which he points out the immense evolutionary importance of the store of heritable variability which a group of organisms will generally possess. In these papers, too, the estimation of the number of genes affecting oil content in Winter's maize is attempted.

The reader of this collection cannot fail to be impressed by the way in which most of the papers, including, we venture to say, all of first importance, are concerned with problems encountered by the author while engaged as a scientific worker in the employment of Messrs. Guinness. His consideration of estimating yeast density by haemocytometer counts, his long interest in field trials of barley varieties, his discussion of the errors of routine analysis, all reflect different aspects of this work; and, above all, his derivation of the ratio he termed z (not to be confused with Fisher's z), later to be transformed into t , reflects the necessity for drawing, from small samples, conclusions of a reliability sufficient to serve as the basis for executive action. Herein we can find the clue to "Student's" success; he was an experimental scientist who knew what he wanted statistics for, and when existing methods failed him, undertook for himself the development of new ones which would work. His mathematics was not always of the most elegant, indeed it was on occasion neither fully rigorous nor wholly successful; but he always tackled the problems which faced him in a downright fashion, using experiment and arithmetic to check his algebra, by methods which must appeal to all those of us who, like him, are not professed mathematicians yet find statistical analysis essential in our experimental work.

"Student" ushered in the new era of collaboration between statisticians and experimenters. But his work was not only hampered by the statistical conventions of his early days; it seems also not to have been fully appreciated by some of his statistical associates, for so late as 1931 we find him defending his small sample test against criticism by Karl Pearson. Nor did "Student" realize the full consequences of his great discovery. The moulding of statistics into the powerful weapon of to-day awaited Fisher, and the effects of Fisher's influence is to be seen in many of "Student's" papers after 1915. In the 1930's, something of a controversy developed between the two, on the necessity for randomization in field trials, and here "Student" took the curious stand that, while we must "superpose randomness on the biased fertility of the soil", this could as usefully be done by certain systematic arrangements as by actual randomization of the plots. Indeed he claimed in his last paper that not only could sampling error be minimized in this way, but that even if it led to a slightly biased estimate of error, the bias was in a helpful direction.

It would, however, be surprising if "Student's" papers did not in places seem open to criticism by the reader of 1943. Nor can such criticism detract from the value of a volume of this kind. These papers are primarily "Student's" record of his results and findings; but they also reveal to us the needs which prompted his work and the way in which he set about it. Few experimenters can fail to derive a new confidence for the attack on their own problems from seeing how his clear recognition of the statistical needs of experiment, and his practical approach to their satisfaction, enabled "Student" to mark the way to the new statistics, the benefits of which we can now enjoy.

K. MATHER.

OPTICAL METHODS IN CHEMISTRY

Optical Methods of Chemical Analysis

By Dr. Thomas R. P. Gibb, Jr. (International Chemical Series.) Pp. xiv+391. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1942.) 35s.

LIKE so many other activities, analytical chemistry is becoming mechanized. A training in the standard procedures of gravimetric and volumetric analysis is, of course, still essential for the chemist, but it needs to be supplemented by experience in the use of a large variety of instruments, many of which are optical. Dr. T. R. P. Gibb is an instructor in analytical chemistry at the Massachusetts Institute of Technology; he has managed (to quote his preface) "to present a compact, abridged survey of optical methods of analysis in a style suited both to the practical analyst and to the advanced student of analytical chemistry". His teaching experience has obviously been gained in splendidly equipped laboratories, and the problems given at the end of each chapter are a clear indication that the task of teaching the newer analytical methods is being tackled on a scale and with a gusto hitherto impossible in Great Britain.

It is impossible to avoid comparing this book with some of its predecessors. Löwe's "Optische Messungen des Chemikers und des Mediziners" (Steinkopff, Dresden and Leipzig, 1933) is a very useful technical progress monograph for research workers, while Fritz Weigert's classical "Optische Methoden der Chemie" (Leipzig, 1927) remains the best comprehensive work for the serious student of the subject, although it is to some extent out of date as regards the design of instruments. It seems unlikely from the text that Dr. Gibb has seen either of these books, but in spite of that handicap he has written a very useful laboratory handbook.

The chapter on spectrochemical analysis provides a skilfully chosen minimum of information for effective practical work. His treatment of spectrophotometry displays more interest in instruments than applications and is, perhaps, a little unbalanced on that account. Any chemist inexperienced in the use of microscopes, colorimeters, nephelometers or fluorophotometers, will find the construction of such instruments and details of their manipulation given very lucidly. Dr. Gibb has an excellent account of elementary crystallography, and his description of the identification of crystals with the polarizing microscope will be of special interest to university teachers who are concerned with the revision of practical chemistry curricula. The refractometer and the polariscope are quite adequately treated.

The book as a whole is clearly written and effectively illustrated. The selection of references for further reading has been done well, but theoretical considerations and the general problems of interpretation have been dealt with too cursorily. The chemist *qua* skilled technician will find the volume admirable; but teachers in Great Britain may doubt whether the scales have not been tipped too far on the side of sheer technique. In terms of the programme outlined in this book, universities and colleges outside the United States are seriously under-equipped for the teaching of modern analytical chemistry, and the scales are weighted in the opposite direction.

R. A. MORTON.