

## **Frank WILCOXON**

b. 2 September 1892 - d. 18 November 1965

**Summary.** Wilcoxon was a notable chemist and had a significant role in developing modern insecticides. He and Jack Youden were two of a three person study group meeting to study R. A. Fisher's newly published book, *Design of Experiments*. Both became statisticians and made important contributions.

### **Introduction**

The first edition of *Statistical Methods for Research Workers* by R. A. Fisher (q.v.), later Sir Ronald Fisher, was published in 1925 and received much attention in the experimental sciences. Some time late in 1925 or early 1926, a physical chemist, Frank Wilcoxon, a chemical engineer, William John (Jack) Youden (q.v.), and a biologist, F. E. Denny were the nucleus of a group that met regularly at the Boyce Thompson Institute for Plant Research at Yonkers, N. Y. to study Fisher's statistical methods.

This introduction to statistics had a profound effect on the careers of Wilcoxon and Youden. Both became leading statisticians of their time, statisticians with the clear goal of devising and using statistical methodology to improve research, particularly in chemistry and the physical sciences. Both Wilcoxon and Youden were early leaders in the annual, week-long Gordon Research Conference on Statistics in Chemistry and Chemical Engineering.

The object of this article is to record highlights of the life and contributions of Frank Wilcoxon. In this, we have relied heavily on earlier writings, Bradley and Hollander (1978) and Bradley (1966).

### **Early Years**

Frank Wilcoxon's parents were wealthy, married young, toured Europe on an extended honeymoon, and rented Glengarriffe Castle near Cork, Ireland for the expected birth of their first child. Frank and a twin sister were born on September 2, 1892. Their father was a poet, outdoorsman, and hunter, the family home being at Catskill, N.Y. on the banks of the Hudson River. Frank developed a lasting love for nature and the water but was never a hunter or fisherman.

Frank's early instruction was by private tutors. He signed on as a crew member on a freighter in New York harbor at age 16 or so, but after a week of chipping paint when the ship failed to sail, he jumped ship. Thinking that

he had committed an offense comparable to desertion from the navy, he fled to a deserted area of West Virginia where he spent several years manning an oil-well pump and later climbing trees as a tree surgeon. Hearing of a school in Boston providing training in forestry, he proceeded to that city only to find the school closed. He returned home. This led to his enrolment in the Pennsylvania Military College from which he graduated in 1917. The school's military system was not to his liking; early manhood was a difficult period in Wilcoxon's life. Also, at about this time, his sister died in child birth, a serious loss to him and an influence in his own decision not to have a family.

After a World War I position with the Atlas Powder Company in Houghton, Michigan, Wilcoxon enrolled at Rutgers University in 1920 and completed the M.S. degree in chemistry in 1921. He then transferred to Cornell University and completed the Ph.D. degree in physical chemistry in 1924, staying on as a postdoctoral Heckscher Fellow in 1924-25. At Cornell, Frank met Frederica Facius, an undergraduate at Cornell and they were married on May 27, 1926. Frank and Freddie became well known and loved in the statistical community through their regular participation in the Gordon Research Conference cited above. On leaving Cornell, Wilcoxon took a postdoctoral fellowship sponsored by the Nichols Copper Company at the Crop Protection Institute located at the Boyce Thompson Institute in Yonkers, N.Y., thus being present to participate in the study group.

### **Career Positions**

Frank Wilcoxon was employed by the Nichols Copper Company in Maspeth in Queens from 1928 to 1929, then returning to Boyce Thompson as a group leader of an investigation of the actions of insecticides and fungicides under a grant from the Hermann Frasch Foundation. Wilcoxon stayed at the Institute until World War II when he took leave for two years in charge of the control laboratory of the Ravenna Ordnance Plant operated by the Atlas Powder Company in Ohio. (Wilcoxon was quite proud of his work with Atlas in both world wars, particularly in avoiding accidents in areas under his control.) Frank took a position as group leader of the insecticide and fungicide laboratory of the American Cyanamid Company in Stamford, Connecticut in 1943. In his later years at Boyce Thompson and his earlier ones at Cyanamid, his interest, study, and knowledge of statistics grew. In 1950 he transferred to the Lederle Laboratories Division of Cyanamid and developed a statistical consulting group. Wilcoxon retired in 1957, took on a part-time consulting

assignment at Boyce Thompson, and was persuaded in 1960 by the present author to take on a half-time, teaching and research position as Distinguished Lecturer in the one-year old Department of Statistics at Florida State University in Tallahassee, where he continued until his death on November 18, 1965.

Frank had two periods in which he engaged in teaching. From 1929 to 1941, although holding full-time jobs, he taught physical chemistry in evening classes to graduate students at the Brooklyn Polytechnic Institute. From 1960 to his death, he taught courses in applied statistics in the newly formed Department of Statistics to natural science majors at the Florida State University. The courses that he developed had real life examples, often based on his own research or consulting experiences, that his students appreciated. They were less pleased that he gave no credit in grading for any problem with an incorrect numerical answer regardless of the technical sophistication of techniques used. He reasoned that incorrect numerical work was totally unacceptable in a research project and his students accepted this. Frank Wilcoxon found teaching to be rewarding and stimulating; he was loved by his students and some formed long-term associations with him.

### **Wilcoxon's Research**

Two brief events illustrate the high regard held for Frank Wilcoxon's research in both statistics and chemistry.

A joint meeting of the Institute of Mathematical Statistics and the Eastern North American Region of the Biometric Society was held in Chapel Hill, N.C. in April, 1962 [See *Annals of Mathematical Statistics*. **38**, 1220-1223, 1962] . Possibly for the first time, Wilcoxon gave an invited address, the topic being, two-sample, sequential, rank tests [Wilcoxon, Rhodes and Bradley (1963) ]. He received a prolonged standing ovation.

The second event was related to a meeting of the Board of Control (now Board of Regents) of the Florida state universities in 1961. The Florida State University Department of Statistics was seeking the approval of the Board for a Ph.D. program in statistics. The President of the university asked the present author to be present at the meeting in case questions arose. When the agenda item was addressed and the Board was asked for comments, a member of the Board commented "I see that Frank Wilcoxon is associated with this proposal and any program with Frank Wilcoxon is good enough for me." The comment was made by a citrus grower familiar with Wilcoxon's role in the development of the insecticide malathion. The proposal was approved

without further discussion.

Karas and Savage (1967) list 80 Wilcoxon articles including several revisions of his well known (1947) pamphlet, *Some Rapid Approximate Statistical Procedures*, 22 of which dealt with statistical procedures or use of statistics in applications. Wilcoxon's statistical work indeed focused on rapid easy statistical methods; he was interested in ranking methods [See his famous paper, Wilcoxon (1945), in which he introduced both the rank-sum and signed ranks tests.], tabling, individual comparisons by ranking methods, nomograms, and methods of dose and time response. He came to the Florida State University with an array of research topics that he had not had time to address in industry and a number of us had the opportunity of working with him on these topics. The FSU research included sequential, two-sample, grouped rank tests, extended tables of significant levels for his 1945 rank tests, and rank-sum distributions in the two-way classification. He motivated other FSU research on sequential signed rank tests and multivariate two-sample nonparametric tests. He also worked with Cuthbert Daniel on factorial treatment combinations robust against linear and quadratic trends.

As often happens, independent proposals for the rank-sum test were later found, some before 1945 [See Kruskal (1957)], but it was Wilcoxon's work that stimulated a burst of research on ranking procedures. We do not discuss Wilcoxon's publications in chemistry but they do relate closely to his training and early work assignments noted above. Major areas of his research relate to fungicides, fumigants, and insecticides, with investigations of their actions, effects and toxicities. McCallan, S. E. A. (1966) reports on Wilcoxon's research in chemistry. Other references are provided by Bradley and Hollander (1978) along with a Wilcoxon bibliography on statistics.

## References

- Bradley, R. A. (1967). Obituary: Frank Wilcoxon. *Biometrics*, **22**, 192-194.
- Bradley, R. A. and Hollander, M. (1978). Wilcoxon, Frank (a biography). *International Encyclopedia of Statistics 2*, 1245-1250.
- Fisher, R. A. (1925). *Statistical Methods for Research Workers* Oliver & Boyd, Edinburgh.
- Karas, J. and Savage, I. R. (1967). Publications of Frank Wilcoxon (1892-1965). *Biometrics*, **23**, 1-11.
- Kruskal, W. H. (1957). Historical notes on the Wilcoxon unpaired two-sample test, *Journal of the American Statistical Association*, **52**, 356-360.
- McCallan, S. E. A. (1966). Frank Wilcoxon (September 2, 1892-November

18, 1965). Boyce Thompson Institute for Plant Research, *Contributions* 23, 143-145.

Wilcoxon, F. (1945). Individual comparisons by ranking methods, *Biometrics Bulletin* 1, 80-83. Reprinted in the Bobbs-Merrill Reprint Series in the Social Sciences, S-541.

Wilcoxon, F. (1957). *Some Rapid Approximate Statistical Procedures*, Stamford, Conn. Stamford Research Laboratories, American Cyanamid Company. Revised in 1949 and revised, jointly with Roberta A. Wilcox, in 1964.

Wilcoxon, F., Rhodes, L. J. and Bradley, R. A. (1963). Two sequential two-sample grouped rank tests with applications to screening experiments, *Biometrics*, **19**, 58-84.

Ralph A. Bradley