The late W. S. B. Woolhouse.

THE numerous valuable contributions of the late Wesley Stoker Barker Woolhouse to the pages of this *Journal* have placed our readers under such considerable obligations that his lamented death in August 1893, calls for some acknowledgment of the debt which actuarial students will always owe to him. Though active to the last, Mr. Woolhouse almost seemed to belong to the past generation of scientific men who were instrumental in laying the very foundations of modern actuarial knowledge. In much of his work he was a pioneer whom successive labourers in the same fields of enquiry were to follow, as a guide and preceptor. Though it is a truth worthy to be borne in mind by all interested in the development of the actuary's special department of research, that profound mathematical ability is not synonymous or co-terminous or correlative with actuarial science, it nevertheless provides its essential basis and foundation; and it needed the great mathematicians who were so active in their contributions to the literature of life-contingencies some thirty years ago to plan the groundwork of the science.

Few more remarkable instances of innate mathematical ability are to be met with in the records of the past than that of the late Mr. Woolhouse. Born in 1809, he attracted the notice of his teachers by his extraordinary gifts while yet in his teens; and, when nineteen years of age only, he produced treatises on "Geometry of Two Dimensions", and "Analytical Dynamics." Thenceforth his triumphs in the field of pure mathematics were frequent and conspicuous; and the reputation he had made for himself received a well-deserved recognition, when in 1830, at the age of twenty-one, he was appointed deputy-superintendent of the *Nautical Almanack* Office. It would be swerving too much from the objects to which this *Journal* is devoted, to dwell upon Woolhouse's brilliant succession of papers on mathematical and astronomical subjects—studies which might have occupied him throughout his life had not a difference of opinion between him and his official chief led to his taking office as actuary of the International Loan Fund in 1839. After this, it is natural to find him appearing as an author on actuarial topics. His well-known "Investigation of the Mortality in the Indian Army" appeared in 1839, and some five years later he was entrusted with

the manipulation of the data and the graduation of the tables of the Seventeen Offices' Experience. By this time his position as an expert actuary was firmly established, and his career as an active force in the advancement of the science of life-contingencies was fairly started.

It is with no object of following that career, step by step, that the present note is written, but rather with the endeavour of tracing Woolhouse's influence on the condition of actuarial knowledge in these days. Our readers will see from the list of his contributions appearing in the *Index to the First Twenty Volumes* how numerous and varied were the subjects on which he wrote. Of the purely mathematical essays we propose to say little. A deep knowledge of the highest branches of the science, extreme neatness and dexterity in analysis, and great inventive skill in applying theory to the elucidation or illustration of practical matters, are the chief characteristics of these writings; but it would ill become us to try to assign to him the position in the world of mathematics which of right belongs to him. It is, however, worthy of remark that he seemed to recognise the limitations of the legitimate application of mathematical laws to actuarial matters. He was, apparently, no advocate of the use of the Theory of Errors in this direction—a branch of study to which recent writers, both in this country and America, have given much thought and labour—for learned as his purely scientific writings were in this path of knowledge, the records of this *Journal* fail to show that he adopted these methods in any of his practical investigations. It is now futile to discuss whether he considered that as there is so fundamental a distinction to be drawn between mortality statistics and observations of a strictly homogeneous character, such as the drawing of balls from a bag at random, and as the laws of error could only remove the single imperfection or defect due to the *number* of the facts observed, leaving all other imperfections untouched, the application of this method served little useful purpose; but the fact itself, in a mathematician of Woolhouse's type, is at least significant.

It is easier—though the task is not free from difficulty—to deal with his claims as one of the most original and brilliant exponents of the actuarial theory. And in this connection, we may first of all notice his attraction to the subject of the graduation of mortality tables, wherein his name subsequently became a household word. His examination of the tables deduced

from Indian Military Experience and the Seventeen Offices' Experience brought home to him the necessity for removing the accidental irregularities in the original facts, and he developed the rough and simple plan of correcting the second (or fourth) differences of the observations by means of formulas given by him (*J.I.A.*, xii, 139-142), which, we believe, has been termed, rather crudely, the Method of Differences. It is a long step from this to the great method of graduation which goes by his name, and was applied by him to the Twenty Offices' Experience. The marked superiority of the later plan is in itself an abiding proof of the progress actuarial science had made in the meantime. Much has been written on this famous system of graduation, and its entire groundwork and *raison-d'être* have been so abundantly discussed by the author and his redoubtable antagonist, Dr. Sprague, in recent numbers of this *Journal*, that we are absolved from any necessity to traverse once more the well-worked field of argument. But it is fitting to call attention to the great improvements in the practical application of Woolhouse's method, which we owe to Mr. T. G. Ackland (*J.I.A.*, xxiii, 352), and Mr. G. F. Hardy (*J.I.A.*, xxiii, 351). These gentlemen showed with extreme ingenuity how Woolhouse's formula, hitherto regarded as somewhat untractable in operation, could be applied by a simple self-checking columnar process to any body of facts; and they thereby earned the gratitude of students and those who were to be employed in the actual work of graduation. Mr. Ackland also made a highly useful suggestion for doubling-back the over-lapping results at the extremities of the table, thus preserving the sum total of the original facts. In connection with the system of Woolhouse, reference must also be made to the eminently practical series of papers by Mr. J. A. Higham on new methods of graduation, which may be held to be based upon or suggested by Woolhouse's writings. In fact, it would be difficult to name any subject which has engaged closer attention in the professional mind and called forth wider research than the method of graduation devised by the subject of this memoir.

It would, however, be far from the truth to say that it is to this effort of his that the profession counts itself Woolhouse's chief debtor. His early paper on "An Improved Theory of Annuities and Assurances" (*J.I.A.*, xv, 95), wherein he propounded the continuous method, is a well-marked stage in the advance of actuarial science, and has had a profound influence on its

development. His masterly papers on "Interpolation, Summation, and the Adjustment of Numerical Tables" (*J.I.A.*, xi, 61, 301; xii, 136) will also be borne in mind in connection with his earlier contributions to actuarial science; and his quick appreciation of the merits and power of Makeham's Formula for expressing the Law of Mortality is to the credit alike of his insight and his generosity. Passing on, we must rest satisfied with brief mention of his practical paper "On the Construction of Tables of Mortality" (*J.I.A.*, xiii, 75), which is of historical value as explaining the methods adopted in working-up the Seventeen Offices' Experience; of his elaborate investigation into the subject of Half-Yearly and Quarterly Annuities (*J.I.A.*, xvii, 171); of his brilliant and most comprehensive treatment of "Integration by means of Selected Values of the Function" (*J.I.A.*, xxvii, 122); and finally of his novel, ingenious and elegant paper "An Easy Method of getting out a Rough Estimate Valuation of a Whole-Life Assurance Business" (*J.I.A.*, xxvii, 433).

Our references to Woolhouse's writings have no pretensions to completeness. From the full list, a sufficient number of papers have, however, doubtless been cited to show the extreme value and importance of his contributions. Woolhouse was a prominent member of a small group of distinguished authors on actuarial subjects, whose services to the Institute of Actuaries in its early years were inestimable; and he deserves to be held in grateful remembrance by generations of students as yet unborn. Luminous and powerful his writings invariably were, but their chief characteristic is, perhaps, thoroughness. "Rare " as epic song is the man who is thorough in what he does. And " happily so; for he subjugates us, and makes us bondsmen to " his ashes." Bondsmen we are, and our successors will be; and actuarial science need suffer no check in its steady advance, and, indeed, know no bounds, if men of such high powers of mind and strength of purpose can be found in the future to devote their time and talents to its cause.

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