

form to prepare the reader for its use in solid-state theory.

A detailed quantitative discussion of ionic and covalent binding precedes the chapter on crystals and the metallic state. Lithium is taken as a typical metal, and the reason for its metallic properties deduced from its  $2s$  wave-function. Next, a one-dimensional square-well model of a metal is considered, and compared with a wave-filter for which  $V$  is the analogue of  $\Psi$ . It is pointed out that matters are much more complicated with actual potential distributions in three dimensions (Brillouin zones are mentioned but not discussed) but that the general principles are the same. Three chapters on the mechanical, thermal and electrical properties of solids follow; and these properties are explained in terms of quantum mechanics. Semiconductors and their many applications are treated fully, and the final chapters deal with thermionic emission, electron optics, radioactivity, and nuclear reactions.

The book is satisfying because the author does not attempt to oversimplify a difficult argument, but instead precedes it by taking simpler cases which allow of a naturally straightforward treatment and analysing them thoroughly. The mathematics is kept to a level that does not require the specialist techniques of the mathematical physicist. For example, the Fermi distribution is introduced with the statement that a Maxwell distribution for conduction electrons could not satisfy the exclusion principle, and this one does; the formula for the Fermi distribution is stated without proof, but its meaning and some of its consequences are explained and worked out quantitatively in the fullest detail.

Many numerical exercises are included, and at the end of each chapter there are references to standard treatises; the reader who has worked through this book should certainly be well equipped to consult such more specialized works with understanding.

G. R. NOAKES

## DISEASES OF TOBACCO IN AFRICA

**Tobacco Diseases, with special reference to Africa**  
By Dr. J. C. F. Hopkins. Pp. xvi+178+4 plates.  
(Kew: Commonwealth Mycological Institute, 1956.) 35s.

**THIS** book is one of a series published by the Commonwealth Agricultural Bureaux on diseases of tropical and subtropical plants. Dr. S. P. Wiltshire says in his foreword that it is designed for plant pathologists, extension officers and tobacco farmers.

The first part of the book is devoted to a detailed consideration of the problems involved in the production of disease-free tobacco seedlings and the maintenance of healthy plants from transplanting to reaping. The subjects discussed include the preparation of seed-beds, cleaning and disinfecting seed, spraying both in the seed-beds and in the field, and the effects of some cultural practices on disease control. The main points of all these operations are dealt with fairly comprehensively, though some of the recommendations will be questioned by the more progressive growers and by many of those engaged in tobacco research in Rhodesia to-day. Some examples of these might include the use of bricks and cheese

cloth in seed-beds, the advice to remove and burn or compost all tobacco stalks in preference to ploughing them in, and priming (removal of lower leaves) as a method of disease control.

The second part of the book contains detailed descriptions of symptoms of diseases and disorders which may be encountered by tobacco growers. Following the pattern of his earlier handbook, "Diseases of Tobacco in Southern Rhodesia", the author introduces each description with a few notes on the causal organism. There are many excellent photographs and coloured plates showing symptoms of the diseases which are described in the text, and these should prove useful to students of tobacco culture, extension officers and farmers. The descriptions include some bacterial, fungal and virus diseases which are comparatively rare, as well as those which are more common. There are also sections dealing with physiological, deficiency and miscellaneous diseases and those peculiar to the curing barn.

Some of the control measures advocated do not find support in the data and recommendations published by the Tobacco Research Board of Rhodesia and Nyasaland in recent years. To that extent this book will tend to confuse rather than to clarify the thoughts of farmers on the control of diseases in tobacco. Nevertheless, this book brings together the author's experiences and personal observations of tobacco disease problems in the course of a long career in Africa, and will therefore be read with great interest by those working with this crop.

I. NEAS

## BIOLOGY OF SENESCENCE

### The Biology of Senescence

By Dr. Alex Comfort. Pp. xiii+257. (London: Routledge and Kegan Paul, Ltd., 1956.) 25s. net.

**D**R. COMFORT has made sure that there are no misconceptions about the subject of his book by calling it the "Biology of Senescence" rather than "The Biology of Ageing". He goes still further in precision by defining what he means by senescence. It is, he says, an increasing likelihood of death with increasing age, or "a decrease in viability and an increase in vulnerability". This precision has much to support it, and in fact one might say that the advance of gerontological studies is to some extent dependent upon the use of a scientifically accurate nomenclature. The word 'ageing', which is often used synonymously with 'senescence', has a very much wider connotation and could include all the changes in the individual following conception and until death.

In his book Dr. Comfort first provides an introduction and historical discussion. In this he devotes some space to that remarkable sponsor of the term 'biological time', Lecomte du Noüy, who in 1936 devoted a good deal of thought to a discussion of the significance of physiological and physical time: "Everything, therefore, occurs as if sidereal time flowed four times faster for a man of fifty than for a child of ten" and "a year . . . seems longer to a child" . . . "Thus we find that when we take physiological time as a unit of comparison physical time no longer flows uniformly". Dr. Comfort takes a cue from these metaphysical circumlocutions and adds to this system "alcoholic time", which he defines as the apparent progress of a bottle towards emptiness as it appears to the alcoholic who

drinks it. The author's final conclusion about Du Noüy's discussion of time is that he "has gone down clutching a platitude and come up embracing a metaphysical system". In other words, just as physiology suffered for hundreds or even thousands of years from the attempts by Pythagoras to apply the lore of number to it, so the study of senescence has long been bedevilled even to the point of "intellectual disaster" by this type of attempt to describe it in mathematical terms.

But it must not be thought that Dr. Comfort's book is all metaphysical discussion; far from it—there is (if one may be pardoned such a metaphor at this point) plenty of meat in it. There are sections on the nature and criteria of senescence, maximum longevities among various animals, the maximum life-span in man, the distribution of senescence among vertebrates and invertebrates, senescence in Protozoa, the influence of genetic constitution on senescence and longevity, growth and senescence and the mechanisms of senescence.

Dr. Comfort's book is the most comprehensive review on the subject of senescence that has appeared since 1920. The publishers' notice on the cover claims that it has been written to marshal information and suggest lines of investigation for the experimental attacks on old age. In my opinion it fulfils this aim, and it thus becomes an essential part of the book-shelf of anyone interested or working in the field of senescence—or even of 'ageing'. G. H. BOURNE

## ENTROPIC ASPECTS OF INFORMATION THEORY

### Science and Information Theory

By Prof. Leon Brillouin. Pp. xvii+320. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1956.) 6.80 dollars.

THE theory of information has not been long in gathering a motley crowd of associates. Too often, in consequence, it has found itself vaguely identified with a wide variety of studies, for which in fact it serves merely as a new and useful tool. "Science and Information Theory", by Prof. L. Brillouin, is a book calculated severely to redress the balance. For Brillouin, information theory means simply what might be called the statistical theory of 'unexpectedness', developed chiefly by Wiener and Shannon for the purposes of communication engineering.

The mathematical 'unexpectedness' or improbability of a signal, measured logarithmically, ( $\log 1/p$ ), is directly related to the size of the most economical code-symbol to represent it. The average unexpectedness ( $\sum p_i \log(1/p_i)$ ), over a long sequence of signals, indicates the minimum average number of code-symbols necessary for each signal-transmission. Extremely important and illuminating coding theorems follow from this quantification of 'unexpectedness' as the additive measure which has operational significance for the code-designer, and it is not surprising that it is termed the 'amount-of-information' in the signal.

Unfortunately, as Shannon has been quick to point out, the improbability of a message need have no direct connexion with its logical content—with the number and complexity of the statements it makes. His measure is not, therefore, as Brillouin (p. 1)

would have it, a definition of *information*, but merely of the *unexpectedness* of information. As a mathematical index of unexpectedness it can be applied, of course, to other things than messages—to states of thermodynamic systems, for example, in which context the same average measure has long been known under the name of entropy. The entropy of an under-specified system is numerically proportional to the 'unexpectedness' of the information which a complete specification would provide.

It is this equivalence of entropy and 'amount of information' (in Shannon's sense) which Prof. Brillouin is chiefly concerned to trace in a wide variety of physical situations, including the mythical case of Maxwell's 'demon'. The treatment is lucid, rigorous and illuminating at many points; but the persistent confusion of the concept of information with the unexpectedness of information leads to unnecessary mystification at a number of points. A particularly unconvincing example is the discussion (p. 155) of "free information", as something held "in the mind" and so "not directly connected with any physical system". Metaphysics has its proper place; but this is metaphysics misplaced. The 'unexpectedness' which Shannon defined by  $\sum p_i \log(1/p_i)$  is not (*contra* p. 10) an absolute quantity, but a function, defined only in relation to a chosen distribution of prior probabilities or 'ensemble' of events. In physics the distribution may be fixed by the temperature of the system; but in other contexts the probabilities may be determined quite otherwise, and the direct relation of Shannon's measure to physical entropy disappears. Much of the mystery can be removed if the reader will substitute 'unexpectedness' for 'information' wherever the Shannon measure is discussed, and define the relevant ensemble; but one is left with the feeling that many questions would have been differently expressed had the author done the same.

Having equated "Information Theory" with Shannon's theory of unexpectedness, Prof. Brillouin has to disclaim for it any interest in questions of the meaning and value of information. In point of fact, as the proceedings of three London symposia on this subject can illustrate, the general theory of information has a well-defined place for measures of *descriptive* information-content as well as of unexpectedness. The author does not appear to realize, for example, that the measure developed by Gabor, which he describes on p. 100, is precisely one of the measures of "structural information-content" (termed "logon-content" by Gabor) for which later (p. 291) he finds no place. To talk of "inconsistencies" (p. 291) between these complementary measures is simply to reveal misunderstanding of their nature.

As one might expect, the incidental expositions of fundamental physics throughout the book are masterly. It is gratifying, too, to find lucid accounts of work such as Mandelbrot's on word-statistics, and recent developments in the design of error-correcting codes, included among the more conventional topics. Schouten's name, on the other hand, is not mentioned, despite the similarities between some of his ideas and Brillouin's.

This is a stimulating work—sometimes to insight, occasionally to exasperation. A novice seeking to learn the gist and drift of information theory may find easier introductions elsewhere; but for the student who wants to broaden and deepen his thinking in Prof. Brillouin's chosen portions of the subject the book is to be recommended. D. M. MACKAY