

Surveying the sugar cane world from China to Peru, the author has extracted the relevant information about all these aspects from a great number of sources. He has not been content with the mere bald presentation of the material, but has made full use of his thirty years' experience of the crop to comment in detail and to criticize constructively. If there is a fault, it is that the book should have been twice as long and much more information might have been given on how a breeding programme is actually executed. The chapter entitled "Breeding Methods" gives details of techniques rather than the methodology of breeding.

The fact that research on sugar cane is mainly, though not always, paid for by industry has inevitably led to a not unreasonable demand for more or less immediate practical results. These are certainly impressive since, as the author points out, sugar yields in some countries have been more than doubled within the past twenty-five years. At the same time, one gets the impression that although much fundamental work has been carried out, it has often been a by-product of work dictated primarily by economic considerations, and organized for economic results. Thus, apart from the author's own important work, there has been little work on the production of pure lines, a procedure almost essential in a long-term breeding programme. Whether apomixis occurs seems to be still in doubt. If it occurs, even though rarely, it would be of great importance to the breeder. There does not seem to have been any organized attempt to produce haploids—also important in long-term work.

The sugar industry is wealthy and if it could be induced to carry out fundamental research on genetics and physiology without the spectre of profits looming large, the long-term benefits might be unexpectedly great.

This book is essential for all sugar cane workers, and it contains lessons for breeders of other vegetatively reproduced crops. Readers will be grateful for the literary style of the author, which is at once elegant, lucid and clear.

S. C. HARLAND

STARCH: ITS FUNDAMENTALS AND POTENTIALITIES

Starch

Chemistry and Technology. Edited by Roy L. Whistler and Eugene F. Paschall. Vol. 1: Fundamental Aspects. Pp. xviii+579. (New York: Academic Press, Inc.; London: Academic Press, Inc. (London), Ltd., 1965.) 22 dollars.

VOLUME 1 of *Starch: Chemistry and Technology* describes the more fundamental aspects of starch chemistry and technology and sets the scene for a second volume, which will cover industrial aspects. There is much that is described here that has yet to be exploited by industry, most of all on the biological side, the fundamental advances in which have been practically without impact on industry. Two exceptions come to mind; first, the growing 'takeover' by amyloglucosidase from acid as a means of converting starch into glucose; and secondly, the selective breeding of maizes rich in high-amylose or high-amylopectin starch. The full potentialities of biology to the starch industry are very far from realization.

Of all sources of organic raw material, starch offers the major opportunity to the industrialist in search of new products. The demand for starch as the largest single item of diet ensures its continuing supply at steady prices, but the shrinking *per capita* consumption of starch in Europe and North America has meant that its output for food purposes has only been kept from serious shrinking by population increases. In the post-war era, the non-food uses of starch, such as for adhesives and sizing, have met severe competition from other natural or synthetic poly-

mers. The starch industry in the United States has reacted by vigorously pursuing research into new products for food or non-food uses. In the main the attack has been through chemical modification of starch, for example by cross-linking or by oxidation, to impart desirable physical properties. An example of a new product is the use of amylose as an edible film for food packaging. The economics of the process, in the form of the present price of amylose, would seem to represent the only bar to what could be a very large exploitation. Glucose production by enzymatic hydrolysis has already been mentioned, and the real possibility of a cheap enzymatic method for the partial conversion of glucose into the much sweeter fructose, to produce an 'artificial' invert sugar, could well make considerable inroads into the sucrose industry, which has already felt the pinch from glucose alone as a sweetening agent. Given the investment in research, the starch industry need not fear any slackening of demand for its products. Indeed the second chapter in the book under review, by P. L. Farris, predicts "a probable doubling of the market for starch between 1960 and 1980". At the same time, R. L. Whistler, in the introductory chapter, foresees a corn (maize) crop of 300 bushels per acre, against the present United States average of 62.4 bushels. In the rest of the world the present average yield is only 30.2 bushels per acre.

The chapters that follow describe genetic control of starch development; occurrence and development of starch; minor constituents; enzymatic synthesis and hydrolysis; oligosaccharides and *cycloamyloses*; chemical evidence for structure; crystallinity; gelatinization; organic complexes; fractionation; properties of starch fractions; paste properties; radiation; pyrolysis; non-degradative reactions; and acid and alkaline degradation. The authors, with one exception, are drawn from United States industry and research institutions and are well known and respected.

This and the second volume are intended as successors to the classic compilations by R. W. Kerr. The multiple authorship and the increase in size over Kerr only reflect the greatly increased knowledge of the subject. The coverage of the fundamental aspects is generally well balanced and much previously unreviewed material is gathered, for example on the *cycloamyloses* (Schardinger dextrans). These particular substances represent a real challenge to industry, for they could be produced very cheaply if required on a large scale. The Schardinger dextrans form inclusion compounds, often crystalline, with every conceivable class of compound, from iodine to bromobenzene, tyrosine and helium. This property must surely find a commercial outlet.

A serious omission from the book is any description of the evidence for starch structure as obtained by the use of enzymes. It is impossible to describe the presently accepted structures of amylose and amylopectin without drawing on the evidence of enzyme action, notably of β -amylase. Indeed, present chemical methods of analysis are, by themselves, inadequate even to elucidate the structures of relatively simple oligosaccharides obtained by degradation of amylopectin, let alone the polymer itself. The Meyer, Staudinger and Haworth formulae for amylopectin have always been presented in a way that takes account of our knowledge of β -amylase action. If one took no account of enzymatic evidence, each of these formulae could be written in a wide variety of ways and many additional formulae could be written that are not excluded by chemical evidence alone. This reservation apart, the book can be recommended as indispensable to anyone with any kind of scientific interest in starch. It reviews the field essentially up to 1963. The documentation is thorough, and the abundant numerical data considerably enhance the value of the book as a work of reference. The senior editor, Prof. R. L. Whistler, has added another notable contribution to his authorship and editorship of works of reference on carbohydrates. W. J. WHELAN