for traces of organic growth substances by plants grown in artificial media as due merely to some fault in the composition of the mineral nutrients and organic foods presented to the plants. This is a natural and healthy reaction, and it is clear that some workers on the growth-substance concept have been hasty in their conclusions. Few doubts can remain after reading this book. The author, in the chapter on methods, points out these possibilities of error at some length, and details the many reasons, apart from lack of growth substances, for which a plant will fail to develop on a purely synthetic medium; in fact, he sometimes leans away from the growth-substance concept himself as, for example, on p. 78, where he says of the germination of pollen: "Natural riboflavin is the most active substance on pollen but, since it is contaminated by boron the activity must be attributed to the latter". It is not, of course, clear that all workers adopt the rigorous attitude of Prof. Schopfer, and some of the investigations recorded in this book will scarcely satisfy the reader (for example, the supposed function of asparagine as a cofactor on p. 105), but the careful consideration given to cultural conditions by the author himself leads the reader to accept his opinion with some confidence in most cases.

Experiments have been carried out on very many species at all phylogenetic levels, and in many cases the vitamin requirement worked out in considerable detail by the use of synthetic as well as natural preparations. Auxo-heterotrophy has been demonstrated clearly in many species, among green plants as well as non-green and even in roots of the flowering plant, and is clearly due to a loss of the power to synthesize some essential vitamin. Apart from the very thoroughgoing determination of the necessity for specific vitamins, the author assesses very carefully and logically the bearing of his findings on problems of sexuality in plants, of symbiosis, of parasitism; and many other points of physiological importance are touched upon throughout the book.

The subject naturally divides itself into three subsections, and this division is adopted in the book. Section 1 deals with plants which can synthesize vitamins; Section 2 with plants which cannot; and Section 3 with general physiological problems involving vitamins, of the type mentioned above. In Part 1, after a study of methods, the principal vitamins synthesized by plants are discussed, together with as full an account of their action on plants as present knowledge will allow. In Part 2 follows a detailed discussion of each of the vitamins concerned: thiamin, riboflavin, pyridoxine, nicotinic acid and nicotinamide, ascorbic acid, carotenoids, etc., and their effects on plants which have lost the power of synthesis, as well as a brief excursion into the effects of animal hormones on plants (particularly of œstrone, the only one with any marked effect). The interplay of various growth factors is emphasized in many cases, and special mention may perhaps be made of the useful discussion of the nitrogen-fixing and lactic acid bacteria. The discussion of each vitamin inincludes the capacity of various plants for synthesis, the specificity of the vitamin and its function in the plant. It is now evident that most, if not all, vitamins operate as coenzymes, or part of coenzyme systems, in the respiratory processes of plants, and this point is well emphasized throughout the book. The third part attempts an analysis of the importance of vitamins in agriculture and horticulture, and a study of parasitism, etc., already mentioned. Lack of precise and wide knowledge makes this the shortest section, but it is in many ways the most interesting, for it shows the way to future fields of great promise. The last chapter is of particular interest to plant physiologists working in related fields, for in it the author attempts to set up a series of micro-organisms as test objects in the study of vitamins.

Apart from a few words of variable spelling (for example, 'thermostabile' and 'thermostable') and one or two sentences the meaning of which is obscure (for example, p. 96, "It is unusual that the fruits richest in carotenoids are frequently the richest in ascorbic acid . . .", meaning actually that carotenoids and ascorbic acid are usually associated) the translator is to be commended on his performance of a task of peculiar difficulty. Prof. Schopfer's book cannot fail to make a wide appeal. His subject is a meeting ground of many specialized sciences—organic chemistry, enzymology, animal and plant physiology, microbiology—and all these meet here to solve problems which are fundamental. His book should therefore be well received as a clear and thoroughgoing exposition of this new field. R. D. PRESTON.

ERATOSTHENIAN AVERAGES

Eratosthenian Averages

By Aurel Wintner. Pp. v+81. (Baltimore, Md.: The Author, Johns Hopkins University, 1943.) 2 dollars.

THIS is a curious and interesting little book, though unlikely to appeal to a wide circle of mathematicians. The author makes heavy demands both on the intelligence and the knowledge of his readers, and his English, though usually 'correct', is English of a very 'continental' type, overpacked with allusions, parentheses and qualifying clauses. A good deal of allowance must be made for the inherent difficulty of the subject-matter, but it is a pity that he could not write in a simpler and less oracular style.

I will not try to give any reasoned account of the content of the book: a few summary indications will be sufficient for any reader sophisticated enough to profit by it. He should be familiar with the outlines of the classical theory of the distribution of primes. He should know the inversion formula of Möbius, and the simpler 'Tauberian' theorems; 'density' and 'almost periodicity' should mean something to him; and he should understand what is meant by talking of theorems of different 'depths'. To such a reader I can commend a book in which he will find plenty to interest him—theorems new to him, and old theorems in unfamiliar settings. If he has not this background of knowledge, he would be more profitably employed in acquiring it.

The most attractive part is probably Part 2, in which the author develops a 'Fourier theory' of arithmetical sequences (which includes, for example, the theory of the 'Ramanujan sums'). But surely there should be some reference here to the work of Carmichael in Vol. 34 of the London Mathematical Society's *Proceedings*? I should add, in fairness to the author, that I have committed the same sin of omission myself.

Part 1 (on the 'Eratosthenian matrix') contains an interesting discussion of various implications, or supposed implications, of the formulæ of Möbius. Part 3 (on the 'statistics' of the prime number theorem) is very tough reading, but that is not primarily the author's fault. G. H. HARDY.