Ladislaus von BORTKIEWICZ
b. 7 August 1868 - d. 15 July 1931

Summary. Bortkiewicz did more than investigate kicks by Prussian cavalry horses. A pioneer faithful to his master Lexis, he extended in numerous and original ways ways the application of the probability calculus to statistical problems.

Bortkiewicz was born into a Polish family in St.Petersburg, capital of the Russian Empire. "Bortkiewicz" is the Polish spelling of his surname, and most of his works are written under this spelling. The German tranliteration from the Russian version is "Bortkewitsch", under which he wrote his best known work *Das Gesetz der kleinen Zahlen (The Law of Small Numbers.)* An English transliteration of his surname from the Russian is "Bortkevich", with emphasis on the "ke". Correspondingly, his first name is variously given as Wladyslaw, Ladislaus, and Vladislav. All three of his identifications: Polish, German and Russian are evident in his life, contacts and writings. His father Joseph Ivanowitsch Bortkewitsch, an aristocrat from Kaunas, now in Lithuania, but then a city of the Russian Empire called Kovno, was a colonel who was also an instructor in artillery and in mathematics, and had written several texts in mathematics, and other works in economics and finance. His mother was Helene von Rokicka.

Bortkiewicz pursued his studies in the Faculty of Law of the University of St. Petersburg, from which he graduated in 1890; he left to improve his training in statistics and political economy in Germany. After spending a short time at the university of Strasburg (1891-1892), where he worked under the direction of Georg Friedrich Knapp (1842-1926), then at Göttingen with Wilhelm Lexis (q.v.), and also at Vienna and Leipzig, he defended his doctoral thesis at the University of Göttingen in 1893. From 1895 to 1897 he taught actuarial studies and theoretical statistics as a *Privatdozent* at the University of Strasburg (the title page of the *Gesetz* describes him in this capacity), where he influenced A.A.Chuprov (q.v.). He returned to Russia in 1897, before coming back permanently to Germany four years later. While employed in the general office of the Pensions Committee for the railways in St. Petersburg between 1897 and 1901, he also taught statistics from 1899 until December 1900 at the prestigious Alexandrovsky Lyceum. In 1901, he was appointed professor *extraordinarius* (Associate Professor) at the University of Berlin, where he remained until his death in 1931. From 1906

to 1923, he taught simultaneously at the Handelshochschule of Berlin as a *Privatdozent*. It was only after the introduction of university reforms under the Weimar republic that Bortkiewicz was promoted to the rank of professor *ordinarius*, (full Professor) and then merely *ad personam* in statistics and political economy. The Chair remained vacant after his death; Bortkiewicz would have liked Gumbel (q.v.) to succeed him, but the latter was marginalized by his anti-nationalist activities, which earned him the hostility of the Berlin establishment. Thus the Chair remained vacant for the entire period of the Third Reich. The short biography of Bortkiewicz by Gumbel (1978), though politically tendentious, is that of a disciple.

In his generation, Bortkiewicz was the main representative of mathematical statistics in Germany and within the sphere of German influence. Scrupulous in the extreme, inclined to be critical and polemical, Bortkiewicz was a highly respected and feared figure; but he was rarely understood, so that his teaching as well as his published work had few imitators. Yet, this work ranges from political economy to probability, through demography, actuarial studies, economic statistics and statistical physics. His published works are mainly in German, although a number, beginning in 1890 are in Russian; and three or so are in Polish.

Bortkiewicz contributed in a decisive manner to the modern development of mathematical statistics, taking up the inheritance of Laplace (q.v.), Poisson (q.v.), Bienaymé (q.v.), Cournot (q.v.) and finally Lexis (q.v.).

Demography and actuarial studies were still the dominant core of statistics at the end of the 19th century, and these were Botkiewicz's first areas of research in Russia and Germany. This research was an extension of the work of his two German masters, Knapp in "theoretical demography" and Lexis in matters concerning the study of mortality and births. Bortkiewicz lectured widely, including at the Congress of the International Statistical Institute, on his methods and on his results on the treatment of tables, as well as on the male ratio at birth.

Posthumous fame was ensured by his short work, the *Gesetz* of 1898, dedicated to Lexis, in which he discussed his famous (but widely misunderstood subsequently) "Law of Small Numbers". In this pamphlet he gave the first account and application of the distribution of rare events, established sixty years earlier by Poisson. What is usually remembered is his famous example on the number of men killed by horse kicks in the Prussian army. But on a less superficial level, Bortkiewicz's book may be interpreted as a twofold plea. First, by giving theoretical proofs and many numerical examples, Bortkiewicz

consolidated Lexis's theory based on his famous Q coefficient of dispersion. He proved that rare events whose frequency is low have a sufficiently regular dispersion to satisfy Lexis's criterion (Q close to 1). This achieved, Bortkiewicz provided the first major validation of Lexis's idea, raising it, somewhat clumsily, to the level of a "Law of small numbers". This title was used to recall, rather than contrast with Poisson's "Law of Large Numbers". His success opened up a far more ambitious perspective. While Lexis's theory provided a simultaneous measure of the stability of statistical series and a criterion for the applicability of probabilistic models, the contribution of Bortkiewicz was essentially a plea for the use of probabilistic methods in the treatment of statistical data. On this score, his work did not fail to trigger some violent and contradictory reactions. One was with Karl Pearson (q.v.) over the Lucy Whitaker paper (Quine and Seneta, 1987). These controversies lasted well after World War I and were followed from time to time by others, particularly one with Gini (q.v.) concerning priority.

At the turn of the century, German statistics, inheriting a long administrative tradition with all its history, was still thoroughly divided on the meaning and existence of social laws established mathematically. The ghost of Quetelet (q.v.) still haunted statistical thinking when Bortkiewicz's work appeared. All the old mistrust concerning advanced mathematics, and even more acutely the aim of basing all statistics on the calculus of probabilities, then resurfaced.

Throughout his career, Bortkiewicz never ceased to defend Lexis' theory. Many of his publications were related to the study of dispersio;n which may be regarded as one of the central themes of his work. Together with Markov (q.v.) and Chuprov in particular, Bortkiewicz tried to develop, perhaps in vain, the basis of a real analysis of variance starting from Lexis' theory, but this direction taken by continental statisticians was not followed up, in contrast to the English Biometric School. While Chuprov, Bortkiewicz's friend and rival, was able to redirect his research and recognize the innovations of the English School, Bortkiewicz for too long allowed himself to be entangled in his interminable quarrels; another with Karl Pearson was about the Chi-square distribution, which Bortkiewicz attributed quite correctly to Helmert.

There remains, however, an area where Bortkiewicz's thinking found a happier outlet: extremes and order statistics. One may set his pioneering contribution to the study of extreme values of 1922 within the framework of his research on dispersion. Starting from the comments of Fechner on the

range, he pursued an argument analogous to that which had led him to the "Law of Small Numbers" and showed that the range, showed a remarkable regularity, similar to that of rare events. His results and comments, echoing the research carried out by the School of his old adversary Karl Pearson, would later be discussed and fruitfully extended by his younger German colleagues R. von Mises (q.v.), and particularly Gumbel, amongst others.

Bortkiewicz took an interest in every possible application of the calculus of probabilities, and had a predilection for intricate problems. In a pamphlet published in 1913, he considered the question of radioactive radiation, and showed that its distribution followed probabilistic laws.

In the 1920s Bortkiewicz concerned himself with questions of economic statistics; the concentration of wealth, which resulted in a new quarrel with the Italian Gini within the International Statistical Institute. In 1923-24 his critical review of the treatise by Irving Fisher (q.v.) on *Price Index Numbers* again started yet another controversy.

Overall, there is only a single area where his name is as familiar as at the dawn of the 20th century, namely Political Economy. Like all statisticians trained in German universities at the end of the 19th century, Bortkiewicz had acquired a taste for economics, and demonstrated it by a remarkably astute study of Book III of *Das Kapital* in which Marx discussed his theory of the transformation of value into price. This work warranted Bortkiewicz being ranked by Schumpeter (1951) as "one of the ten greatest economists from Marx to Keynes" and

> "By far his most important achievement is his analysis of the theoretical framework of the Marxian system, much the best thing ever written on it and, incidentally, on its other critics."

Bortkiewicz maintained active contacts with Polish scientists, notably Neyman (q.v.), and was sounded out on accepting a Chair at the University of Warsaw, and in Kraków. There is a posthumous survey of his work by Neyman - who regards Bortkiewicz's *Die Iterationen* (1917) as his most important work - followed by an anonymous obituary, both in Polish, in *Kwartalnik Statystyczny*, **8**(1931), 1116-1120.

A systematic study of Bortkiewicz as a statistician would throw valuable light on this crucial period in the history of mathematical statistics.

References

[1] Bortkiewicz, L.v. (1893). *Die Mittlere Lebensdauer. Die Methoden ihrer Bestimmung und ihr Verhältnis zur Sterblichkeitsmessung*, Fischer, Jena, 117 pp.

[2] Bortkiewicz, L.v. (1898). *Das Gesetz der kleinen Zahlen*, Teubner, Leipzig, 52 pp.

[3] Bortkiewicz, L.v.(1913). *Die radioaktive Strahlung als Gegenstand wahrscheinlichkeitstheoretischer Untersuchung*, Springer, Berlin, 1913.

[4] Gumbel, E.J.(1978). Bortkiewicz, Ladislaus von, *International Encyclopedia of Statistics*, **1**, 24-27 (with a Postscript by O.B. Sheynin).

[5] Quine, M.P. and Seneta, E.(1987). Bortkiewicz's data and the Law of Small Numbers. *International Statistical Review,* **55**, 173-181.

[6] Schumpeter, J.A.(1951). Ladislaus von Bortkiewicz (1868-1931),*Ten Great Economists, from Marx to Keynes*, Oxford Univ. Press, New York, pp. 302-305.

[7] Sheynin, O.B. (1970). Bortkiewicz(or Bortkewitsch), Ladislaus (or Vladislav) Josephowitsch. *Dictionary of Scientific Biography*, **2**, 318-319.

S. Hertz