, to Delphi in Greece, where they sacked the famous temple of the oracle, and to Rome itself in search of booty and fame.

The author is poised between two traditions of archeological research. The first is a continental European one, characterized by firm control of the evidence and providing the specialist literature but less dynamic and imaginative when it comes to social and economic interpretation of the data. The other is a newer, English-American tradition that seeks to interpret archeological finds in terms of social change. Oriented toward social anthropology, this tradition has, as its basic weakness, difficulties in coming to grips with historical reality, particularly with diversity. In the present case we note the reverence of the author for the European, mainly German, scholarship. Yet one would have liked to see the data from this tradition studied more deeply, rather than only summarized within a framework derived from the other tradition.

Clearly Wells's intention has been to produce a book useful for the reader who is seeking acquaintance with the problems of early European society. To this end the work is lavishly furnished with illustrations and has a long (59 pages) bibliography. All in all Wells has done a fine job of summarizing in a scholarly manner interesting archeological evidence much of which is for the first time made available in English.

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Die Art in Raum und Zeit. Das Artkonzept in der