William Fleetwood Sheppard, Sc.D., LL.M.

WILLIAM FLEETWOOD SHEPPARD was born on November 21, 1863, in Sydney, N.S.W., the second son of Edmund Sheppard, a Judge of the Supreme Court of Queensland, and was educated at Brisbane Grammar School and at Charterhouse. In 1881 he entered Trinity College, Cambridge, as a Foundation Scholar, and in 1884, at the age of twenty, he graduated as Senior Wrangler. It was a brilliant year: the second Wrangler, W. P. Workman, became the well-known headmaster of Kingswood School; the third is now Sir William Bragg, O.M., K.B.E., President of the Royal Society; the fourth was the eminent mathematician, W. H. Young, F.R.S.; the sixth, Alexander Anderson, became President of University College, Galway, and Vice-Chancellor of the National University of Ireland; and somewhat lower came Professor A. S. Eve, F.R.S., of Montreal. In 1887 he was elected a Fellow of Trinity, and shortly afterwards was called to the Bar. Realising, however, that his interests were in education and research rather than in the law, in 1896 he accepted an appointment as a Junior Examiner in the Education Department (now the Board of Education), and wrote the first of a long series of memoirs.

Sheppard's original contributions to mathematics lie almost without exception in the field of finite differences, interpolation, and mathematical statistics; and the genesis of any other papers can easily be traced to these preoccupations. In the development of statistics in England, to which the late Professor Karl Pearson imparted such momentum at the turn of the century, Sheppard played no inconsiderable part. Indeed in retrospect this development is seen to be less the progress of a homogeneous school (as continental opinion is still apt to suppose) than the resultant contribution of such differing minds as Pearson, Edgeworth, Yule, and Sheppard, strongly reinforced half a generation later by R. A. Fisher.

Almost at once, in his first paper (*Proc. L.M.S.*, 1897) Sheppard attached his name permanently to the famous "Sheppard's corrections" for the moments of a frequency distribution grouped into classes. The paper will still repay the pains of close perusal, for although the original demonstration has since been simplified in various ways, it has sometimes been over-simplified in such a way that the remarkable nature of Sheppard's approximation has been obscured. Sheppard returned to the topic in a second paper (*Biometrika*, 1907) and in a paper on the calculation of the moments of an abrupt distribution, presented to the Cambridge Congress of Mathematicians in 1912. The problem of "Goodness of fit" always

exercised him. In 1899 he published a paper on the rejection of extreme statistical variations, and one of his last and best papers, perhaps the most characteristic of all, subjected the derivation and use of Pearson's χ^2 to a close analysis, which he never entirely completed.

Sheppard calculated what is perhaps the most valuable table of the normal probability integral, his seven-figure table (*Biom.*, vol. ii, 1903, pp. 174–190) with mean square deviation standardised to unity. He was the first in this country to formulate the use of central differences and central sums (though actuaries had for some time been using these in special formulæ) as an independent calculus, and his various papers on these, taken together, are almost an encyclopædia of formulæ and results in this subject. He examined the error terms of central formulæ for interpolation and quadrature, and recognised the importance of factorial moments.

The problem of finding a polynomial curve of closest fit to given points of equally spaced ordinates attracted his attention in a series of papers in 1912, 1914–15, and 1921. Study of these papers and personal contact with Sheppard at Edinburgh in 1926–27 led A. C. Aitken to complete Sheppard's work by introducing orthogonal polynomials, while retaining Sheppard's predilections for central differences and factorial moments.

In 1923 Sheppard followed up a short paper on the extended meaning of conjugate sets by a book, *From Determinant to Tensor* (Oxford, 127 pp.). This may seem at first sight to lie quite away from his usual field; but perusal of his paper, "The fit of a formula for discrepant observations" (*Phil. Trans.*, 1927), shows that the origin of the book was statistical, deriving indeed from the fact that questions dealing with least squares and normal frequency in many variables constantly require the transformation of vectors and quadratic forms, to which the tensor notation is highly adapted.

The characteristics of Sheppard's work are thoroughness and independence. His was an original, questing mind, dissatisfied until he had penetrated to the root of a difficulty, accepting nothing on authority. He took extraordinary pains, yet his exposition and notations are often difficult. Agility, shafts of brilliance, are not to be found; but there is no superficiality. A careful study of his papers, especially the first and the last on statistics, will always be rewarding.

Sheppard was much interested in methods of teaching mathematics, and was president of the Mathematical Association in 1928 and 1929.

He was made an Assistant Secretary of the Board of Education in 1914, and retired from the Civil Service in 1921.

On June 10, 1902, he married Miss Elsa Stevens, daughter of Edward Henry Stevens; there were three sons of the marriage.

He was elected a Fellow of the Society in 1932 and died on October 12, 1936.

A. C. A.
E. T. W.

Papers of Dr W. F. Sheppard.

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"On the statistical rejection of extreme variations." *Proc. Lond. Math. Soc.*, vol. xxxi, 1899, pp. 70–99.

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"Table of the probability integral." *Biometrika*, vol. ii, pp. 174–190.

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"The accuracy of interpolation by finite differences. II." *Proc. Lond. Math. Soc.*, vol. x_2, 1912, pp. 139–172.

"The power-sum formula and the Bernoullian function." *Math. Gaz.*, vol. vi, 1912, pp. 332–336.

"Summation of the coefficients of some terminating hypergeometric series." *Proc. Lond. Math. Soc.*, vol. x_2, 1912, pp. 469–478.

"Calculation of the moments of an abrupt frequency distribution." *Proc. Fifth Intern. Congr. Math.*, vol. ii, 1912, pp. 414–426.

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"Factorial moments in terms of sums and differences." *Proc. Lond. Math. Soc.*, vol. $xiii_2$, 1914, pp. 81–96.

"Fitting of polynomials by method of least squares. (Solutions in terms of differences and sums.)" *Ibid.*, pp. 97–108.

"Graduation by reduction of mean square of error." Parts I and II. *Journ. Inst. Act.*, vol. xlviii, 1914, pp. 171–184, 390–412. Part III. *Ibid.*, vol. xlix, 1915, pp. 148–157.

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Various papers and lectures on probability, statistics, arithmetic, etc., to the Math. Assoc., in *Math. Gaz.*, *T.F.A.*, etc.