



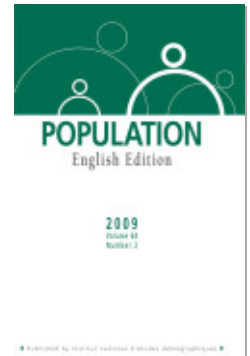
PROJECT MUSE®

The French Response to the Demographic Works of Alfred Lotka

Jacques Véron, Catriona Dutreuilh

Population, English edition, Volume 64, Number 2, 2009, pp. 319-339
(Article)

Published by Institut national d'études démographiques



➔ For additional information about this article

<https://muse.jhu.edu/article/365230>



Jacques VÉRON*

The French Response to the Demographic Works of Alfred Lotka

*All demographers are familiar with the name of Lotka, for it was he who first defined the concept of stable population and demonstrated convergence towards a stable state: a population that maintains constant levels of fertility and mortality by age over an indefinite period tends towards an invariable age distribution and a constant rate of increase. Pioneering the use of mathematical notations to demonstrate his ideas, Lotka can be regarded as the founder of mathematical demography. Although his earliest works were published in the United States from 1907, it was not until 1931 that they were first cited by a French statistician. His name soon became well known, however, and his most important scientific work, the *Théorie analytique des associations biologiques* (Analytical Theory of Biological Populations) was first published in French. Drawing from archives and from the publications of the *Société de statistique de Paris*, Jacques VÉRON describes the dissemination of Lotka's work in France, and his relations with French demographers and statisticians up to 1949, the year of his death.*

In 1934, Éditions Hermann issued the first part of the *Théorie analytique des associations biologiques* by Alfred James Lotka, a US citizen born to a mother of French extraction. The second part followed in 1939. Although resident in the United States, it was in France that Lotka chose to publish this synopsis of his contribution to the discipline he called “demographic analysis”. The English version of this work, initially entitled *Analytical Demography*, which Lotka was preparing at the time of his death, did not finally come into print until 1998. Before then, a Spanish translation of the text was published in Santiago de Chile in the late 1960s by the Population Division of the United Nations Economic Commission for Latin America and the Caribbean (ECLAC, 1969). The *Théorie analytique des associations biologiques* is not Lotka's only publication in French; in 1933 the *Journal de la Société de statistique de Paris*

* Institut national d'études démographiques.

Correspondence: Jacques VÉRON, Institut national d'études démographiques, 133 boulevard Davout, 75980 Paris, Cedex 20, tel.: 33 (0)1 56 06 21 76, e-mail: veron@ined.fr

published his article entitled “Applications de l’analyse au phénomène démographique” (Applications of analysis to the demographic phenomenon). Likewise, he presented “Quelques résultats récents de l’analyse démographique” (Some recent findings in demographic analysis) to the 1937 International Population Conference held in Paris by the International Union for the Scientific Investigation of Population Problems.

Lotka’s work attracted strong interest when it became available in France in the 1930s and 1940s, and the *Journal de la Société de statistique de Paris* presented his writings on several occasions. Lotka also developed close personal relations with the community of French statisticians, as testified by a statement to the Société de statistique de Paris on 21 December 1949. Announcing Lotka’s death, René Roy, Chairman of the Board, declared that Lotka “was universally known for his remarkable demographic work” and that “all those who knew him were touched by the modesty and affability of this great thinker who will be unanimously mourned by his peers”.⁽¹⁾

This article aims to look more closely at the French response to Lotka’s works. Following on from the study by Paul-André Rosental (2003), it focuses on the demographic questions of most interest to French statisticians. We will see how Lotka’s ideas were disseminated in France during his lifetime, primarily via the publications of the Société de statistique de Paris, a lively centre of scientific discussion and debate in the field of “human statistics”. By analysing the contents of each issue of the *Journal de la Société de statistique de Paris*, we can date the discovery of Lotka’s ideas very precisely. It is clear that the works of this “mathematical demographer” soon become a universal reference and that it was his contribution to demographic analysis that most impressed the French scientific community.

I. Delayed discovery of Lotka’s works

French statisticians did not find out about Lotka’s existence until 1931, almost 25 years after his first demographic publication. His founding article on the relations between birth and death rates was published in *Science* in 1907, followed in 1911 by a second, no less important, article on a problem of age distribution, co-authored with F. R. Sharpe.⁽²⁾ By the time he was discovered in France, Lotka had already published numerous articles on demographic questions, along with a book entitled *Elements of Physical Biology* (1925) which focused on population dynamics.

(1) Minutes of the meeting of 21 December 1949, *Journal de la Société de statistique de Paris*, 1-2, January-February 1950, pp. 1-2. Regarding Lotka’s death, see also Dublin (1950).

(2) These two articles are fundamental: the first presents the relationship between the size of a population of a given age, birth rates, population growth rates and probability of survival up to this age (see below), and the second introduces the notion of stable age distribution of a population. For a summary presentation of Lotka’s contributions to mathematical demography, see Véron (2008).

Raoul Husson⁽³⁾ (1931) was the first French statistician to refer to Lotka's work, in an article on birth rates and population growth:

“In this respect, the brief exposition of the main ideas and recent findings of the mathematical demographer Lotka were most appropriate here, in that they shed new light on the problem of changes over time in the age distribution of a population formed of juxtaposed generations, and provide demographic science with new capacities of prediction.”

Husson explains “the terms of the problem solved by Lotka”, a problem simplified by hypotheses of constant mortality, fertility and sex ratio:

“Given the age distribution of an isolated population at a certain instant, its survival curve, the fertility rate at each age and the sex ratio at birth, find the age distribution of the population at any subsequent instant.”

In this article, the French statistician examines the indicators of births, fertility, reproduction and growth best suited to comparisons in space or time. In the first, essentially theoretical, part of the article, Husson states that “as early as 1907 [...], through the systematic use of functions of fertility [...] and mortality, Mr A. J. Lotka produced a rigorous and very general theory of the development of populations over time”. In a dozen pages, Husson sums up Lotka's analytical concepts, focusing on the “asymptotic” stability of the age distribution of a population – stability associated with time-invariant laws of fertility and mortality – and presenting “Lotka's theoretical characteristics” such as “the mean length of a generation”⁽⁴⁾ and “the intrinsic rate of natural increase”.⁽⁵⁾

Concerned primarily with comparisons, Husson thus looks for a characteristic of births or fertility that does not introduce bias. He looks closely at the net reproduction rate, introduced in the 1880s by Richard Böckh of the Berlin statistical office, and reused later by Robert R. Kuczynski (1928), but faults it as “a characteristic of an *isolated generation* and not of a *global population*”. In Husson's view, the major limitation of the net reproduction rate, i.e. the ratio between the number of daughters born to women observed from birth to the end of their reproductive life – taking account of mortality – and the number of these women at birth, is its failure to take account of time. Yet time is a “key factor in the notion of reproduction”: the younger the mean age at childbirth, the faster the reproduction of generations. For Husson, the importance of the time factor in the analysis of reproduction “seems to have escaped Kuczynski, but not Lotka”. Although Lotka's annual natural rate is seen as a better characteristic of reproduction than Kuczynski's net reproduction rate, Husson,

(3) A graduate of the École normale supérieure at rue d'Ulm, in 1931 Raoul Husson was a deputy statistician at Statistique générale de la France (SGF). He later made a radical career change.

(4) Husson cites the following works: Lotka (1907), Lotka and Sharpe (1911), Lotka (1913, 1918, 1921, 1922), Dublin and Lotka (1925), Lotka (1925), Dublin and Lotka (1930).

(5) Time required by a population, whose growth law is that of a population with stable limit distribution, to increase by the value R_0 (ratio of births of two successive female birth cohorts, taking account of mortality, i.e. net reproduction rate).

for reasons of simplicity, nonetheless opts in favour of “demographic potential [...] the difference between the adjusted birth and death coefficients⁽⁶⁾ established on a single standard population”.

The following year, after Alfred Sauvy presented his “Calculs démographiques sur la population française jusqu’en 1980” (Demographic calculations on the French population up to 1980) to the Société de statistique de Paris (Sauvy, 1932), Raoul Husson took another look at Lotka’s work. Sauvy projected population growth from 1929 on the basis of a single mortality hypothesis, but two different fertility hypotheses: constant fertility rates by age, and rates equivalent to those of the Seine *département*, considered at that time to be the most “advanced”.

Commenting Alfred Sauvy’s paper, Raoul Husson explains that the method adopted by Sauvy is admittedly “the most *rigorous* and the most *flexible* that can possibly be used” but that the calculations required “were certainly long and tedious”. He even thanks “Mr Sauvy for not being discouraged by their length” and for producing “results which are absolutely unattackable with regard to method”. Husson nonetheless states that the projections could have been calculated in a very different manner. He then refers to Lotka, while signalling his own contribution to the dissemination of the American demographer’s ideas:

“A condensed and synthetic projection method was given in 1911 by the American mathematician Lotka. It was my honour to make the first presentation of his work in the French language in the *Bulletin de la S. G. F.* dated January-March 1931. Lotka shows that the age distribution of a *closed population* at any moment in the future is given by a certain *integral equation*. But, until now, this integral equation has been solved only by assuming that the fertility and mortality functions are *time-independent*. Naturally, these restrictive hypotheses severely limit the value of the predictive conclusions that can be drawn from Lotka’s analysis. We know, indeed, that in reality, mortality varies quite rapidly over the centuries, as does the fertility of women.”⁽⁷⁾

Husson points out that Sauvy’s “progressive method”, presents the advantage of requiring no invariance in the fertility and mortality laws,⁽⁸⁾ although he seems to prefer Lotka’s approach, especially since it can readily be applied to

(6) The birth and death coefficients are crude rates. They are “adjusted” by applying the age structure of a standard population to the age-specific fertility and death rates. Hence, the adjusted general birth rate coefficient λ_g is obtained with the following formula:

$$\lambda_g = \frac{\sum_{x=15}^{49} \frac{f_x}{\omega} \varphi_x}{\sum_0^{\omega} f_x + \sum_0^{\omega} h_x}$$

where f_x and h_x are the numbers of women and men of age x in the standard population, and φ_x is the overall fertility rate at age x .

(7) *Journal de la Société de statistique de Paris*, 7-8-9 July-August-September 1932, pp. 338-339.

(8) Sauvy does, in fact, adopt constant mortality and fertility assumptions. He defined just two scenarios, depending on fertility rates.

open populations, assuming net immigration rates by age that do not vary with time (but do vary with age), thereby extending the survival law to a “law of ‘presence in the country’ at each age”.

In another issue of the *Journal de la Société de statistique de Paris*, published the same year, Lotka is referred to once again, this time by Édouard Rastoin (1932),⁽⁹⁾ in an article on demographic forecasting and analysis. The references made in this text to the age distribution of a stable population, “a population formed exclusively on the basis of mortality and fertility that remained unchanged across the ages” and to Lotka “who established the mathematical formulae to determine such a distribution” show that French statisticians were already familiar with the work of the American demographer by 1932.

II. 1933: Lotka’s first publication in French

Unknown until 1931, Lotka’s work is frequently cited from that year onwards by Raoul Husson⁽¹⁰⁾ and by most French statisticians interested in population questions. Lotka and Husson did not appear to be on familiar terms, however. In a letter addressed in French to Raoul Husson in 1933, judging his review of Kuczynski’s book *Fertility and Reproduction* over-complimentary, Lotka began by expressing his “sincere gratitude for the generous references to his work made on several occasions”,⁽¹¹⁾ although the tone of the letter and the rest of its content are exclusively scientific in nature. Note that in 1932, René Risser,⁽¹²⁾ in his *Applications de la statistique à la démographie et à la biologie* mentioned “Dr Lotka” who, like Vito Volterra or Warren S. Thompson “has used the resources of mathematical analysis” to address demographic and biological questions. He quotes Lotka’s *Elements of Physical Biology* but without discussing its content, limiting the relevant chapter to a synthesis of Volterra’s work. However, in his important work entitled *La Révolution démographique*, published in 1934 but apparently written in 1933 (the preface is dated November 1933), Adolphe Landry shows that Lotka’s ideas had been clearly assimilated:

“Primarily with regard to birth rates, the population of historical France was practically ‘stable’, to use the term employed by certain demographers, i.e. of the type defined by invariant fundamental demographic data.”

(9) A graduate of the École polytechnique, and member of a prominent family of oil merchants in Marseille, Édouard Rastoin pursued a career in industry. According to his biography in the *Who’s Who*, he published “a variety of economic and demographic reports”.

(10) Lotka is again cited by Raoul Husson in 1933, in two book reviews: *Fertility and Reproduction* by Robert R. Kuczynski (1932) and *Les applications de la statistique à la démographie et à la biologie* by René Risser (1932).

(11) “Alfred J. Lotka Papers”, letter dated 22 April 1933. This reference to the Lotka collection at Princeton will subsequently be referred to as AJLP.

(12) At that time, Risser was a professor at the Conservatoire national des arts et métiers and a tutor at the École polytechnique. The monograph he published in 1932 is included in Volume III of the *Traité du calcul des probabilités et de ses applications* edited by Émile Borel.

In a note to this commentary, Landry refers to Lotka's work and cites the article "On the true rate of natural increase" (Dublin and Lotka, 1925).

The publication of a text by Lotka in the *Journal de la Société de statistique de Paris*, just two years after his discovery by French statisticians, confirms the high level of interest he attracted. Entitled "Applications de l'analyse au phénomène démographique" (Applications of analysis to the demographic phenomenon), the article was printed in the "Variété" section of the November 1933 issue. It presents the "development of the fundamental equation" linking population size at a time t to the past number of births weighted by survival probabilities:

$$N(t) = \int_0^{\infty} B(t-a)p(a)da$$

where $N(t)$ represents the number of living individuals at time t , $B(t-a)$ ⁽¹³⁾ the number of births at the time $(t-a)$ and $p(a)$ the probability for an individual of surviving from birth to age a .

The text also examines the logistic law of population growth and presents a three-dimensional change in the age-distribution of a population evolving logistically, based on the demographic characteristics of the United States and on invariable mortality, under the conditions of 1919-1920. Lotka stated clearly that his aim in this presentation was not to develop a "forecasting theory", but to examine the links between demographic variables:

"The value of the illustrated method lies rather in the light it sheds upon certain fundamental characteristics of a population and, above all, on the relations between these characteristics."

There is no further reference to the questions outlined in this 1933 article in the first part of *Théorie analytique des associations biologiques*, also published in French the following year. This part, entitled "Principles", is a sort of introduction to the dynamic analysis of biological systems. Lotka defines various concepts, such as those of "system" or "evolution". He analyses the notion of time, associated or not with the irreversibility of phenomena, and the notion of progress in the evolution of species. He examines the evolution of a "complete system" of different mutually dependent biological species, a form of evolution which must be analysed directly, looking beyond each biological species considered separately.

It was not until 1939 that a French-language synthesis of Lotka's work on population dynamics became available to French statisticians, but he was frequently cited from the early 1930s. In *Le point de vue du nombre*, published a few years later (Halbwachs and Sauvy, 1936), Alfred Sauvy, author of section C "Le potentiel vital d'un peuple" (The vital potential of a people) presented Kuczynski's net reproduction rate before citing the "mathematician Lotka who

(13) The letter N denotes Number and B Births.

has addressed the problem [of population dynamics] in great length". Sauvy describes Lotka's contribution:

"For a population subject to invariable laws of mortality and fertility, Lotka has produced an integral equation whose solution provides the function $f(t, x)$ which gives the population size at any time t for age x . He has also shown that the age distribution of a population tends asymptotically towards a limit distribution".

He also highlights Lotka's important role in the study of population dynamics:

"Lotka's method is of considerable theoretical interest because it introduces the notion of limit distribution and defines the concept of the declining (r negative), stationary ($r = 0$) or increasing (r positive) population."⁽¹⁴⁾

It would seem that Lotka's relations with Sauvy were barely more personal than they were with Husson. Lotka's Princeton archives include a single undated visiting card from Alfred Sauvy, who "presents his kindest respects to Mr A. Lotka", attached to a copy of his paper to the 1937 Conference on the return to equilibrium of a "regressive or retrograde" population.

Thanks, very probably, to the Paris Conference, Lotka was later to build closer ties with French "demographers", Adolphe Landry in particular.

III. 1937: The Paris Conference

From 29 July to 1 August, 1937, the International Union for the Scientific Investigation of Population Problems held its International Population Conference under the patronage of the President of the Republic, Albert Lebrun, who attended the opening session. The organizing committee, headed by Adolphe Landry, included personalities from wide-ranging scientific backgrounds: Alfred Sauvy, the ethnologist Paul Rivet, founder of the Musée de l'homme, the sociologist Célestin Bouglé, then director of the École normale supérieure, Henri Bunle and Michel Huber, both members of Statistique générale de la France (SGF), Georges Darmois, professor of probabilities and mathematical physics at the Faculté des sciences de Paris, René Gonnard, professor at the Faculté de droit de Lyon and author of *l'Histoire des doctrines de la population* (Gonnard, 1923), Maurice Halbwachs, Chair of scientific methodology and logic at the Sorbonne, André Siegfried, Chair of economic and political geography at the Collège de France, etc. Adolphe Landry also headed the Conference bureau, of which Alfred Lotka was a vice-chairman.⁽¹⁵⁾

The conference papers were published by Hermann in 1938 in the series "Actualités scientifiques et industrielles". Those concerning demographic analysis

(14) Halbwachs and Sauvy, 1936, pp. 788-813.

(15) The Conference bureau counted 29 vice-chairmen, of whom 9 were French. The secretary general was Georges Mauco.

appear in the first of the eight published volumes entitled “Théorie générale de la population” that includes papers by Landry, Lotka, Husson, Kuczynski, Sauvy, Depoid, Hersch, Livi, etc. In his paper on “Quelques résultats récents de l’analyse démographique” (Recent findings in demographic analysis) Lotka seeks to reconcile the “empirical” and “rational or formal” methods used in “quantitative demography” (Lotka, 1938). Selecting “three fundamental types” – stationary, Malthusian and logistic populations⁽¹⁶⁾ – he considers the relations between these theoretical populations and “actual populations”. He thus comments that “the Malthusian type has practically been achieved in several cases” while noting that with the falling birth rates observed in the most developed countries, the logistic model deserves closer attention: this model is thus applicable in the United States for the “female, white, indigenous” population, although the logistic curve starts to diverge from the actual curve after 1930. Lotka points out in a footnote that these questions would be analysed in more detail in a paper published by Hermann in “Actualités scientifiques et industrielles”. This was to be the second part of the *Théorie analytique des associations biologiques*.

Lotka was cited by several speakers at the Paris Conference. In Landry’s paper entitled “Notes de démographie pure” (Notes on pure demography), the American demographer is quoted three times in relation to the expression “length of a generation” to designate the interval between generations and the way it is measured. In a paper whose printed version totals just two pages, Husson (1938) mentions the generalization of “Lotka’s method” which “starts out from the notion of a sex-specific fertility law and leads to an integral equation of the type:

$$B(t) = \int_{\alpha}^{\beta} B(t-x)p(x)m(x)dx$$

where $B(t)$ represents female births in year t , $B(t-x)$ female births in year $t-x$, $p(x)$ the probability for women born in year $t-x$ of being alive in year t , at age x , and $m(x)$ the fertility of women of age x in year t , i.e. the number of liveborn daughters per woman aged x in year t .⁽¹⁷⁾

Sauvy mentions “Lotka’s rate r ” in his paper “Sur les possibilités de retour à l’équilibre pour une population régressive ou rétrograde” (On the possibilities of a return to equilibrium for a regressive or retrograde population) and Pierre Depoid refers to Lotka and Kuczynski in his text devoted to “La précision dans le calcul des taux de reproduction” (Precision in the calculation of reproduction rates). Lotka is also cited by Henri Bunle in his report “De la meilleure méthode

(16) A population is “stationary” when its growth rate is zero. It is “Malthusian” when it grows at a constant rate. It is “logistic” when its growth law takes the form

$$N(t) = \frac{N_{\infty}}{1 + e^{-rt}}$$

where N_{∞} is the maximum population size, r is the growth rate and t is time.

(17) This is indeed a case of generalization, since mortality and fertility are no longer assumed to remain invariant over time.

pour dégager et mesurer la tendance du mouvement naturel de la population” (The best method for identifying and measuring the trend of natural population change”) presented at the plenary session on 29 July 1937. Bunle points out that Lotka “has offered a solution to this same problem [natural population change from a theoretical viewpoint] in the specific case of a closed or isolated population, with no inward or outward migration, and whose laws of fertility, sex ratio at birth and survival are independent of time”. He also comments on Lotka’s affirmation “that since 1930, the population of the United States has diverged substantially from the logistic curve plotted on the basis of all censuses prior to that date” and on the utility of his intrinsic rate of natural increase. In practice, remarks Bunle, this rate r can be estimated from Kuczynski’s net reproduction rate R , given the approximate relation:

$$(1 + r)^\tau = R$$

where τ is the mean interval between generations.

In the discussion that followed Bunle’s presentation, Landry made further reference to Lotka’s rate, and Lotka himself took part in the debate. Michel Huber, the session chairman, concluded on the importance of not “ignoring the complexity of phenomena”, even if the human spirit “follows a natural inclination to condense multiple phenomena into a single coefficient” (Bunle, 1938).

In 1937, the relationship between Lotka and the French community of statisticians was already very convivial, as attested by a comment from the Secretary General of the Société de statistique de Paris in his review of a book published by the Metropolitan Life Insurance Company, to which “our sympathetic colleague Mr Lotka has greatly contributed.”⁽¹⁸⁾

IV. The reference text: the second part of *La Théorie analytique des associations biologiques*

The year 1939 marked a new stage in the diffusion of Lotka’s ideas in France, with the publication of a synthesis of his contribution to population dynamics. Although based on various articles published in English from 1907, this French edition was an original work. It was finally translated into English in 1998, by David P. Smith and Hélène Rossert, under the title *Analytical Theory of Biological Populations* (Lotka, 1998).⁽¹⁹⁾

In this second part of his *Théorie analytique des associations biologiques*, Lotka aims to clarify what he calls the “necessary relations” of “demographic

(18) *Journal de la Société de statistique de Paris*, 6, June 1937, p. 371.

(19) In the late 1940s, Lotka was preparing a revised and extended English version of his *Théorie analytique des associations biologiques* for publication by the University of Princeton. Despite several letters from Herbert S. Bailey, scientific editor at Princeton University Press, expressing concern about the delayed delivery of the manuscript and reiterating his considerable interest in this work, Lotka, occupied elsewhere, was unable to complete the project, as he explained himself in a letter dated 27 October 1948 (AJLP). He died the following year.

analysis”. His introduction includes interesting reflections of an epistemological nature on observation and theory and on the distinction between demographic statistics and demographic analysis, the first being “a purely arithmetic examination” of relations between different quantities, while the second is “the application of mathematical analysis to demographic problems”.

The analysis of relations between variables – population density and death rate for example – would “rest in an empirical framework” if they were viewed from an exclusively mathematical angle. Without denying the importance of studies based on demographic statistics, Lotka believes that “more complete or at least deeper knowledge” is obtained by identifying and specifying the “necessary” rather than empirical relations between quantities. He also claims that demographic analysis is not only theoretical, but has practical applications, in life insurance for example. His justification for a theoretical approach to population questions clearly illustrates his concern for practical issues:

“Whoever has failed to grasp clearly the necessary relations among the characteristics of a theoretical population subject to simple hypotheses, will certainly be unable to manage in the much more complicated relations that exist in a real population.”

In this second part of the *Théorie analytique des associations biologiques*, Lotka defines the relations between birth rate, death rate and age structure for “Malthusian populations”, i.e. populations growing at a constant rate and whose constant age distribution is given by:

$$c(a) = be^{-ra}p(a)$$

where $c(a)$ represents the proportion of persons of age a , b is the birth rate, r is the (constant) growth rate and $p(a)$ the probability for an individual at birth of being still alive at age a .

He examines the specific case of a stationary population in which the birth rate is equal to the death rate and to the reciprocal of life expectancy:

$$b = d = \frac{1}{e_0}$$

where d is the crude death rate and e_0 is life expectancy at birth.

“Malthusian” populations become “stable” if fertility by age is also constant. The following equation is thus verified:

$$1 = \int_0^{\infty} e^{-ra}p(a)m(a)da$$

where $m(a)$ measures the actual fertility⁽²⁰⁾ of women of age a .

The stable state is the “final state” towards which a population tends when fertility and mortality are constant.

(20) Potential fertility, which is unknown, is distinguished from actual fertility. For women, actual fertility is defined “as the annual number of daughters born alive *per capita* to woman of age a ”.

In line with the editorial constraints of Hermann's "Actualités scientifiques et industrielles" collection – "the limits imposed on the monographs in this series" – Lotka's book is presented, in his own words, as "a summary of recent progress in demographic analysis". The relations between demographic quantities being probabilistic in nature,⁽²¹⁾ the American demographer concludes with an original simulation method based on disks divided into sectors proportional to the probabilities of interest. These disks can be spun and then stopped by a "convenient mechanism", thus simulating a series of events by age (marriage, death, etc.). In the bibliography, Lotka cites articles he has published in English-language journals, but also many other authors including Bortkiewicz, Gumbel, Kuczynski, Gini, Lorimer, etc., and likewise Husson, Risser, Landry, Rastoin, Sauvy, Depoid and Bunle. This second part of the *Théorie analytique des associations biologiques* soon became a key reference among population statisticians. Vincent, for example, drew extensively on this book to define the "growth potential of a population".

The relationship between Lotka and the community of population statisticians grew increasingly personal over time. The letter in French sent by Lotka to Landry on 20 October 1939 illustrates his strong attachment to France and his strong affection for Landry:

"It would be impossible to live through these troubled days without expressing my warmest sympathy to yourself and to your compatriots. My wife also wishes, under the present circumstances, to convey her kindest regards once again."⁽²²⁾

Aloplhe Landry's reply on headed notepaper of the Chambre des députés, dated 22 November 1939, proves that these warm feelings were shared:

"My dear colleague and friend,
The sympathy that you have so kindly expressed at this dramatic moment in the history of my country – and in the history of the world – touches me most deeply.
Please convey my thanks to Mrs Lotka for sharing your expression of concern. I send her my warmest greetings and, to you, my very best regards."⁽²³⁾

V. Some of Lotka's other demographic works are less well-known

Although Lotka is cited mainly for his theory of stable populations and for the intrinsic rate of natural increase, his writings on mortality, while attracting some attention, did not reach such a wide audience.

(21) Lotka drew a distinction between "functional relations", such as the period of a pendulum in relation to its length and the acceleration of the force of gravity, for example, and "probabilistic relations" such as the height and weight of individuals: for a given height, a range of weights, associated with different probabilities, are possible.

(22) AJLP.

(23) AJLP.

In the late 1930s, Adolphe Landry published a French-language review⁽²⁴⁾ of Lotka's book *Twenty-Five Years of Health Progress* (Dublin and Lotka, 1937) in the *Journal de la Société de statistique de Paris*, and also mentioned *Length of Life* (Dublin and Lotka, 1936), brought out two years earlier (Landry, 1938). In this work, Dublin and Lotka supplied life tables for the main causes of death, and calculated the years of life that were lost due to various diseases at different ages. For Landry, *Twenty-Five Years of Health Progress*, whose purpose is to specify the "best points of attack" for increasing length of life, is more useful for France than for the United States, given France's poorer performance in terms of health. He sees this to be notably the case with regard to "pushing back death", given the existence of an "apparently unsurpassable limit" to longevity. In the following issue of the *Journal de la Société de statistique de Paris*, in his discussion of a text by Depoid, Landry again refers to the pages of Dublin and Lotka's book devoted to the mortality decline in the United States over twenty-five years for each cause of death. Indeed, the French statisticians express a certain disappointment when comparing their working conditions with those of statisticians and demographers based in the United States. Landry states:

"L. Dublin and Lotka are actuaries of the great Metropolitan Life Insurance Company, with 17 million policy holders; their scope for study is vast and, furthermore, they certainly benefit from much more generous credits than those available to our Statistique générale de la France!"⁽²⁵⁾

Michel Huber adds that in their statistical office, Dublin and Lotka dispose of "more personnel than the Statistique générale de la France as a whole".

Some years later, in his discussion of a paper by Pierre Delaporte entitled "Évolution de la mortalité en Europe depuis l'origine des statistiques"⁽²⁶⁾ (Mortality trends in Europe since the origins of statistics) Landry again refers to *Length of Life* which, in his view, provides "interesting information", notably the decrease in Massachusetts, between the mid-nineteenth century and the 1930s, of life expectancy at ages 50, 60, 70 and 80 for both sexes, an observation worth comparing with the findings of Delaporte.

In the *Traité de démographie*, published in 1945, *Length of Life* is mentioned yet again by Landry, but also by Michel Huber, then honorary director of la Statistique générale de la France, who cited the book "for the numerous American [life] tables" it contained.⁽²⁷⁾

However, Lotka's book *The Money Value of a Man*, first published in 1930, and reprinted in 1947 as a revised edition with the collaboration of Mortimer

(24) *Journal de la Société de statistique de Paris*, 2, February 1938.

(25) *Journal de la Société de statistique de Paris*, 3, March 1938, p. 111.

(26) *Journal de la Société de statistique de Paris*, 9-10, September-October 1942, p. 199.

(27) The *Traité de démographie* also refers to the second part of the *Théorie analytique des associations biologiques* and, regarding the intrinsic rate, cites Dublin and Lotka's 1925 article "On the true rate of natural increase".

Spiegelman, did not attract the attention of French population statisticians during his lifetime (Dublin and Lotka, 1930; 1947).

VI. Lotka's contribution to the analyses of Pierre Depoid and Paul Vincent

In his book *L'Intelligence démographique*, Paul-André Rosental (2003) notes the important role played by two other people – Pierre Depoid and Paul Vincent – in the diffusion of Lotka's work in France.

In 1941, Pierre Depoid, a statistician at *Statistique générale de la France*, published an important study on net reproduction in Europe. He began by explaining that although the observed excess of the birth rate over the death rate offers a means to determine the natural population growth rate, it merely informs on the “current state of events” without providing “any indication of the probable direction of future variation, or of future trends in population change”. To forecast the possible future, a number of rates exist, notes Depoid and “among them, the one judged to provide the best indication is the intrinsic rate of increase suggested by Mr Lotka”. Pierre Depoid affirms that “the intrinsic rate of increase or decrease of this stable limit population [under a regime of constant fertility and mortality] may [thus] serve to characterize very satisfactorily the trend of natural population change at a given instant”. Böckh-Kuczynski's net reproduction rate was used more widely than that of Lotka “although its definition is somewhat less satisfactory” because it was easier to calculate while giving similar results. For the purposes of his study, Depoid thus chooses the reproduction rate. But this text shows once again that comparison of Kuczynski's and Lotka's rates had become a classic of the literature devoted to population dynamics.

Lotka procured this study on net reproduction in Europe in 1947⁽²⁸⁾ directly from Pierre Depoid and, in a letter dated 29 July 1947, asked for some clarifications on the text that was sent to him. Depoid, then secretary general of the *Société de statistique de Paris*, offered to exchange journals with Lotka, who accepted.⁽²⁹⁾ It was decided that the *Société de statistique de Paris* would send each new issue of the *Journal de la Société de statistique de Paris* to the statistical office of the Metropolitan Life Insurance Company which, in return, would send its *Statistical Bulletin* to the library of the *Société de statistique de Paris*.

But the demographer closest to Lotka in scientific terms was certainly Paul Vincent.⁽³⁰⁾ In his article on the “Potentiel d'accroissement d'une population” (Growth potential of a population), Vincent (1945) began the theoretical part

(28) AJLP.

(29) AJLP.

(30) A graduate of *École polytechnique*, Paul Vincent notably headed the department of quantitative studies and demographic trends at INED.

with a reminder that Lotka had shown that “any population subjected indefinitely to a regime of constant fertility and mortality tends to acquire a stable age distribution” and that, if K is a constant dependent on the initial age structure, the size $N(t)$ of the population at time t tends towards the value $Ke^{\rho t}$, with the growth rate tending, over time, asymptotically towards the value ρ of the “intrinsic rate of natural increase”.⁽³¹⁾

Vincent cites the second part of the *Théorie analytique des associations biologiques*, published six years earlier, and borrows Lotka’s notations in his study. He also uses the property of population stability to define the growth potential of a population.

In 1946, Vincent published his article “De la mesure du taux intrinsèque d’accroissement naturel dans les populations monogames” (Measuring the intrinsic rate of natural increase in monogamous populations) in *Population*. In the same year, he sent a typed manuscript⁽³²⁾ of the article to Lotka, who responded by adding a few remarks in the margins. The article began with an affirmation: demography became a true science when, moving beyond mere description, “scholars sought to analyse demographic phenomena in depth and to determine the laws which govern them”. Lotka’s contribution in this respect is decisive:

“The most important advances in this field are doubtless due to Mr Alfred J. Lotka, who has combined true mathematical virtuosity with a profound grasp of demographic realities.”

Lotka’s death in December 1949 was deeply felt by the community of French statisticians. The words of René Roy, speaking of his “remarkable achievements in the field of demography” and paying tribute to his unassuming nature, have already been cited in the introduction. Vincent goes even further. In the obituary he wrote for *Population*, published in the first issue of 1950, he pays tribute to Lotka the scientific personality, but also to Lotka the man:

“In the person of the great American demographer Lotka, who passed away on 5 December last year close to New York, science has just lost one of its most illustrious representatives, and our country a friend who never concealed the strength of his attachment.”

Vincent mentions “A problem in age distribution”, the “fundamental article” published by Lotka in 1911 in collaboration with Sharpe, and pursues his obituary by referring to his contribution to the mathematics of populations:

“And yet, more so than his work on statistical demography, his research in mathematical demography will surely immortalize his name. Indeed, demographers from across the world did not wait for his death to name the “intrinsic rate of natural increase” after the person who can rightly be considered as the father of demographic analysis.”

(31) A rate based solely on stable regimes of fertility and mortality.

(32) Text dated 21 October 1946 (AJLP).

A letter sent in 1950⁽³³⁾ by Vincent to Louis I. Dublin,⁽³⁴⁾ with whom Lotka co-authored several publications, clearly expresses Vincent's respect and affection for Lotka:

"I was also very touched by your gesture of enclosing a portrait of Lotka. The nature of our journal prevents me from including it, but I have taken the freedom – for which I trust you will pardon me – of keeping it as a personal souvenir. I have had it framed and placed on my desk, to whose atmosphere his presence will confer an intimacy conducive to productive thought."

VII. Demographic analysis: theoretical distraction or practical tool?

Lotka's ambition was to develop the techniques of demographic analysis. This raised the question of the utility of the equations presented. Were they pure theoretical speculation, or could they serve as a practical tool?

The position of the sociologist Maurice Halbwachs on this issue deserves to be mentioned. Despite his interest in a quantitative approach to social phenomena,⁽³⁵⁾ Halbwachs paid little attention to Lotka's work, considering it to be of scant practical value. While in *Le point de vue du nombre* Sauvy highlighted Lotka's contribution to the theory of population growth, Halbwachs, in this same book, made only anecdotal reference to the American demographer:

"A. J. Lotka, of the Metropolitan Company, after an attentive study of all data at our disposal, concludes that around 47% of the white population in 1920 is comprised of descendants of the 1790 population, and that its foreign origins are distributed in approximately the same proportions. The remaining 53%, he claims, comprise immigrants who arrived after 1790 and their descendants."

In his "Notes sur l'application de certains procédés analytiques à l'étude de la population" (Notes on the application of certain analytical procedures to the study of population), dated 1937, Halbwachs draws upon the presentation made a year earlier by Sauvy to discuss the contributions of Kuczynski and Lotka, although he expresses doubts as to the true value of Lotka's work:

"We do not underestimate the theoretical interest of these formulae. They express actual movements or states in mathematical language. They are techniques of analysis. But what, exactly, do they analyse? Data borrowed from the present and, what is more, highly simplified. We are told what will happen if the conditions remain unchanged. But this is the very question.

(33) Letter dated 12 June 1950, on headed notepaper of the Institut national d'études démographiques (AJLP).

(34) Second vice-president and statistician at the Metropolitan Life Insurance Company.

(35) With the mathematician Maurice Fréchet, Halbwachs co-authored a book entitled *Le calcul des probabilités à la portée de tous*, published by Dunod in 1924.

What, precisely, are these life tables which play such an important role in Lotka's theory?"⁽³⁶⁾

Maurice Halbwachs' "literary" background (*agrégation* in philosophy, *Doctorat ès lettres* and PhD in law) may explain his limited interest in Lotka's work, although Landry, also *agrégé* in philosophy and doctor of the Sorbonne, cited Lotka at every opportunity. Like Landry, Halbwachs attached great importance to demography, even stating that "population is the general framework in which all social facts must be placed" (Halbwachs, 1938). His interest in statistics and in probabilities is illustrated by the book he wrote with the mathematician Maurice Fréchet (Fréchet and Halbwachs, 1924) and by his article on "L'expérimentation statistique et les probabilités" (Statistical experimentation and probabilities) (Halbwachs 1923). The profiles of Halbwachs and Landry were very similar in the eyes of the French scientific elite of the 1930s, although Landry was more politically engaged and Halbwachs perceived as more scientifically oriented (Brian and Véron, 2005). But the modelling techniques used by Lotka postulated a form of autonomy in demography – a field of "pure demography" – that Maurice Halbwachs doubtless judged to be unacceptable.

Long after his death, the question of the utility of Lotka's works was raised anew, notably by Jean Bourgeois-Pichat who, in some respects, can be seen as a disciple of the American demographer. For him, the value of Lotka's work was not simply theoretical (United Nations, 1966):

"Scholars such as Alfred J. Lotka have provided definitive proof of the interest and utility of calculating a stable population corresponding to a given set of demographic conditions."

In a layman's guide to demography published in 1970, Jean Bourgeois-Pichat, director of INED, described the developments in population dynamics that followed on from Lotka's work:

"Theoretical considerations also brought progress in their wake. The concept of stable population developed before the war by Alfred J. Lotka was looked at once again and the new concepts of 'quasi-stable population' and 'nearly stable population' were created."

Note that "quasi-stable" populations are empirical populations where fertility is constant and mortality varies in line with the model life tables; these quasi-stable populations differ little with respect to stable populations. "Nearly stable" populations, for their part, are populations with an invariable age distribution. Bourgeois-Pichat once again extols the utility of this theoretical approach to population dynamics:

"The pages that follow will seek to show, on the contrary, that the concept of stable population has a wealth of practical applications."

(36) "Notes sur l'application de certains procédés analytiques à l'étude de la population" (Halbwachs and Sauvy, 1936).

In his book *La dynamique des populations*, published posthumously, Jean Bourgeois-Pichat (1994) again refers to the theory of stable populations, citing the pioneering work of Euler and Malthus, and acknowledges Lotka's contribution to the renewal of interest in this theory. Lotka's work, he claims, found "no practical application", but only until the Population Division and the Office of Population Research (OPR) at Princeton developed new ideas enabling them to "see how Lotka's theoretical developments could give rise to practical applications".

Conclusion

Although French statisticians were late to discover Lotka's work, they quickly developed a keen interest in his ideas and established close personal relations with the American demographer. It is the notion of stable population, and the method for calculating the intrinsic rate of natural increase that are most commonly cited, notably in the *Journal de la Société de statistique de Paris*. The discussions recounted in this periodical show that population statisticians soon became familiar with the concept of stable population and with "Lotka's rate". Lotka's other works are also cited. His book *Length of Life*, first published in Dublin in 1936, and later reprinted in the United States, is mentioned several times, for example, although not extensively. Other work on the family or on the monetary value of a human life appear to have remained largely undiscovered. For example, the important book by Louis I. Dublin and Alfred J. Lotka entitled *The Money Value of Man*, published in 1930 and again, in a revised version, in 1946, is not mentioned, to our knowledge, in any articles or books on demography published in Lotka's lifetime. It was cited by Sauvy, however, in Volume I of his *Théorie générale de la population* published in 1952. Quite naturally, the community of population statisticians was not directly concerned by the Lotka-Volterra equations on interactions between species and prey-predator models, more relevant to the field of biology⁽³⁷⁾ than to demography. Husson nonetheless draws comparisons between these two authors, speaking of "Lotka's brilliant synthesis, equal in elegance to that of Volterra".

We note also that French statisticians rarely refer to Lotka's articles written in English. From 1939, the second part of the *Théorie analytique des associations biologiques* became the reference text for specialists of "pure demography" or population dynamics, and it is generally Lotka's only cited publication. In later work on population dynamics, this book is also the most frequently cited reference to Lotka's contribution, including in the English-speaking world, as attested by Nathan Keyfitz (1985)⁽³⁸⁾ in his classic work on mathematical demography.

(37) For the more specifically biological aspects, see Kingsland (1995).

(38) In the third edition of this book, co-authored by Nathan Keyfitz and Hal Caswell in 2005, a few other references to Lotka are added, and the English translation of *Théorie analytique des associations biologiques* is mentioned.

REFERENCES

- AJLP (Alfred J. Lotka Papers), 1933, MC #032, Seeley G. Mudd Manuscript Library, University Library, Princeton.
- BOURGEOIS-PICHAT Jean, 1970, *La démographie*, Paris, Gallimard, Idées-NRF, 188 p.
- BOURGEOIS-PICHAT Jean, 1994, *La dynamique des populations. Populations stables, semi-stables et quasi stables*, Paris, Ined/Puf, Travaux et documents, Cahier 133, 296 p.
- BRIAN Éric, VÉRON Jacques, 2005, "La démographie en révolution", *Le point de vue du nombre*. Critical edition, edited by Marie Jaisson and Éric Brian, Paris, INED, pp. 111-130.
- BUNLE Henri, 1938, "De la meilleure méthode pour dégager et mesurer la tendance du mouvement naturel de la population", in *Théorie générale de la population I*, International Population Conference, Paris, 1937, Paris, Hermann, pp. 1.255-1.268.
- DEPOID Pierre, 1941, "Reproduction nette en Europe depuis l'origine des statistiques de l'État civil" *Études démographiques* 1, Statistique générale de la France, Paris, Imprimerie nationale.
- DUBLIN Louis I., LOTKA Alfred J., 1925, "On the true rate of natural increase. As exemplified by the population of the United States, 1920", *Journal of the American Statistical Association*, Vol. XX, pp. 305-339.
- DUBLIN Louis I., LOTKA Alfred J., 1930, "The true rate of natural increase of the population of the United States. Revision on the basis of recent data", *Metron*, Vol. 8, pp. 107-119.
- DUBLIN Louis I., LOTKA Alfred J., 1930, *The Money Value of a Man*, New York, The Ronald Press Company (a revised version of this book was published in 1947, with the additional collaboration of Maurice Spiegelman).
- DUBLIN Louis I., LOTKA Alfred J., 1936, *Length of Life. A Study of Life Table*, New York, Ronald Press Company (a revised version of this book was published in 1949, with the additional collaboration of Maurice Spiegelman).
- DUBLIN Louis I., 1950, "Alfred James Lotka, 1880-1949", *Journal of the American Statistical Association*, 45 (249), March, pp. 138-139.
- DUBLIN Louis I., LOTKA Alfred J., 1937, *Twenty-five Years of Health Progress*, Metropolitan Life Insurance Company, New York.
- ECLAC, 1969, *Teoria analitica de las asociaciones biológicas*, Centro Latinoamericano de demografía, Santiago de Chile.
- FRÉCHET Maurice, HALBWACHS Maurice, 1924, *Le calcul des probabilités à la portée de tous*, Paris, Dunod, 260 p.
- GONNARD René, 1923, *Histoire des doctrines de la population*, Paris, Nouvelle librairie nationale, 352 p.
- HALBWACHS Maurice, 1923, "L'expérimentation statistique et les probabilités", *Revue philosophique*, 96, pp. 340-371.
- HALBWACHS Maurice, SAUVY Alfred, 1936, *Le point de vue du nombre*. Critical edition, edited by Marie Jaisson and Éric Brian, 2005, Paris, INED, 470 p.
- HALBWACHS Maurice, 1938, *Morphologie sociale*, Paris, Armand Colin, 1970 reprint, 190 p.
- HUSSON Raoul, 1931, "Natalité et accroissement de la population en France et à l'étranger avant et après la guerre", *Bulletin de la Statistique générale de la France et du service d'observation des prix*, Présidence du conseil. Sous-secrétariat d'État de l'économie nationale, Volume XX – Monograph II, January-March, pp. 245-300.
- HUSSON Raoul, 1938, "La démographie mathématique. Équations générales. Propriétés générales des trajectoires démographiques", in *Théorie générale des populations I*, pp. 1.108-1.109.
- KEYFITZ Nathan, 1985, *Applied Mathematical Demography*, New York/Berlin/Heidelberg/Tokyo, Springer Verlag, Second edition, 388 p.
- KINGSLAND Sharon E., 1995, *Modeling Nature, Episodes in the History of Population Ecology*, Chicago/London, University of Chicago, Second edition, 267 p.

- KUCZYNSKI Robert R., 1928, *The Balance of Births and Deaths*, Vol. I, Western and Northern Europe, New York, The Macmillan Company, 170 p.
- KUCZYNSKI Robert R., 1932, *Fertility and Reproduction, Methods of Measuring the Balance of Births and Deaths*, New York, Falcon Press, 94 p.
- LANDRY Adolphe, 1934, *La Révolution démographique. Études et essais sur les problèmes de la population*, 1982 reprint, Preface by Alain Girard, Librairie du Recueil Sirey, Paris, INED, 227 p.
- LANDRY Adolphe, 1938, "Bibliographies", *Journal de la Société de statistique de Paris*, 2, pp. 60-61.
- LANDRY Adolphe, 1945, *Traité de démographie*, composed in collaboration with Henri Bunle, Pierre Depoid, Michel Huber and Alfred Sauvy, Paris, Payot, 651 p.
- LOTKA Alfred J., 1907, "Relation between birth rates and death rates", *Science*, New Series, Vol. 26, Issue 653, pp. 21-22.
- LOTKA Alfred J., SHARPE F. R., 1911, "A problem in age-distribution", *Philosophical Magazine*, Series 6, Vol. 21, pp. 435-438.
- LOTKA Alfred J., 1913, "A natural population norm", *Journal of the Washington Academy of Sciences*, Vol. 3, pp. 241-248.
- LOTKA Alfred J., 1918, "The relation between birth rate and death rate in a normal population, and the rational basis of an empirical formula for the mean length of life, given by William Farr", *Quarterly Publications of the American Statistical Association*, pp. 121-130.
- LOTKA Alfred J., 1921, "A simple graphic construction for Farr's relation between birth rate, death rate and mean length of life", *Journal of the American Statistical Association*, Vol. 17, p. 998-1000.
- LOTKA Alfred J., 1922, "The stability of the normal age-distribution", *Proceedings of the National Academy of Sciences*, Vol. 8, pp. 339-345.
- LOTKA Alfred J., 1925, *Elements of Physical Biology*, Baltimore, Williams and Wilkins Company.
- LOTKA Alfred J., 1933, "Applications de l'analyse au phénomène démographique", *Journal de la Société de statistique de Paris*, 11, November, pp. 336-343.
- LOTKA Alfred J., 1934, *Théorie analytique des associations biologiques. Part 1, "Principes"*, Paris, *Actualités scientifiques et industrielles*, Hermann & C^{ie}, 46 p.
- LOTKA Alfred J., 1938, "Quelques résultats récents de l'analyse démographique", in *Théorie générale de la population I*, International Population Conference, Paris, 1937, Paris, Hermann, pp. 1.96-1.107.
- LOTKA Alfred J., 1939, *Théorie analytique des associations biologiques*, Deuxième partie, "Analyse démographique avec application particulière à l'espèce humaine", Paris, *Actualités scientifiques et industrielles*, Hermann & Cie, 150 p.
- LOTKA Alfred J., 1998, *Analytical Theory of Biological Populations*, Introduction and translation of *Théorie analytique des associations biologiques* by David Smith and Hélène Rossert, New York, Plenum Press, 220 p.
- RASTOIN Édouard, 1932, "Analyse et prévision démographiques", *Journal de la Société de statistique de Paris*, 10, pp. 367-379.
- RISSE René, 1932, *Les applications de la statistique à la démographie et à la biologie*, Monograph III of Volume III *Les applications de la théorie des probabilités aux sciences économiques et aux sciences biologiques*, of the *Traité du calcul des probabilités et de ses applications* by Émile Borel, Paris, Gauthier-Villars.
- ROSENTAL Paul-André, 2003, *L'intelligence démographique*, Paris, Odile Jacob, 367 p.
- SAUVY Alfred, 1932, "Calculs démographiques sur la population française jusqu'en 1980", *Journal de la Société de statistique de Paris*, 7-8-9, July-August-September, pp. 319-337.
- SAUVY Alfred, 1952, *Théorie générale de la population*, Paris, Puf, Vol. I, 370 p.
- UNITED NATIONS, 1966, *Le concept de population stable. Application à l'étude des populations ne disposant pas de bonnes statistiques démographiques*, New York, p. vii. Document drafted by Jean Bourgeois-Pichat.
- VÉRON Jacques, 2008, "Alfred J. Lotka and the mathematics of population", *Electronic Journal for History of Probability and Statistics*, 4(1), 10 p. "<http://www.jehps.net/juin2008/Veron.pdf>"

VINCENT Paul, 1945, "Potentiel d'accroissement d'une population", *Journal de la Société de statistique de Paris*, 1-2, January-February, pp. 16-39.

VINCENT Paul, 1946, "De la mesure du taux intrinsèque d'accroissement naturel dans les populations monogames", *Population*, 4, October-December, pp. 699-712.

VINCENT Paul, 1950, "Alfred J. Lotka (1880-1949)", *Population*, 1, pp. 13-14.

Jacques VÉRON • THE FRENCH RESPONSE TO THE DEMOGRAPHIC WORKS OF ALFRED LOTKA

Although Lotka published his founding article on demography in 1907, he was not discovered by French statisticians interested in population questions until 1931. It was Raoul Husson who introduced his work in France, with the publication of a comparative study of population growth in France and abroad. Lotka's notion of stable population and his method for calculating the intrinsic rate of natural increase are his most commonly cited contributions, primarily in the *Journal de la Société de statistique de Paris*. Dublin and Lotka's work on health and mortality, notably in relation to the United States, are also known. The second part of *Théorie analytique des associations biologiques*, published in French in 1939, rapidly became a reference text for specialists of "demographic analysis". Adolphe Landry helped to popularize Lotka's work, and Paul Vincent explicitly acknowledged his intellectual debt to the American demographer. Over his lifetime, Lotka developed close relations with French statisticians who appreciated both his scientific intellect and his human qualities.

Jacques VÉRON • RÉCEPTION DE L'ŒUVRE DÉMOGRAPHIQUE DE LOTKA EN FRANCE

Bien que Lotka ait publié son article fondateur sur la démographie dès 1907, il est découvert par les statisticiens français s'intéressant aux questions de population seulement en 1931. C'est Raoul Husson qui le fait alors connaître, à l'occasion de la publication d'une étude sur l'accroissement comparé de la population en France et à l'étranger. C'est aux notions de population stable et de taux intrinsèque d'accroissement qu'il est le plus souvent fait référence, en particulier dans le *Journal de la Société de statistique de Paris*. Les travaux de Dublin et Lotka sur la santé et la mortalité sont connus notamment à propos des États-Unis. La deuxième partie de la *Théorie analytique des associations biologiques*, parue en français en 1939, devient très vite le texte de référence pour tous ceux qui abordent le champ de "l'analyse démographique". Adolphe Landry contribue à la popularisation des travaux de Lotka, et c'est Paul Vincent qui reconnaît le plus explicitement sa dette intellectuelle envers le démographe mathématicien. Les relations entre Lotka et les statisticiens français ne cessent de se renforcer de son vivant, tant pour les qualités scientifiques du démographe américain que pour ses qualités humaines.

Jacques VÉRON • RECEPCIÓN DE LA OBRA DEMOGRÁFICA DE LOTKA EN FRANCIA

Bien que Lotka publicó su artículo fundador en 1907, los estadísticos interesados en las cuestiones de población sólo lo descubrieron en 1931. Es Raoul Husson quien lo dio a conocer en ocasión de la publicación de un estudio comparativo de la población en Francia y en el extranjero. A partir de ese momento, son las nociones de población estable y de tasa intrínseca de crecimiento a las que se hace más frecuentemente referencia, en particular en el *Journal de la Société de statistique de Paris*. Los trabajos de Dublin y de Lotka sobre la salud y la mortalidad son conocidos sobre todo a propósito de los Estados Unidos. La segunda parte de la *Teoría analítica de las asociaciones biológicas*, publicada en 1939, constituye rápidamente el texto de referencia para todos los que abordan el campo del « análisis demográfico ». Adolphe Landry contribuyó a la difusión de los trabajos de Lotka, y Paul Vincent fue el que reconoció más claramente su deuda intelectual con el demógrafo matemático. Las relaciones de los estadísticos franceses con Lotka no cesaron de reforzarse mientras vivió, tanto por sus cualidades científicas como por sus cualidades humanas.