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Die Lehre von der Mortalität und Morbilität by Harald Westergaard

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science might not form a very strong bond of political union. But in expressing an opinion about compacts other than those bargains of which the terms are settled by the play of supply and demand, we are sensible how modest is the rôle of the political economist compared with that of the prophet.

F. Y. EDGEWORTH

Die Lehre von der Mortalität und Morbilität. 2nd edition).
By HARALD WESTERGAARD. (Jena: Gustav Fischer. 1901.)

"ABOVE all, wherever statistics discovers a difference in the death-rates of two groups, the problem is presented how to bring the conditions of health of the group with the least favourable rate to the level of the other; all philanthropists, physicians, hygienists and school-masters can co-operate with manufacturers and law-givers, in creating the best possible hygienic surroundings in the home, factory, place of work and school." This sentence, taken from Prof. Westergaard's last page (p. 687), supplies a key to the purpose of his very valuable and exhaustive treatise. He has analysed both death-rates from various causes and the incidence of disease in relation to all the conditions of age, race, place, occupation and economic conditions, for which statistics with the requisite degree of accuracy could be found in the records of any country of the world. The book thus forms a very useful index to and critical analysis of existing health statistics, while the author is careful to point out the most important fields for future research. But though this compilation occupies the major part (pp. 206 seq.), it is perhaps less interesting, and from the point of view of this *Journal* less important than the first five chapters; these deal with the history and rationale of the life-table with much careful detail as to the methods of preparing the finished table from the raw material, and with several illustrations drawn from the author's own researches and special investigations, and in particular they contain many wise remarks as to the general methods of statistics together with a detailed investigation on an important point with which we will presently deal.

"In statistics, as in all positive sciences, it is of special importance to learn to recognise the value and sufficiency of the observations," and to find out whether the original material is sufficiently trustworthy to bear the superstructure of conclusions. In this connection we have some analysis of the effect of errors of various kinds, and a demonstration that we can often arrive at a positive conclusion of greater or less, in spite of erroneous data. Actual comparisons are given of the statistics obtained by different observers of the same phenomena; while the results of some special investigations give a clue to the basic problem in demographical accuracy, the trustworthiness of the census figures.

At present, however, we wish to concentrate attention on Prof. Westergaard's solution of a problem, which, though of fundamental importance in statistical investigation, is unfortunately, generally ignored in works dealing with demography. He propounds it as follows:—"I come

now to a chief question of statistics, the question what influence chance exerts on statistical measurements. For example, a death-rate of 2 per cent. is calculated from observations, but will this result be given again by later investigations? Or if a greater death-rate is found in one calling than in another, is this difference merely chance or a permanent fact? If there is no criterion by which we can determine the working of chance, it will be impossible to isolate the causes, with which the inquiry is concerned." A criterion is found in the use of the "mean error." Prof. Westergaard's method is practically that which he expounded in his *Grundzüge der Theorie der Statistik* in 1890. In a population n , it is found that in a series of years the number of deaths (for example) is pn . It is assumed that, in general, the observations will fit a curve of error with modulus $\sqrt{2p(1-p)} \cdot n$; ¹ and the deduction is drawn that the probability of a divergence from the average pn of a further observation is determinable from the integral of the curve of error, and that the existence of a disturbing cause can thus be often demonstrated. That a method of this class is often applicable and is the only sound method of establishing the existence of a significant difference, we are far from denying, but there are three important criticisms to be made on the procedure indicated. First, it is an assumption, only now in the course of justification, that the statistics of demography can be properly treated by the laws of probability at all; but discussion on this point would take us too far afield. Secondly, it is by no means frequently the case, when we review the whole field of sociological statistics, that a given series of figures fits the normal curve at all closely. Prof. Karl Pearson holds that the number of such cases is practically negligible, and Prof. Edgeworth finds that asymmetry is to be expected on *a priori* grounds. At the best, figures relating to a series of years, such as total number of births, are very unlikely to be normally distributed; it is only proportional numbers, such as birth-rates, that can be so treated, and thus the practical utility of the method is limited. Thirdly, even if we are dealing with symmetrical figures, there are two competing methods of computing the modulus. Our author says himself that in practice the two methods will only give approximate agreement. The first method is that already described, giving $\sqrt{2np(1-p)}$, the second is to find the various divergences from the average and take the square root of twice the mean square of error as modulus. Prof. Westergaard explains both methods, but hardly seems to recognise the very important theoretical distinction, emphasized by Prof. Lexis and Prof. Edgeworth between the "combinational" and "physical" groups to which the means respectively relate. It can be shown that the group from which a given series would arise with least improbability is that whose modulus is derived from the error of mean square, not the combinational modulus. Prof. Lexis finds that the two are very rarely in close agreement, and it can hardly

¹ Prof. Westergaard uses the "mittlere Fehler," which multiplied by $\sqrt{2}$ gives the modulus.

be held that the few instances adduced by our author are sufficient to establish any strong presumption in favour of the universal use of his p, n modulus; so far as we can follow his detailed method, it is this form that he uses in practice. He appears to recognize that the method is still on its trial, and cannot be extended beyond those regions (such as anthropometrical grouping, and some others of which he gives examples here and in his *Grundzüge*) where it has been shown to apply. But in practice he applies it in such a case as follows (p. 516). The death-rate from consumption for men of 35-65 years in consumptive families is 151 (per 10,000) while it is only 132·7 in the general population. Here $pn = 132·7$; n is large (presumably the total number of deaths from all causes, or the total population), p is small and $\sqrt{2p(1-p)n}$ is 16·1, which is the modulus. The difference between the two rates just given is 18·3, only just greater than the modulus. From a calculation of this kind the conclusion is drawn "that the difference is not greater than can be explained by accidental causes." Now in such a problem it is very doubtful what value should be taken for n (though if p is less, say, than ·01, twice the observed number of cases is the square of the modulus independently of n), and it is still more doubtful whether a series of such observations would satisfy the normal curve with the assigned modulus.

It may be that we have overlooked some of our author's qualifying statements and if so we offer him our apologies. We are only asking as he does himself (p. 678) for a more careful examination of the assumptions underlying the method, and we are very grateful to him for bringing the question forward in so practical a form.

It is to be hoped that the work will appear in English where it would be of great use to more classes of people than one; and if so, that some illustrative diagrams will be inserted, and that care will be taken to supply clear headlines to the numerous tables, for the explanation of which we have often at present to search in the context. Perhaps also the book might be reduced in bulk for English readers without seriously impairing its value.

A. L. BOWLEY

Francis Hutcheson: his Life, Teaching, and Position in the History of Philosophy. By W. R. SCOTT. (Cambridge: University Press. 1900.)

FRANCIS HUTCHESON will be remembered rather by the men he made than by the books he wrote. The books he wrote were neither few nor unimportant; but, as this biography shows us, he aspired to be a great teacher rather than an eminent writer, and he fulfilled the aspiration abundantly. He contrived to make philosophy a favourite study in Scotland, and with philosophy economics. Without Hutcheson to prepare the way for them David Hume and Adam Smith would have found fewer readers in their own country.

Hutcheson's early life (1694—1730) was spent chiefly in Ireland,