upon the nature of the lights to be compared. The most hopeful of all the instruments described for colour photometry seems to be the mixture photometer of Grosse. In this instrument the lights A and B, to be compared, are estimated not by directly measuring the ratio A : B, but by comparing two mixtures, $A + mB$ and $nA + B$, where m and n are constants fixed for each instrument. Here the colour difficulty is got over by mixing the lights, and the relative illuminations of the surfaces compared is varied, partly by adjusting the distances of the lights, and partly by turning the eyepiece of the instrument, the working of which depends on the phenomena of polarisation. As far as one can judge from the description, this photometer appears to be an excellent one.

The third chapter, on photometric standards, is a full and trustworthy account of the efforts which have been made at different times towards obtaining a good standard of light. Its usefulness is increased by plentiful references to original papers, as is the case with the other portions of the book. The French work was published too soon to include the final results of the work of the English Committee on Light Standards, but almost all previous work is alluded to. A short, but good, chapter on the equipment of photometric laboratories is succeeded by one entitled "electric lights," which contains a large amount of photometric matter relating to electric lighting, that has not hitherto appeared in book form.

The sixth and last chapter of the book is reserved for the distribution and measurement of illumination. As illumination is the whole object of artificial lighting, it seems strange that the consideration of it should have been so much neglected. For every photometer that has been designed for the measurement of illumination, there are at least twenty for the measurement of candle-power. The present book is, we believe, the first to take up this subject as an important part of photometry; and the ordinary reader, who has not followed the subject in the technical press, will find here much which is quite new to him. It is a subject of increasing importance, and since the issue of the French edition of this book some valuable work on it has been done by Trotter and Blondel, which should be incorporated when a new edition is called for. It is somewhat remarkable that no allusion is made to the diffused system of lighting by inverted arc lamps, or corresponding arrangements of glow lamps, in which the lights themselves are hidden from view, the rays being directed to walls and ceilings for subsequent diffusion downwards. This system has been used on the continent and in this country, especially for the lighting of factories, and its use is extending. It is in reality one of the most efficient systems of lighting, although any one seeing it for the first time is apt to think it weaker than it really is. A description of it should certainly find a place in a book such as this. There is, however, a large amount of new matter given in this chapter, and the only fault to find is a minor one, and one for which the author is not directly responsible. In quoting the different writers on this subject, a number of terms have been introduced which are needless, confusing, and badly chosen. Such terms as "volume of illumination" and "surface of illumination" are quite needless, while the phrase "useful effect of illumination" is a very bad and mis-

leading name for a quantity which is of doubtful importance. It follows from the definition that the "useful effect of illumination" is always greater than the illumination itself, and that it increases rapidly as the distance from the light is increased, until at an infinite distance from the light the "useful effect" of its illumination is infinite. "This result was easy to foresee," writes the author, who asserts that the criticisms to which it has been subjected "are not well founded"; and calculations are then made by means of which "the volume of useful effect," the "surface of useful effect," and the "mean useful effect" may be obtained by any one anxious to know.

In spite of a few minor blemishes, the book is a thoroughly good one. It is well printed, well illustrated, and contains a mass of valuable matter which is not to be found elsewhere. Some useful appendices by the translators conclude the work.

W. E. S.

THE NOTES OF BIRDS.

The Evolution of Bird-song. By Charles A. Witchell. Pp. x + 348. (London: A. and C. Black, 1896.)

THIS little work will be heartily welcomed by all ornithologists as the first elaborate attempt to deal in a scientific spirit with the very difficult subject of the utterances of birds. Considering the great amount of careful observation necessary to the formation of any theory on the subject, and the difficulty of recording such observation correctly and intelligibly, Mr. Witchell is to be warmly congratulated on his book. It is, in fact, a very welcome and agreeable call-note, addressed to his brethren of the craft, and urging them to come and test the flavour of the food its author has discovered. Should any of them be critical of details, as indeed in such a subject they inevitably must be, it is to be hoped that the call-note will not change into an "alarm"; for however much we may differ from Mr. Witchell in detail, we shall hardly be disposed to quarrel with the main line of his argument, and we shall be grateful to him for his work as a pioneer. Personally I am glad to acknowledge that during the present season of song I have derived the greatest benefit from this book, which fortunately appeared at the very time when fresh observation was most easy and agreeable.

Starting with Darwin's theory of the origin of voice, Mr. Witchell states his belief that it was first occasioned by fear or anger in combat, and that, consequently, the earliest cries were alarm-cries. He then proceeds to show that "the first call-notes of birds were probably mere adaptations of alarm-cries, the use of which was induced by the influence of mutual aid among associated individuals." Rapid reiteration of call-notes had a tendency to produce something in the nature of song; and Mr. Witchell is able to produce several good examples of this in species which are still incapable of any true vocal effort, though he gives one or two, e.g. the willow-warbler, about which I feel, as yet, uncertain. Closer observation on this point is much wanted, but I can quote one case, that of the tree-sparrow (not mentioned by Mr. Witchell), which may occasionally be heard in the spring constructing a quasi-song by linking call-notes together. Mr. Witchell is careful not to commit himself to the view

that *all* songs were so developed ; but it is quite possible that this view may eventually hold the field, if due credit be given to the inventive and imitative powers of the bird, which, having once found a voice, would naturally make constant use of it and thus develop its resources. As regards imitation, he has much to say later on ; but throughout the book he seems to me to neglect what I should call *invention*, or the varying use of the voice for the mere pleasure of using it. I am pretty confident that many birds will go on uttering "call-notes," and even songs, not for any special immediate purpose, but to express a certain sense of comfort, and for the pleasure derived from the effort. A good example of this is the greenfinch, a bird in the interpretation of whose notes Mr. Witchell surprises me ; but want of space forbids me to enter into details.

Next follows a chapter on certain noticeable incidents of bird-song, which may be strongly recommended to those who are beginning to make observations of the utterances of birds. They will find their attention directed to such points as this : that variation from the specific type of song is generally to be heard at the end of the phrase, and, conversely, that the first part of the phrases sung by allied birds have the most resemblance to common types. Or, again, that the call-notes and alarms of allied birds are more alike than are their songs—a point of great importance. A theory (p. 70) to account for the fact that the most voiceful birds are, as a rule, small, is also worth consideration.

But it is in the last three chapters that we find the most original and interesting contributions to the subject. Of these, chapters vii. and ix. are on the influence respectively of heredity and imitation, and between them the author has placed a shorter one on variation. The chapter on heredity, though it would be the better for a thorough revision, both in the ordering and expression of the matter, is nevertheless of great importance. Here Mr. Witchell endeavours with success to trace the influence of the principle of heredity by comparing the notes and songs of allied species, so as to provide fresh scientific reasons for their connection in classification. As might be expected, he finds more to the purpose in call-notes and alarms than in songs, and more in the first phrases of song than in the conclusions. Some things in this chapter may astonish us, such as the statement that the buntings are more closely allied by voice to the pipits than to the finches (p. 121), and the whole of a paragraph on p. 113, in which the songs of nightingale, lesser whitethroat, and curl-bunting are declared to resemble each other ; but the general value of this part of the work is beyond question, and cannot fail to act as a fresh stimulus to many field ornithologists.

In chapter ix. Mr. Witchell discusses his second leading principle in the development of song, viz. imitation, whether of the voices of other birds, or of prevalent sounds in fields and woods. This is, I think, his favourite topic, and the one which he has most carefully elaborated by observations and records. He has gone far beyond any previous writer in the wide range of result he ascribes to this influence, and his conclusions as to the imitative capacity of many species will have to be most carefully tested. For the last two months I have been endeavouring to test them with varying result. As regards the

thrush and the robin, he has already convinced me that they mimic much more than I had suspected, though I cannot detect in these songs more than an occasional imitation of which I can be *quite certain*. In others, such as those of nightingale, redstart, whitethroat, &c., I can as yet hardly detect any at all, though I have been listening to these voices constantly and carefully for more than twenty years. As far as my own experience goes, I should be disposed to think that Mr. Witchell often exaggerates superficial and accidental resemblances ; but on the other hand, I can readily grant that his ear may be more accurately trained than mine for the purpose of detecting them. And in any case I must refrain from detailed criticism, which can be but the pitting of one man's experience against that of another.

The short chapter on variation might well be amplified. Not only do many birds show dialectic variation in different localities, but in the same locality the singers vary from each other, and even the individuals constantly vary from one minute to another, as I have often observed this spring. And yet the specific type is always preserved, which is owing in great degree to the peculiar tone or *timbre* of the vocal instrument of the species—a point to which I hope Mr. Witchell will turn his attention more closely than he seems yet to have done.

It gives me pleasure to sign a notice in which I hope I have done justice to the merits of this work, for in a book published a year and a half ago, I alluded to Mr. Witchell's theory, as it was then known from papers in the *Zoologist*, with somewhat scant respect. Some fanciful conclusions to which he formerly gave prominence, have in this volume retired modestly into the background.

W. WARDE FOWLER.

THE STRUCTURE OF MAN.

The Structure of Man: an Index to his Past History.

By Prof. R. Wiedersheim, translated by H. and M. Bernard. 8vo, pp. xxi + 227. (London : Macmillan and Co., 1895.)

THIS book, which is a translation of Prof. Wiedersheim's "Der Bau der Menschen," by H. and M. Bernard, has the advantage of a preface and notes by Prof. G. B. Howes. As the preface states, the object of the work "is an endeavour to set forth the more salient features in the anatomy of man which link him with lower forms, and others in that of lower forms which shed special light on parts of the human organism." Such books as this give to the scientific study of anatomy much assistance by calling attention to the interesting deductions which may be made by a careful study of the different variations met with in the dissection of man and animals. In order that such deductions may be placed on a firm basis, it is necessary to have careful observations recorded in a very large number of cases, and in the English preface of Prof. Wiedersheim's book a special tribute is paid to the work carried out in the different anatomical schools through the "Collective Investigation Committee of Great Britain and Ireland." The English translation has in a great many places been added to, and brought up to date in notes by Prof. Howes. Some of these additions are exceedingly valuable in themselves, and further, their