Book Reviews

Metrology

British Weights and Measures. A History from Antiquity to the Seventeenth Century. RONALD EDWARD ZUPKO. University of Wisconsin Press, Madison, 1977. xvi, 250 pp., illus. $15.

Pints in a quart, barleycorns in an inch, perches in a chain, poppyseeds in a barleycorn, feet in a fathom, rundlets in a butt, gallons in a bushel, square feet in a square yard. . . . I have often thought of trying to see how far I could get, with a list of equivalents, in traditional English measures, running systematically through the integers. Ten gives no difficulty (chains in a furlong), although the very fact that ten occurs so infrequently is a constant source of consternation, not to say amusement, to those who live in the supposedly rational wake of Napoleon. The apologetic air of the Anglo-Americans, aware only of the oddities of the systems of weights and measures they have inherited and not of any virtues it might have, is slowly disappearing as metrication makes its mark. One could argue—however perversely—in favor of the thoroughgoing binary system in the scale of dry measure, or for the advantages of a scale, such as the Babylonian sexagesimal system, involving 3 as a factor. ("What a tragedy that we were born with ten fingers," and so forth.) Zupko is not concerned with systematic advantage and disadvantage, except insofar as these are a part of history. And in writing his history of British weights and measures he shows us that there are many more facets to the subject than those a scientist would tend to examine first.

Elizabethan avoirdupois weights. "The most significant weights and measures developments of the Tudor era occurred during the reign of Elizabeth. . . . Through orders-in-council [she] impaneled special commissions to supervise the examination of weights and measures everywhere in the realm. The commissioners destroyed any standards that did not conform to Crown specifications and constructed new sets which they distributed to the Exchequer and to various local authorities. The history of the Elizabethan standards began the very year Elizabeth succeeded Mary," 1588, when the Exchequer received the series of weights shown here. The denominations of the weights, which are made of gunmetal, are 1, 2, 4, 14, and 28 pounds. [Photograph from the Science Museum, London, reproduced in *British Weights and Measures*]

The social, economic, linguistic, and legal aspects of metrology are of interest in their own right, as well as being of relevance to other sorts of history, and in tracing their evolution from Roman times to the 17th century Zupko has a surprisingly rich story to tell. His sketch of Roman metrology is rather brief, but with Anglo-Saxon Britain the treatment grows more detailed. A system of weights and measures requires a reasonably stable society to support it. "Not until the fortunes of Wessex rose in the ninth century under Egbert and Alfred was there any attempt to fashion a government, a law, and an economy even remotely similar to those that had existed in Roman days," writes Zupko, adding that "Scandinavian pirates" soon upset the new stability. Notwithstanding that such broad generalizations sweep aside numerous historical problems (such as the lost history of the Mercian rule and of whatever organized power it was that had kept the Saxons at bay for so long), the drift of the argument is surely right. The intimate connection between metrology and trade, easily overlooked in a scientific age like ours, is here explored. The evidence for Saxon governmental standards is slender but positive. One of the surprising things about the Norman period is that the earlier metrology was apparently deemed effective and was adopted by the new regime. During the 13th century new legislative programs were inaugurated, made desirable but also complicated by the expansion of national and international trade. New physical standards were constructed and were distributed throughout the realm, and in many of the regions compromises were struck. The use of public balances ("the king's beams") became necessary for certain transactions. The medieval enforcement of standards was often as uncertain and corrupt as some of the standards themselves, but the very fact of having an ideal must have contributed something to commercial confidence and social cohesion at home and abroad. As to the problem of who should enforce the assize of weights and measures, it is almost worthy of a book in itself, reflecting as it does one aspect of the power structure of the nation. As an interesting case, we find the officers of the universities of Oxford and Cambridge being put into positions of authority over the townsmen, thus adding to the grievances that then as now tended to separate citizen from scholar.

Fewer than a hundred pages of the book are given over to the historical text, which ends—apart from an epilogue—with the Tudor period, finishing at the death of Elizabeth I in 1603. (Nearly half as much again is given over to some invaluable indexes, bibliographies, and tabular appendices of European equivalents and other numerical data, reminding us that the author also has to his credit *A Dictionary of English Weights and Measures from Anglo-Saxon Times to the Nineteenth Century*.) The scientific revolution had in many senses already begun, but not until the end of the 18th century did government metrology begin to take on an appreciably scientific character. The Imperial Weights and Measures Act was passed in 1824. While retaining such oddities as a reluctance to work to scales of 10, it served as a basis for much of the world's trade for a century and a half, and even for much valuable 19th-century science. Perhaps there are here even more paradoxes to be resolved than in earlier centuries. At all times, systems of weights and measures are a compromise between what is rational and what is socially acceptable; and perhaps the biggest surprise to be found in Zupko's book is that our rulers in the past were if anything braver than those of the present in overriding the popular demand for inherited idiocies.

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Evolution of Radio Sources

Radio Astronomy and Cosmology. Papers from a symposium, Cambridge, England, Aug. 1976. DAVID L. JAUNCEY, Ed. Reidel, Boston, 1977. xx, 398 pp., illus. Cloth, $38; paper, $19.50. International Astronomical Union Symposium No. 74.

This volume is the proceedings of a symposium at which a rather distinguished group of experts in observational radio and optical astronomy, and to some degree in the theory needed to blend it all together, listened to each other and argued over interpretations.

The symposium reinforced the awareness that cosmological quests are difficult and that the achievement of their goals depends on a physical understanding, by way of radio emissions and optical properties, of what is going on in the observable universe. (Radio and optical astronomy need each other.) Simple morphological study is, of course, a common way of getting started, and this volume presents exactly that, discussing various radio-source surveys (which, to this reviewer, remain almost a necessary bore).

There are a variety of cosmological tests involving the large number of radio sources currently cataloged. The source counts alone will probably not tell us much. Five papers discuss the relation between received radio energy and angular size; data on angular size and strength of source can place additional constraints on evolving models of the sources and the universe. The interpretation of radio-source angular sizes, cogently summarized by R. D. Ekers and G. K. Miley, depends upon the radio-source luminosity function, the linear size distribution function, and any correlation that may exist between size and intrinsic radio power. The Cambridge observers J. M. Riley, M. S. Longair, and A. Hooley argue that, to a moderately low level of apparent flux, radio sources identified with quasars (sources showing large redshifts) maintain a physical size that does not vary according to cosmological epoch and thus could be used to determine deceleration parameters. However the observed angular-size–redshift pairs show so much dispersion that no decision of interest can yet be made.

I was interested in and impressed by the work presented on optical identifications, spectroscopy, and interpretation, particularly that described by J. Kristian; C. Hazard; R. Fanti and G. C. Perola; J. K. Katgert, H. R. de Ruiter, and A. G. Willis; D. E. Osterbrock; A. Boksenberg; G. R. Burbidge and E. M. Burbidge; and H. E. Smith.

Kristian's work on optical identifications of the 3CR sources, the only ones likely to be observed completely at optical, radio, and later perhaps high-energy frequencies, is encouraging, although the presentation is a bit sugarcoated. A surprising result mentioned here by Kristian (and elsewhere by Grueff) is the lack of optically faint quasars in radio catalogs (down to $\simeq$ 1 Jy at 408 MHz). The more plentiful optically selected (radio-quiet) quasars, however, are largely dominated by faint objects; is this a real difference, or does it just point out the obvious need for "complete" identifications of radio sources with $S_{408} \lesssim 0.1$ Jy? This will be an important subject for collaborative research by radio and optical astronomers. An exciting look ahead may be gained from W. C. Saslaw's paper on future radio observations—I liked it.

Finally, I was impressed by the soundness of H. van der Laan's concluding remarks on progress, problems, and priorities. This paper should be read by all interested professionals and students.

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Agricultural Plant Biology

Genetic Engineering for Nitrogen Fixation. Proceedings of a conference, Upton, N.Y., Mar. 1977. ALEXANDER HOLLAENDER and seven others, Eds. Plenum, New York, 1977. xiv, 538 pp., illus. $37.50. Basic Life Sciences, vol. 9.

Can the experimental approach and reductionistic world view of molecular biology be applied to problems in agricultural plant biology? Will a correlation of events in vitro with the responses of crop plants in the field provide a better understanding (and, perhaps more important, allow manipulation) of the biological processes underlying crop productivity? There are several possible responses to these questions. Some have pointed out that current levels of productivity were achieved in the absence of a direct knowledge of molecular mechanisms and have argued that there is no reason to believe such knowledge would enhance productivity. Others hold that only by a complete molecular analysis of the processes underlying productivity is there any hope of manipulating the components of yield in a rational way. A more realistic response suggests that a molecular analysis will be of importance in manipulating some biological processes but will not be a panacea for the problems of agricultural biology.

Genetic Engineering for Nitrogen Fixation is a record of one of the first of the major meetings of the faithful—those who are convinced of the utility of a rigorous molecular analysis. The volume appeared quickly, contains over 50 papers, and carries the message (indeed, dogma) that our understanding of nitrogen fixation as a component of productivity will benefit from a complete molecular analysis, permitting genetic manipulation to increase the rate of nitrogen fixation or to expand the range of crop species with which nitrogen fixation can be utilized. I find myself in agreement with both the message (although not as an article of faith) and the analytical approach of the volume. Of those aspects of agricultural plant biology that are often identified as prime areas for a molecular biological approach (nitrogen fixation, photosynthesis, genetic manipulation, plant nutritional quality, and so on), nitrogen fixation is perhaps closest to providing an ideal experimental system. In addition, nitrogen fixation is likely to be the first to become amenable to manipulations or modifications that work in the real world of agriculture and not just in the test tube.

The present volume covers topics ranging from fast reaction kinetics