Finally a survey is given of the numerous outstanding lines of work which could be further pursued with profit. It is to be hoped that this work will indeed be continued, and this seems the more probable in that it has already been supported for more than a quarter of a century by a State (California) Agricultural Research Station, although *Crepis* is a genus of no economic importance. It is fitting to express appreciation of such an enlightened policy, and the world is no less indebted to the University of California for providing in its "Publications in Botany" a medium admirably suited in format and style to the issue not only of individual research papers of the usual kind, but also to an extended work of pure scholarship of the dimension of a large book such as that under review. International co-operation and disinterested support of fundamental research on this scale cannot easily be found even to-day in this age of planned science, and this is perhaps not the least important of the issues raised by Babcock's work. I. MANTON

[1] Hultén, E., "Outline of the History of Boreal Biota during the Quaternary Period" (Stockholm, 1937).
[2] Babcock, E. B., *Advances in Genetics*, **1**, 69 (1947).
[3] Tobgy, H. A., *J. Genet.*, **45**, 67 (1943).
[4] Gerassimowa, H., *C.R. Acad. Sci. U.R.S.S.*, **11**, 143 (1937); **25**, 148 (1939).

RADIOELEMENTS AS A TOOL IN SCIENTIFIC RESEARCH

Radioactive Tracers in Biology

An Introduction to Tracer Methodology. By Prof. Martin D. Kamen. (Organic and Biological Chemistry, a Series of Monographs, Vol. 1.) Pp. xiii+281. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1947.) 5.80 dollars.

AT the beginning of this century, one of the facts most intriguing to chemists was the impossibility of concentrating some of the radioactive elements. Radium D, for example, a substance well characterized by its radioactive properties, proved to be completely inseparable from the large quantities of lead with which it was always burdened when extracted from minerals. Early in 1913 it was realized that the strange inseparability observed in radiochemistry, and the atomistic complexity of inactive elements as revealed by mass spectroscopy, were aspects of one and the same phenomenon, for which the new Rutherford–Bohr theory of the atom provided a convincing explanation. But even before this recognition of the nature and importance of 'isotopy', attempts had been made to turn the negative results of the separation experiments into a positive service to science: the solubility of sparingly soluble lead salts was determined by mixing them with radium D and using the imparted radioactivity for the electroscopic measurement of the invisibly small quantities of dissolved lead.

In those days there were only half a dozen or so suitable radioelements available, all of them in the last two rows of the Periodic Table. Therefore, 'radioelements as indicators', while a great help for a variety of investigations in inorganic and physical chemistry, were scarcely applicable to biological experiments—although so early as 1923 G. von Hevesy made some interesting observations about the intake of lead by plants by means of such an indicator. For the most important biological elements like carbon, hydrogen, oxygen, phosphorus, sulphur, or sodium, unfortunately no radioactive isotopes were known. Now the 'labelling' of an element should be possible also with inactive isotopes, though the methods of their detection and measurement are necessarily different and, in general, less simple; but in those days this way was barred too, as no means were known of preparing the inactive isotopes in more concentrated form than they occur in Nature, let alone in a pure state.

To-day in both directions the situation has completely changed. The discovery of the artificial radioelements in 1933 soon made radioactive isotopes of most of the elements available, and the development of several methods for isotope separation also put inactive atomic species at the disposal of scientific workers. As a consequence, the use of 'tracers', as they are now usually called, became a much more important practice in biological as well as non-biological research. Of special influence in this development was the erection during the War of big plants in the United States for isotope separation and for plutonium manufacture, the products and by-products of which can now be used for peaceful purposes. Similar plants will soon be operating in Great Britain and Canada; but in the meantime the American Government is willing to provide scientific workers all over the world with the invaluable materials, under the same conditions as laid down for American laboratories.

In these circumstances, many scientific workers who have otherwise no contact with radioactivity are anxious to make themselves acquainted with the powerful new method. By far the best way is, naturally, a course of instruction in one of the radioactivity centres; but as the principles of the method are simple, and the apparatus as well as the tracer material can be bought, training by books is certainly possible. It is therefore a pleasure to find that an excellent guide to the tracer technique with radioelements has been published by one of the most successful workers in this field. Prof. M. D. Kamen calls his manual "Radioactive Tracers in Biology"; but he is so thorough in making the reader well acquainted with the physical and chemicals aspects of radioactivity and with the theory of the measuring instruments before discussing biological applications, that those who intend to use radioactive tracers for non-biological research will also find in the book a wealth of useful information. In points of detail there may be some disagreement. Thus the author defines 'specific activity' (p. 33) as the ratio of the number of radioactive isotope atoms to the total number of isotope atoms; while later (p. 152) he uses as specific activity the number of counts per minute per milligram. Most workers in this field will probably prefer the second definition; and they may also not share the author's predilection (p. 91) for the term 'rutherford' instead of 'curie' (compare, *Nature*, **160**, 778; 1947).

Biologists will find the final chapters of particular value, for here the author deals, one by one, with the principal radioactive tracers as applied to metabolic studies. Very frequently he can draw on personal experience, and his descriptions display all the freshness which only first-hand knowledge can impart. In conclusion, we would like to express the hope that the other branches of radioactive and inactive tracer methodology will soon find authors as competent and literarily gifted as Prof. Kamen has proved himself to be in the very important field he has chosen as his own. F. A. PANETH