

Obituary

WILLIAM GEMMELL COCHRAN, 1909–1980

WILLIAM GEMMELL COCHRAN was born in Rutherglen, a suburb of Glasgow, on July 15th 1909. He read mathematics at Glasgow University, and in 1931 came to Cambridge to study statistics for a Ph.D. under Wishart, who had just been appointed Reader in Statistics in succession to Udny Yule, after 4 years as Fisher's principal scientific assistant at Rothamsted, following 3 years under Karl Pearson at the Galton Laboratory.

While at Cambridge Cochran completed his first statistical paper on the joint distribution of several quadratic forms in a univariate normal system (*Proc. Camb. Phil. Soc.*, **30**, 365–375 (1934)), embodying what later became known as Cochran's theorem. Essentially the results he obtained are the analogue of the condition that a pair of single degrees of freedom are orthogonal if the sum of the products of the coefficients of the x 's in the corresponding linear contrasts is zero. Although elegant mathematically, it is perhaps doubtful whether his results were of much practical value; certainly, as Cochran himself recognized in his paper, they did nothing to resolve the question of exact tests of significance in analyses of covariance, which had been bothering Wishart, and which was the practical motivation for the paper.

I succeeded Wishart at Rothamsted in 1931, and when in 1933 Fisher was appointed to the Galton Chair at University College, London, in succession to Karl Pearson, I was put in charge of the Station's Statistics Department, but at first without any scientific assistant. However early in 1934 I succeeded in convincing the Director, Sir John Russell, that I must have an assistant, and was able to make an offer to Cochran, on whom I already had my eye, provided he could join us immediately. Because of the required University residential qualification, acceptance of this offer necessitated abandoning his Ph.D., though Cambridge did later award him an M.A. It was, I think, a measure of his good sense, and perhaps also of my persuasive power, that he judged that practical work at Rothamsted, with its long Fisherian tradition, might be a better future qualification than a Ph.D., even from Cambridge.

Cochran came to Rothamsted at an opportune time. Fisher's new ideas on experimental design and analysis, which had been developed in the 1920s and with which I was particularly involved in my work at Rothamsted, were finding increasing recognition at other research institutes, both in the United Kingdom and overseas. Cochran worked closely with me in their further development and in their application to the research problems of Rothamsted, and through our association with agronomic research workers in overseas dependencies to the problems of tropical agriculture.

Factorial design, confounding and the estimation of error from high-order interactions provided powerful tools for the assessment of the fertilizer requirements of arable crops. Factorial experiments with 27 or 32 plots could be repeated in successive years and on different soil types on commercial farms without undue burden on the farmers. Summaries of such series presented new statistical problems to which Cochran made notable contributions, particularly in his paper on problems arising in the analysis of a series of similar experiments (*J. R. S. S., Suppl.*, **4**, 102–118 (1937)), and in the joint paper with me on the analysis of groups of experiments (*J. Agric. Sci.*, **28**, 556–580 (1938)).

Experiments running for several years in which the treatments or the crops or both were rotated were also coming to the fore. Such experiments present much more complicated problems, both of design and of statistical analysis, than do 1-year experiments on a single crop. The paper Cochran read at a meeting of the Industrial Applications Section of our Society (*J. R. S. S., Suppl.*, **6**, 104–148 (1939)) was the first thorough exploration of these problems.

Sampling is an important adjunct of agricultural and biological experimental work. Techniques for sampling experimental plots had early been the concern of the Statistics Department and in the 1930s we developed and tested techniques for sampling commercial fields to provide estimates of yield. The effects of meteorological factors, particularly rainfall, on yields were also of continuing interest, as were the possibilities of using growth measurements as additional information for forecasting yields; an exploratory scheme of observations on wheat ran at 10 centres for 7 years, until interrupted by the War. To these activities Cochran also contributed substantially. During his 5 years at Rothamsted he published some 20 papers, one-third on experimental design and analysis, one-third on sampling problems and agricultural meteorology and the remainder on miscellaneous practical and theoretical problems, a creditable beginning to the total of over 100 published during the whole of his career. (There is a good bibliography in G. S. Watson's memorial article in the *Annals of Statistics*, **10**, 1–10 (1982).)

Fisher was by this time well known in North America. Snedecor, who with A. E. Brandt was developing statistics at the Iowa State College of Agriculture, Ames, was one of the first to recognize the value of Fisher's work, and Fisher spent 6 weeks there as visiting professor in 1931, and again in 1936. Snedecor then endeavoured to persuade him to take a permanent post. When Fisher decided against this the College made an offer to me and then in 1938, after a visit to Ames, to Cochran. This he accepted, as the prospects for promotion at Rothamsted or indeed elsewhere in the U.K. were not at that time promising, but cried off at the last moment for patriotic reasons, because of the expected outbreak of war. However the offer was renewed and he left for Ames in the summer of 1939. It is an amusing sidelight on the high value attached to a Ph.D. in the United States that lack of this qualification by both myself and Cochran caused some heart-searching amongst the Ames authorities.

Cochran's appointment to Iowa State greatly furthered the spread of sound experimental techniques in agriculture and biology in America. For the first time he was involved in teaching and rapidly showed his abilities in this direction. His stay at Ames saw the genesis of his book on experimental design and analysis, in collaboration with Gertrude Cox, who had already been collecting examples illustrating the Fisherian techniques. This was eventually published in 1950 and rapidly became the standard textbook on the subject. He also did much to popularize the use of quasi-factorial and lattice designs for varietal trials and published a number of papers on them. His Rothamsted experience on the sampling problems of surveys was of value in the collaborative work, led by Jessen, of Ames and the U.S. Bureau of the Census, and subsequently Cochran was chairman for many years of a panel which provided guidance to the Bureau. In 1944 he was seconded from Iowa State to join S. S. Wilks' statistical research group at Princeton which was engaged in military and naval research, and he was a member of the U.S. team which after the war had the task of evaluating the effects of air raids.

In 1946 Gertrude Cox moved to North Carolina to set up an Institute of Statistics with Cochran as head of the graduate programme in experimental statistics at the State College at Raleigh, and Hotelling as head of the Mathematical Statistics Department at the University in Chapel Hill, Cochran was very successful in developing a sound graduate programme, but he found that the rapid increase in the number of students left little time for research activities, and in 1949 he accepted a post as head of the Biostatistics Department in the School of Hygiene and Public Health at the Johns Hopkins University. The sharp division between theory and practice resulting from the two widely separated centres of the Institute may also not have been to his liking.

The work at the Johns Hopkins led to increasing involvement in the problems of public health, and this in turn to the problems arising in observational studies on human populations, which became one of his main interests. His book, *Sampling Techniques*, was published in 1953 and soon became a standard textbook on sample surveys. Together with Mosteller and Tukey he was chosen by the American Statistical Association to make a critical review, published in 1954, of the Kinsey reports on human sexual behaviour.

Harvard University had up to that time lagged behind Princeton and Yale in the development of modern statistics, but in 1957 a Department of Statistics was set up, and Cochran, together with Mosteller and others, was chosen to head it. At Harvard he continued his work on problems involving human populations and amongst other activities was a member of the committee that produced the very thorough Surgeon-General's Report on Smoking and Health (1964). He also revised Snedecor's *Statistical Methods*.

He retired from his Harvard chair in 1976 but continued actively in statistics until his death at his home at Cape Cod on March 29th 1980. In his later years he was troubled with serious circulatory problems, but did not allow these to interfere with his work. I recall that at a conference on experimental design at Fort Collins, Colorado, in 1973, he confided that he had brushed aside his doctor's warning that the altitude of Fort Collins (5000 ft) constituted a serious risk.

Cochran played a very active part in American and international statistical societies. He was a member of the committee, chaired by C. I. Bliss, which in 1947 set up the Biometric Society, was its President in 1954–55, and was made an honorary member in 1976. He was President of the Institute of Mathematical Statistics in 1946, of the American Statistical Association in 1953 and of the International Statistical Institute from 1967 to 1971. He was also Vice-President of the American Association for the Advancement of Science in 1966 and was made an honorary fellow of the Royal Statistical Society in 1959 having been the first recipient of the Guy Medal in Bronze in 1936. He was elected to the American Academy of Arts and Sciences in 1971 and to the National Academy of Science in 1974.

A passage from a letter to me from G. S. Watson, with perhaps substitution of "Fisherian" for "British", well sums up his achievements:

"I feel his great contribution was to bring the theory and practice of British statistics to the United States and to maintain it. Being a cautious Scot he never took extreme positions on any issue—he fairly represented all sides and so remained friendly with everyone. He was also very modest and never claimed to have the 'truth'."

He married Betty Mitchell, who was a member of the Entomological Department at Rothamsted, in 1937. There were three children by the marriage, a son and two daughters. I have many memories of friendly and stimulating meetings with him and Betty in the States and elsewhere. They spent the summer of 1964 (part of a sabbatical leave from Harvard) at Rothamsted, where I was able to arrange for them to be accommodated at Rothamsted Manor, Sir John Lawes' ancestral home, now in part a hostel for overseas visitors, and to allocate to Bill a room overlooking the Harpenden Common in the Georgian house which was then part of the Statistics Department. Present and past members of the Department still speak with affection of their recollections of his visit.

F. YATES

SIR GEORGE MADDEX, 1895–1982

GEORGE HENRY MADDEX became one of the most distinguished actuaries of his day. He began work in the Office of the National Health Insurance Joint Committee soon after it was formed to operate the systems of social security introduced by Lloyd George in 1911. He had had a good scholastic record at Owen's School and had obtained a high place in an examination for junior professional, scientific and technical appointments in the Civil Service. He began to study for the Fellowship of the Institute of Actuaries and, after war service in the Meteorological Section of the Royal Engineers, qualified for it in 1920. (Later, he was able to add the Fellowships of the corresponding bodies in Scotland and the USA.) By 1920, the Government Actuary's Department had been formed and it was in this Department that he made his career. He was promoted through all the ranks of the hierarchy and in 1946 became its head with the title of Government Actuary. After his retirement from the Public Service in 1958 he served on, and became Chairman of, the Board of an Insurance Company.

Maddex quickly became expert in the field of the statistics and intricate finances of the British National Insurance System, the various branches of which were in a state of almost perpetual development throughout his service. He was responsible for a large number of White Papers and other official reports, noted for their clarity and accuracy. In the late 1930s he spent a time in New Zealand advising the Government there on its own social security plans. After his return began a period of most intense activity, starting with the Beveridge Report and ending in a spate of far-reaching new legislation. He also did notable work, mostly behind the scenes, in the other fields of work of the Department, and he was awarded the KBE in 1948.

Among the public bodies on which he served were the Statistics Committee of the Royal Commission on Population (the reports of which he discussed at one of the Society's meetings), the Committee on Motor Insurance as a Road Safety Factor and a Working Party on University Teachers' Superannuation. For a time he was a member of the Council of the RSS but most of his efforts were devoted to the Institute of Actuaries, of which he became in due course the President, after serving it in other capacities and reading two papers to its Sessional Meetings.

PETER R. COX

J. NEYMAN, 1894–1981

Jerzy Neyman, one of the main architects of statistical inference, died at Berkeley, California, on August 5th, 1981. He spent nearly half his life in the United States, but his roots were Polish. His paternal grandfather was a Polish nobleman and a revolutionary, who was burned alive in his house during the 1863 Polish uprising against the Russians. The elder children (i.e. Neyman's uncles) were deported to