

(often very involved) may be achieved. It would certainly not be easy to do it better than it is done here. Something of the kind found a place in the best German books of the nineteen-twenties, but they lacked the stimulus to deep comprehension on the reader's part which Dr. Wright has managed to introduce.

Another question treated with unusual clarity is that of the human retina, especially from the point of view of Polyak's work (1941). This leads naturally to a comparison of the wave-length and relative luminosity positions of the scotopic (low brightness) and photopic (high brightness) curves, the former for rod (monochrome) vision, and the latter for cone (coloured) vision. Artists and the like are well aware, empirically, of the darkening of red surfaces with diminishing illumination, a species of Purkinje effect for which the relative displacement of the scotopic curve towards higher frequencies is responsible. Although perhaps not directly concerned, psychologists will read this portion with interest, since implicit in these energy relations is supposedly the nature of the connexion between 'fact' and 'correlate'. It may well be that the useful, though problematical, concept of isomorphy will be unable to stand up in its present form against increasingly exact knowledge of retinal reactions. There are other complications, no doubt, but a better biophysics of colour-vision is evidently on the way.

Now for some of the applications. Many industrial matters demand the fixing of minute colour differences rather than absolute 'norms'. The Hardy spectrophotometer is excellent here, since much of the work may be concerned with reflexion, where the accuracy is most favourable. I have witnessed Hardy's machine at work upon reflectance measurements of specially prepared artists' pigments. Even allowing for somewhat elaborate calibration and checking, the speed at which the curves could be constructed was remarkable. As Dr. Wright points out, one must not cavil at Hardy's inability to cope perfectly with fluorescence or specular reflexion, since these troubles are inseparable from the system. Nevertheless, the latter component can now be wholly included or wholly excluded, thus removing uncertainty. It is characteristic of the author's practical attitude that he adds a number of methods, more or less approximate, applicable to cases where complete spectrophotometry would not be justified. Much can be done by these means, so long as the absorption wave-length curve does not change direction too abruptly.

A chapter is devoted to colour atlases. These common adjuncts clearly suffer from the disadvantages of being incapable of supplying more than a fraction of all discernibly different colours and, moreover, they fade and get dirty. Nevertheless, they have their uses, as Dr. Wright explains. An interesting forecast is that we might "in, say a hundred years' time", be able to do our colour matching and selection by means of the tristimulus values,  $X$ ,  $Y$ ,  $Z$ , alone. Meanwhile, we are driven by some psychological urge to ask for a pattern, transient as it may be. Musicians say they can appreciate perfectly a melody by reading the score; it is hard to see why artists should not do likewise some day, and obtain colour-harmony from the appropriate algebra.

Several other intriguing outlets for colorimetry follow: chemicals and their mixture, lighting, agriculture, pulp, paper and paint, signal glasses, photoelasticity and so on. In fact, their name is legion; and as if to practise what is preached, several excellent

coloured charts are included, some quite novel, and all of them helpful.

The price is the crux: for what is little more than a manual, thirty shillings does seem excessive. One would like to imagine a student reading this book time and time again; but if he does, he will probably have had to borrow a copy from somebody else.

F. IAN G. RAWLINS.

## INTERACTIONS OF HEREDITY AND ENVIRONMENT

### Livestock Improvement

In Relation to Heredity and Environment. By Dr. J. E. Nichols. Pp. vii+208+7 plates. (Edinburgh and London: Oliver and Boyd, 1944.) 10s. 6d. net.

**T**HIS book, as the author says, attempts to outline the principles and to indicate how the genetic and environmental concepts are interwoven in the idea of livestock improvement. Much original work is included in the book, especially work on problems of sheep-breeding drawn from personal observations in many different countries.

In addition to an outline of the principles and details of genetics as applied to the breeding of farm animals, other factors closely linked with genetics and affecting livestock improvement are dealt with—such as environmental aspects, type and environment, and breed construction. These latter chapters indicate some of the problems which the applied animal breeder as distinct from the pure geneticist has to take into account. Here the idea of evolution as distinct from the modern analytical aspects of genetics creeps in, and the facts given may provide a means of bridging the gap between the ideas of Darwin and of Mendel, or between those of Lysenko and Vavilov. In particular, Nichols' conception of the stratification of the sheep industry in time and space provides the palaeontologist and zoologist with a concrete example of what has occurred, and is occurring, in the evolution of a species, or in the evolution of the fauna in a district. The agriculturalist's aim to control and change environmental conditions is from the zoologist's point of view a grand experiment in the evolution of animals. Throughout the book there is a number of references to work done in tropical countries; these should provide a basis for the development of the animal industry in British Colonies and other tropical countries.

The chapters on gene and character frequency, inbreeding, outbreeding and hybrid vigour, and performance and progeny testing should prove most useful to the practical breeder of livestock, as they will enable him to see how the modern science of genetics can be usefully employed to effect a short cut to his objectives. The formulæ given in several places may prove somewhat difficult to practical breeders, but they are reduced to the minimum that is necessary for proper comprehension by a student of the subject.

The book is packed with information concerning farm animals, well illustrated and has an extensive list of references to which the reader can go for further details. With government policy giving encouragement to the better breeding of farm animals, this book should meet a widespread demand from students, teachers and breeders for more information on the methods of livestock improvement.

JOHN HAMMOND.