home price should be raised to equality with the foreign price and kept equal to it. The increased revenue, some £150 million, should be put to various altruistic uses, such as general aid to the Welfare State, and particularly a rise in mining wages, the support of the sick and aged, family allowances and the development and use of approved domestic appliances for burning fuel. "Some slight turn of the inflationary screw" is regarded as harmless in comparison with the benefits foreshadowed.

Unfortunately, much of the carefully marshalled material and apparently logical argument is spoilt by a too rigid adherence to political dogma. There is lack of realism in the plea for the manipulation of electricity tariffs to put the electric fire out of existence. The ordinary man just will not accept it. Naturally, the evidence discussed is largely obtained from the literature of the subject, but in these matters, as in so many concerned with the world of affairs, the best knowledge frequently lies with the lifelong practitioners of the subject, and is not necessarily to be found in the books. Thus, the practice of fuel efficiency, sometimes described as the application of good engineering, was carried on in Great Britain long before the reports quoted. To make such an elementary error as to describe the Fuel Efficiency Committee as a "Council" resembles in its import the straw in the wind.

However, the book is an excellent essay in economic dogma, and there are so many interesting problems discussed that one may almost forgive the author for his dogma. The final chapters discuss such matters as the co-ordination of tariffs; that well-worn topic, a national fuel policy; and even nuclear power. To the reader genuinely interested in the subject, the book should certainly appeal for its wealth of material fact. The argument is a stimulating challenge at the present time and therefore to be welcomed.

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DATING BY RADIOACTIVE CARBON

Radiocarbon Dating

By Willard F. Libby. Pp. vii+124. (Chicago: University of Chicago Press; London: Cambridge University Press, 1952.) 26s. net.

THE work of W. F. Libby and his collaborators during recent years has held out to archaeologists and Quaternary geologists some possibility of absolute dating for organic materials from deposits between about A.D. 1000 and 20,000–30,000 B.C. Such was beyond our dreams a decade ago. Should this ideal be realized, it would very much enhance our understanding of the Pleistocene and immediate post-glacial periods, and, for lands of which the recorded history is of little antiquity, such as the New World, of the more recent past as well. The possibility of correlations of chronology between widely separated areas is also of paramount importance.

The results obtained up to the autumn of 1951 are brought together in this book. They have provoked much interest among archaeologists, but are perhaps most of all a pointer to future possibilities, since the standard error for the method as deduced from them is of the order of ± 8 per cent (there are evidently uncertainties other than those due to counting random events in the Geiger counter) and, when comparisons are made between carbon-14

dates and those derived from archaeological context, there are a number of 'rogues'. Moreover, the carbon-14 dates tend to be on the low side in the comparatively small number of cases so far studied in which a satisfactory archaeological dating can be established. A number of effects may cause these low carbon-14 dates¹, such as bacterial or mould growth, or the penetration of minute rootlets into buried charred wood. It may thus be that for given materials and environmental conditions of survival there may be archaeological half-life periods which are not absolutely identical with that of carbon-14 itself. It is not so easy to point out effects which may cause the carbon-14 dates to be too old, except the re-use in antiquity of organic materials already old, as 'bog-oak' is used to-day. In peats and muds such apparently enhanced antiquity may be due to percolation of water containing carbonates from old formations. It is evident that some materials give better results than others, wood being good and peats erratic, with the carbonate material of mollusc shells of dubious service.

As might be expected, progress in this field has been rapid, and even since this book was produced some refinements of method have been published². Libby³ has also given "a serious attempt to test the limit of sensitivity of the radiocarbon method", and a useful supplementary discussion of the errors involved, though the dating is again low as compared with the known limits of historical dating in this case, and his interpretation is open to criticism. Three replicate determinations were done on material from a carbonized beam from Nippur in Mesopotamia, the counting being prolonged in each case to one month from the usual forty-eight hours. These conditions of refinement yielded an overall standard error of the method of about ± 3 per cent. It is therefore clear that any really secure chronological framework which is to be built up from carbon-14 determinations must be based upon statistical interpretation of adequate data and should, for more biochemical reasons, be derived as much as possible from charcoals or cellulose or perhaps keratin material. What is now particularly needed is considerably more work on charcoal and timber samples which are closely datable archaeologically, so that the method may be extended with greater precision and confidence to material of otherwise unknown antiquity; and there still remains the necessary investigation of possible fractionation of the carbon isotopes on incorporation into various phases of the biosphere, already demonstrated for carbon-13⁴.

This book, though technical, is written in a commendably straightforward manner and should not be beyond the scope of any archaeologist proposing to utilize carbon-14 dating in his work. Libby and his collaborators have earned much gratitude for devoting so many years of painstaking work to this programme, and it is a welcome sign that it now bears fruit in the appearance of data from other centres. It is much to be regretted, however, that British laboratories are only now beginning to make their rather belated start on this particular aspect of isotope research, though they have thereby the advantage of experience which has led to a number of improvements in method.

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¹ *Nature*, 166, 756 (1950); *Antiquity*, 26, 35 (1952). Zeuner, F. E., "Dating the Past", 343 (3rd ed., 1952).

² *Science*, 119, 116 and 155 (1954).

³ *Science*, 119, 135 (1954).

⁴ *Phys. Rev.*, 61, 696 (1941); *Science*, 118, 141 (1954).