historians of physics (including Hermann) began as physicists, it is especially interesting to read his account of Haas, who is probably the only one to have made the inverse transformation.

Despite its merits Hermann's book is not adequate as history. It does not begin to reconstruct the science of the early 20th century in the kind of depth and detail that we need in order to understand what happened in the crucial first decade of the quantum revolution.

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Archeometry

Dating Techniques for the Archaeologist. HENRY N. MICHAEL and ELIZABETH K. RALPH, Eds. M.I.T. Press, Cambridge, Mass., 1971. xii, 228 pp., illus. $12.50.

This collection of papers, which inaugurates a series of handbooks to be produced under the auspices of the University of Pennsylvania Museum Applied Science Center for Archaeology, joins a collection of volumes that have appeared over the last three years dealing with the various technical and analytical specialties that can be grouped together under the heading archeometry. The other recent works include *Radiocarbon Variations and Absolute Chronology*, edited by Olsson; *Science and Archaeology*, edited by Brill; *The Impact of the Natural Sciences on Archaeology*, edited by Allibone; *Scientific Methods in Medieval Archaeology*, edited by Berger; and the second edition of *Science in Archaeology*, edited by Brothwell and Higgs. With the appearance of these works, archeometry can be said to have come of age, although the actual number of people engaged in it is relatively small. It has been, and presumably will continue to be, a contributory factor in nudging archeological research in the direction of more rigorously built strategies and methodologies modeled on those of the physical sciences. Although the so-called "new archeology" has a number of tangled roots, certainly the advent and increasing precision and accuracy of chronometric—"dating"—methods now in use must not be overlooked in any explanation of its origins.

The volume under review brings together contributions by eight authors, with four of the seven chapters—on dating by means of radiocarbon (Ralph), archeomagnetics (Bucha), thermoluminescence (Winter), and obsidian hydration (Michels and Bebrich)—providing extended discussions that include outlines of laboratory procedures. The other chapters—on dendrochronology (Michael), fission-track dating (Faul and Wagner), and potassium-argon dating (Faul)—although brief and selective, are valuable for those who wish to understand or review the basic elements of these techniques. The chapters on the two techniques with which most archeologists have had the most contact—radiocarbon and obsidian hydration—should be commented on specifically.

The chapter on radiocarbon is one of the most complete summaries of the technique available. Especially pertinent is the discussion of sample types suitable for radiocarbon work and of problems connected with their utilization. Very valuable also is a concise outline of the laboratory procedures, including the specific basis of statistical manipulations of counting data and the significance of $^{13}C/^{12}C$ ratios in fractionation determinations. Some, however, may be puzzled to find that a discussion of the basic assumptions of radiocarbon dating has been alloted only about twice the space of a section devoted to the McBee edge-punched retrieval cards for radiocarbon dates, especially in view of the fact that a project to provide a computer-based data-retrieval system is now well under way. Ralph's discussion of the relation of radiocarbon years to calendar or "true" years, in other words the secular variation or De Vries effect, apparently does not completely utilize the data published by Suess, and Ralph specifically notes some concern about the use of some radiocarbon data in magnetic intensity studies in Bucha's chapter in the volume. Ralph accepts the validity, *on the average*, of the long-term cycles identified by Suess, but does not agree on the existence of short-term oscillations. The occurrence of at least some of these short-term perturbations has been supported by carbon-14 data from European medieval samples (see the Berger volume). Those concerned with the problem of correcting carbon-14 data for secular variation may wish to use the "MASCA Correction Factors" in conjunction with the Suess values published in *Radiocarbon Variations and Absolute Chronology*.

The chapter on obsidian hydration provides a complete historical survey of the development of the technique, noting the lack of immediate acceptance of it as a time-placement method. Although the grounds are not specifically stated, the reluctance to accept the technique can be attributed to the simple fact that, on the average, 60 to 70 percent of the early obsidian hydration "dates" did not agree with the age of the obsidian sample as determined by other criteria. It was not until about five years ago that other workers began to investigate the chemical and physical nature of the hydration phenomena and the effect of compositional variability on hydration rates. Although the chapter notes the chemical problems in obsidian hydration work, it does not bring into clear focus the trends of the current research, in particular the realization that all hydration rates cannot be assumed to follow a simple diffusion formula. Evidence available by 1968 called into question, at least for one area, the use of a simple diffusion formula, and subsequent geochemical evidence confirms the extremely complex nature of obsidian hydration chemistry.

One trusts that, as the editors intend, this handbook will be regularly updated.

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Metropolitan Expansion

Suburban Land Conversion in the United States. An Economic and Governmental Process. MARION CLAWSON. Published for Resources for the Future by Johns Hopkins Press, Baltimore, 1971. xviii, 406 pp., illus. $12.50.

This comprehensive and careful study characterizes the broad results of America's century-long process of urbanization and illuminates the subtle and complex mechanisms that produce those results. Although the primary focus is on the land conversion process as it operates at the growing suburban fringe of our cities, its scope reaches into the slums and city halls of the metropolitan centers and the vast remaining rural areas of the nation. Based primarily on the last two decades, this study tells as much about our future as an urban nation as it does about our past.

The principal contribution of Clawson's book, in my view, is provided by the well-documented, analytic overview of the process of urban expansion in the United States in the period since World

War II. The general findings are not novel. For at least a full century, on a national scale the concentration of population in metropolitan areas has been increasing while at the same time the population within the metropolitan areas has been moving outward toward the suburban fringes. Three-quarters of the American population now reside within a land area representing only 1½ percent of the total. In the last generation, a centrifugal process of resettlement has created sharp divisions of age, race, and income among the 150 million metropolitan Americans as the young, white, affluent segments have moved out to the suburbs.

Who builds the metropolis? Sam B. Warner, Jr., asked that question in *Streetcar Suburbs* (1962), a study of the process of growth in Boston in the 19th century. Warner's answer, "The . . . metropolis is the product of hundreds of thousands of separate decisions," is echoed and elaborated by Clawson and his colleagues at Resources for the Future. As they put it, "The decision-making process in urban expansion is highly complex and diverse. It is incredibly fragmented and diffused among a wide variety and large number of private individuals and organizations and among many public agencies at each of the major levels of government." What follows is a rich description and analysis, constituting one-third of the book, of the characteristics of the decision-making process, the chief actors in it, the market for suburban land, and the role of public agencies and services.

Clawson's concise appraisal offers a balanced view: The process has great vitality and has produced a lot of good housing and pleasant neighborhoods. Although diffuse decisions sometimes produce inconsistent results, the process avoids massive errors. On the other hand, housing costs appear to have been higher than was perhaps necessary. Land has been consumed lavishly, with undistinguished esthetic results. Most distressing is the fact that fully half the population—the poorer half—is not served at all by high-cost suburban growth. The strengths and weaknesses of the process are shown to be consequences of the diffuseness of decision-making and the inexorable force of the land market.

A "case study" of the Northeastern Urban Complex provides a more detailed example of the forces at work in urban expansion. Ideas that are treated generally and within a national scope elsewhere in the study are quantified and made particular in this part. A detailed analysis of the region, at a much finer grain than is usually found in such work, reinforces the general note of caution to the effect that the real story of urban America lies in the variegated unfolding of local action, that sweeping generalizations about urban trends on a national scale may mislead as much as they inform.

The book concludes with a look at the future. Not surprisingly, Clawson finds that the future of the American city will greatly resemble its past if there is no major effort to change the process of development. How might that be done? The concluding chapter cites some possibilities for change, such as improving the land market, reforming local government, providing housing for the poor. It is no criticism of this book to say that these ideas are insufficient to induce great confidence in the nation's ability to alter the flow of a process so integral to the lives and interests of the broadest segment of our population.

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Environmental Physiology

The Temperature and Water Relations of Reptiles. J. L. CLOUDSLEY-THOMPSON. Merrow, Watford, Herts., England, 1971 (U.S. distributor, Bonn Industries, Metuchen, N.J.). vi, 160 pp. + plates. $8. Merrow Technical Library, Zoology.

The ancestral amphibians and reptiles were the earliest terrestrial tetrapods; they invaded the land and gradually shifted from the shores of lakes and swamps to occupy the interior of the continents. Invasion required specialization to resist the effect of gravity, the unbuffered incidence of solar radiation and celestial cooling, and the more limited availability of water. Water was required for maintenance of the internal milieu, removal of waste products, and conditioning of exchange surfaces. All the true invaders of the land have long since become extinct, and the surviving amphibians have adapted for a quite different mode of life history. Hence one must look to reptiles for clues to the diverse solutions that ultimately made terrestriality successful.

There was a long time before physiologists realized that interesting answers might indeed be obtained from studying reptiles, and even longer before it was seen that reptiles might incorporate basically different solutions from those seen in most mammals and birds. The last three decades have led to an explosion of information regarding these animals. The diversity of thermoregulatory patterns, the different solutions arrived at by different species and in different environments, and the critical importance of the behavioral state of the animal have been documented multiple times; we stand at the beginning of a true comparative physiology. This small book addressed to the informed undergraduate deals with problems of thermal (*not* temperature as in the title) and water relations, the latter topic occupying less than 20 percent of the whole. The treatment is by examples and is more ecologically than physiologically oriented. Though much literature, particularly some later references, has been omitted, the text gives an excellent conception of the diversity of solutions developed by reptiles and the diversity of approaches used by ecologists and physiological ecologists studying them.

The volume does show a certain lack of synthesis (for a more synthetic approach see J. R. Templeton's chapter in G. C. Whittow's *The Comparative Physiology of Thermoregulation*, Academic Press, 1970). When two species are stated to differ one is left with the question whether the difference is due to experimental approach, to interspecies variation, or to ecological adaptation. There might also be a more critical approach to questionable data or to methods that should not be used; a small addendum pointing out approaches to further study and cautions needed in experimentation might well have been desirable. The proofreading, particularly of Latin names, leaves a bit to be desired, as does the subject index, which is much shorter than those of author and species names. Perhaps the greatest strength of this volume is in its extensive use of examples, particularly from tropical (mainly African) situations. Here the author is closest to his own research, and this competence definitely shows through. This view makes the volume a reference that may be as useful for specialists as for the audience to whom it is addressed.

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