

# **DEMOGRAPHIC DESTINIES**

## **Interviews with Presidents of the Population Association of America**

### **Interviews Referencing Alfred J. Lotka PAA President in 1938-39**



This series of interviews with Past PAA Presidents was initiated by Anders Lunde  
(PAA Historian, 1973 to 1982)

And continued by Jean van der Tak (PAA Historian, 1982 to 1994)

And then by John R. Weeks (PAA Historian, 1994 to present)

With the collaboration of the following members of the PAA History Committee:  
David Heer (2004 to 2007), Paul Demeny (2004 to 2012), Dennis Hodgson (2004 to  
present), Deborah McFarlane (2004 to 2018), Karen Hardee (2010 to present), Emily  
Merchant (2016 to present), and Win Brown (2018 to present)

## ALFRED J. LOTKA

We do not have an interview with Alfred Lotka, who was the fourth PAA President (1938-39). However, as Andy Lunde and Jean van der Tak (VDT) were interviewing other past presidents, they regularly asked questions about those early presidents whom they had been unable to interview. Below are the excerpted comments about Alfred Lotka.

### **CAREER HIGHLIGHTS**

Alfred Lotka was born in 1880 in Lemberg--a city that is now part of the Ukraine, but was then part of Austria-Hungary. His parents were American nationals, but he spent his youth in France, and then went to university in England, receiving his B.Sc. from Birmingham University in 1901. He then spent a year at the University of Leipzig before coming to the United States to work at the General Chemical Company. In 1908 he went to Cornell University, where he received his M.A. in physics in 1909. He then worked at the U.S. Patent Office, while also receiving his D.Sc. from Birmingham University in 1912. He returned to General Chemical for five years, and then took an academic position at The Johns Hopkins University from 1922-1924. In 1924 he took a job as Supervisor of Mathematical Research at Metropolitan Life Insurance Company. He worked there as a statistician until he retired in 1948, just a year before his death in 1949 at his home in New Jersey. While at Metropolitan Life Insurance Company, he worked closely with Louis Dublin (PAA President in 1935-36).

### **From Andy Lunde's interview with Conrad Taeuber in 1973:**

**QUESTION:** What do you recall of the major figures in PAA during the early years?

**TAEUBER:** Louis Dublin [President, 1935-36] was a fascinating figure. I read his autobiography a few years ago. He arrived in New York penniless. From the ship, his father brought the family to a boarding house where he had rented space and they walked there from the ship, carrying the luggage. Louis took full advantage of the educational opportunities that were available to immigrant groups in New York City. Louis was a short person, very earnest, very friendly, very human. He was deeply devoted to the work he was doing and very competent. He was devoted to the improvement of public health and improvement of living conditions, especially of the poor. He worked very closely with Alfred J. Lotka.

Lotka [PAA President, 1938-39] was also a short person. He seemed very much more reserved. He worked closely with P.K. Whelpton [President, 1941-42] in the development of methods of measuring deaths and births and the "true" rate of natural increase, recognizing that current birth and death rates were not necessarily good measures of the long-run trends.

**QUESTION:** What other issues do you recall as being of particular interest in PAA meetings over the years?

**TAEUBER:** There were some rather intriguing methodological developments in measuring population growth, many of which can be attributed to Pat Whelpton. Lotka also brought them up; they worked very closely together. The whole development of demographic methodology came up again and again.

### **From Andy Lunde's interview with Clyde Kiser in 1973:**

**LUNDE:** What about Louis I. Dublin? He was president in 1935-36. [See comments about Lotka]

**KISER:** He was the second president of PAA. Louis I. Dublin began writing articles for the New York Times. He'd have articles in the Sunday issue, on the aging of the population, so he was becoming pretty well known in the middle 1920s. Dublin was rather a curious fellow. He became second vice president of the Metropolitan Life Insurance Company. I suppose he was a very good administrator and he certainly put together--and sold to the Metropolitan Life--the work in population. And we should always give him credit for bringing Alfred Lotka to the Metropolitan. But they were a rather incongruous team. Dublin was the man who could sway audiences; he was not a technician. Lotka on the other hand was a technician and he was a little timid about talking in public. But they got along well together, and Lotka himself would always defend Dublin. If you asked Lotka why Dublin's name came first on an article--one of their famous articles was "On the True Rate of Natural Increase" which came out in 1925 in the Journal of the American Statistical Association--if you asked Lotka why Dublin's name came first when you knew very well that Lotka had done most of the calculations, he would defend Dublin and say "We're coauthors."

**From Andy Lunde's interview with Irene Taeuber in 1973:**

**LUNDE:** Irene, can you tell us a bit about the history of our organization?

**TAEUBER:** ...At the Metropolitan Life Insurance Company, you had, again, two men: Louis Dublin, who was a great humanitarian in that he strived for the immigrants and the reduction of mortality, paired with Lotka, who was one of the most imaginative statisticians that we've had in the field, who did more for theoretical demography than anyone else.

**From Jean van der Tak's interview with Henry Shryock in 1988:**

**VDT:** Your mention of the international conference of 1954 reminds me of the IUSSP. I noticed that you were one of the 29 Americans among the 147 people who were first invited to be IUSSP members when IUSSP switched after the war from membership by national organizations to individual membership. Could you tell a bit about your involvement with IUSSP [International Union for the Scientific Study of Population]? Were you, for instance, involved in the IUSSP meeting held in New York in 1961?

**SHRYOCK:** I remember being there. I don't remember whether I had a paper at that time or not; seems to me I was busy working on my first migration book. But I was at the first IUSSP meeting after the war, in Geneva in 1949, and there I had several assignments. The person in charge of our delegation was Henry Pratt Fairchild of New York University, the very first president of PAA. He was quite an imposing character. Quite a gourmet. He was a friend of Oscar of the Waldorf, I remember. He also was suspected of some leftwing activities, with regard to immigration groups. He belonged to some organization and he used to take the membership file home from his office every night and hide it under his bed during the McCarthy era, I was told. He was instrumental in organizing the American delegation to that first IUSSP meeting after the war, along with Frank Lorimer, who was the secretary of IUSSP at that time. He was the executive director, based in the U.S.

At that 1949 meeting, Wilson Grabill, Calvin Beale and I had a paper forecasting, projecting, fertility for the U.S. I was the only one of the three who went. Frank Lorimer also had asked me to defend the late Thomas J. Woofter, who was the first one along with the Frenchman Pierre De Poid to get onto the idea of generation reproduction rates, rather than cross-sectional ones that had been developed by Dublin and Lotka. Lotka was giving a paper then in which he was very critical of Woofter--sort of brushing this off as, "Well, everyone had known this beforehand and it wasn't very important." P.K. Whelpton had told me that Woofter's work was what really inspired his getting into

cohort fertility, which Whelpton developed and led to some of these field studies and so on. So I was supposed to get up and comment on the paper by Lotka, the great man, defending Woofter, which really put me on the spot. I was sort of a friend of Lotka too. But that went off not too badly.

This was a very primitive meeting. We had no simultaneous translation then. When anybody spoke, someone had to get up and give a precis of that in the other official language--French or English; I think there were only two then.

**From the Harry Rosenberg (substituting for Andy Lunde) interview with Joseph Spengler and Clyde Kiser in 1976:**

**SPENGLER:** One thing that struck me early in the game was how many people were interested in population. I was just looking at something I'd forgotten about--a chap named Punke, he was down at Georgia State Women's College in Augusta. I don't remember him from Adam, but the thing that struck me was he had an interest in this. We had some correspondence. Like Horace, I had the feeling that there were a large number of people interested and you had an opportunity to get acquainted.

I bought Lotka's book [Elements of Physical Biology, 1924?, or Théorie Analytique des Associations Biologiques, 1939?]. I thought that was the greatest book I read in the first 50 years of my life. What it showed me was the rich variety of matters that [centered on population]. This was what I got out of Wolfe's course on population; you had to study geography and this, that, and the other. As an economist, when people asked me what I was doing and I said I'm working on population. "Well, what's that?" I just let the fools suffer in silence and never paid attention. My wife said I was really rude. The thing that caught my eye and what led me to introduce a course on it just as soon as I could was that you had a tremendous range of materials; all kinds of things emerged here. As far as an economist was concerned there was nothing else.

**KISER:** The PAA had its organizational meeting May 7th, 1931. In that article I mentioned the first meeting of the American National Committee. The International Union was organized not on the basis of individual members but of national committees, so we had to have a national committee. The first meeting of that American National Committee was held February 4th, 1931. Lotka was the secretary. He gave me the minutes of that meeting and I quoted from that in that article. The first paragraph read something like this: "Louis I. Dublin opened the meeting by stating that he had been asked by the president of the International Union for the Scientific Investigation of Population Problems to become chairman of the American National Committee, in accordance with the organization of its executive committee. Dr. Dublin had accepted and in conjunction with Professor Fairchild and a group that had met at the latter's invitation, he had invited a small group to constitute the American National Committee. Those attending were: Louis I Dublin, elected chairman; Alfred J. Lotka, elected secretary; and then H.P. Fairchild, C.E. McGuire, Lowell J. Reed, Clarence C. Little, and P.K. Whelpton."

Now last night I was digging through some old files and one of the things I read was a letter from Lotka to Edgar Sydenstricker, March 3, 1931, just about two weeks after that February meeting of the American National Committee. He wrote:

"Dear Mr. Sydenstricker,

In accordance with a motion carried at a meeting of the American National Committee, held in New York on February 4th, 1931, the chairman has prepared a draft of statutes, of which a copy is enclosed. The several members of the committee are hereby requested to communicate to the chairman any comment or suggestion that they may have to make regarding this draft in order that he may be able to send the statutes in final form to Dr. Carr-Saunders for publication."

Raymond Pearl was the first president of the International Union. Lotka gave the list of the original members of that American National Committee: Louis I. Dublin, C.E. McGuire, vice-chairman, and Alfred J. Lotka, secretary-treasurer. And members: O.E. Baker, Department of Agriculture; H.P. McGuire; James W. Glover, the life table man; George W. Kosnak, editor of the American Journal of Obstetrics and Gynecology; Dr. Clarence C. Little of Harvard Club--he was a biostatistician and he once was the president of the University of Michigan--and Dr. Raymond Pearl and Lowell J. Reed, both from Johns Hopkins, and Mr. Edgar Sydenstricker of the Milbank Fund, Warren Thompson and P.K. Whelpton.

**From Jean van der Tak's interview with Dudley Kirk in 1989:**

**VDT:** Now let's turn to your reminiscences of PAA. We don't have to dwell on that too long because you wrote such a fine vignette on "PAA Meetings Over the Years" for PAA Affairs in the Spring 1983 issue. I love that one. In the book in which I'll put together excerpts from these interviews, I'll also include the "vignettes of PAA history" and that's an important one.

Your first meeting was in Washington in 1939; it was at the Hay Adams Hotel. Irene Taeuber interviewed you for the job at OPR. Lotka was president then and gave a dramatic talk. I believe it was Kingsley Davis's first meeting too and he was so impressed with Lotka that he applied for a Social Science Research Council fellowship to go study demography, this wonderful field. [Editor's note: Davis had already received this fellowship.] You wrote of the early meetings, often at Princeton, and there was such a difference from later on, because there were single sessions to which you all went, it was a small group, and so on.



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Alfred James Lotka (1880–1949)

Author(s): Frank W. Notestein

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interpretations he had developed over the years, and spoke and wrote often on the national tragedy of declining fertility. He also became deeply concerned about the dangers of high fertility and rapid population growth in areas of the world politically and culturally different from the United States.

Dr. Baker's personal life reflected the values which he had developed during decades of study of rural life here and abroad. The simple virtues of traditional America were stressed. A farm was purchased in the Shenandoah Valley, and here Dr. Baker spent each week end during the last years of his life developing land that he hoped would become a haven of refuge for future generations during the collapse of the individualistic civilization he so deplored.

Irene B. Taeuber

### ALFRED JAMES LOTKA

1880-1949

In the death of Alfred J. Lotka on December 5, 1949, at his home in Red Bank, New Jersey, demography lost its foremost analyst, and demographers everywhere lost a charming friend.

Dr. Lotka was born in Lemberg, Austria, on March 2, 1880, the son of American parents, Jacques and Marie Doebely Lotka. After spending his boyhood years in France, he went for his education to England, where he received his B.Sc. from Birmingham University in 1901. He studied at the University of Leipzig in 1901-1902, there finding his abiding interest in the mathematical theory of evolution. In 1902 he came to the United States, where he served as assistant chemist in the General Chemical Company until 1908. During this period he published his first papers on the mathematical theory of evolution and on population. In 1908-1909 he went to Cornell University as graduate student and assistant in physics, taking his M.A. in 1909. In that year he went to the United States Patent Office, and was also an assistant physicist with the United States Bureau of Standards until 1911. From 1911 to 1914 he served as editor of the Scientific American Supplement; during this interval, in 1912, he received his D.Sc. from Birmingham University. After returning to the General Chemical Company for five years from 1914 to 1919, he resumed his academic work at The Johns Hopkins University in 1922, where he remained until 1924, working mainly on his Elements of Physical Biology, which appeared in 1925.

In 1924 Dr. Lotka went to the Metropolitan Life Insurance Company, serving first as Supervisor of Mathematical Research in the Statistical Bureau; then, in 1933, as General Supervisor of the Statistical Bureau; and finally from 1934 to his retirement in 1947, as Assistant Statistician. It was here that he developed systematically the demographic analysis started in 1907 and 1911.

Dr. Lotka was active in many professional societies. He served as President of the Population Association of America in 1938-1939, and of the American Statistical Association in 1942. He was Vice President of the International Union for the Scientific Study of Population, and Chairman of the United States National Committee of the Union in 1948-1949.

It was at the meeting of the Union in Geneva during the past summer that he presented his last technical paper. He was a fellow of the American Public Health Association, the American Statistical Association, the American Association for the Advancement of Science, and the Institute of Mathematical Statistics, and a member of many learned societies, including the Swiss Actuarial Society.

This is not the time for a definitive evaluation of Dr. Lotka's contribution to knowledge. Nothing indicates the breadth and penetration of his interests more than the bibliography of his publications that is given below. As chemist, physicist, biologist, mathematician, actuary, and demographer, he left permanent contributions of high scholarly standing which center on the mathematics of self-renewing and evolutionary processes. To Dr. Lotka's work, the field of demography owes virtually its entire central core of analytical development. In 1907 he showed that a closed population with a fixed age distribution and fixed mortality increases in geometric progression with time. In 1911, with F. R. Sharpe, he demonstrated that a closed population submitted to fixed schedules of birth and death would develop a stable age distribution with a characteristic rate of increase. In 1925, in an article with Louis I. Dublin, "On the true rate of natural increase," Lotka showed for the first time the method of computing the stable age distribution and the "true" rate of natural increase. (This first stable age distribution is reproduced on the front cover of this issue of the Index.) He went on to the age distributions of populations growing according to the logistic law, and to many studies of self-renewing aggregates. Much of this work was summarized in his Théorie analytique des associations biologiques. In his last months he was busily engaged in the preparation of a systematic English edition of his demographic work, which was unfortunately left incomplete by his final illness.

Dr. Lotka was a scientist of the first rank, but he was much more. His popular writings, mostly in a lighter vein, reveal a delicate sense of humor and a deep appreciation of the arts. A quiet, learned, modest, and gently humorous man, a wise counselor, and, with his wife Romola Beattie Lotka, a gracious host, Dr. Lotka will always be held in highest esteem by his colleagues of the demographic profession, among whom his is the greatest name, and by his friends, who valued the man above his knowledge.

Frank W. Notestein

The following bibliography of Dr. Lotka's publications has been made available through the courtesy of the Metropolitan Life Insurance Company.

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3. "Studies on the Mode of Growth of Material Aggregates," *American Journal of Science*, 1907, vol. 24, pp. 199, 375.

**We do not have a presidential address for Alfred Lotka, but this paper published in 1936 gives us a glimpse of this thinking around the time of his PAA presidency.**

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Modern Trends in the Birth Rate

Author(s): Alfred J. Lotka

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# Modern Trends in the Birth Rate

By ALFRED J. LOTKA

THERE is no phenomenon in current population statistics of greater interest or of more serious importance than the decline in the birth rate experienced by most of the leading civilized nations within recent history. The bald facts are illustrated in Table I and Figures 1 and 2, which tell the story so plainly that little comment regarding the *surface* indication is needed.

## SURFACE INDICATIONS

In Sweden, for example, for which an exceptionally long series of data is available, the annual birth rate about the middle of the eighteenth century was over 34 per thousand. A figure of about this order was maintained until the beginning of the nineteenth century, and as late as the sixties, rates of over 33 per thousand still occurred. From about 1865 on began a period of gradual decline, continued to about 1920, after which a decline so rapid set in that in the course of a single decade the birth rate fell from over 20 to a little more than 15, a decrease by over 25 per cent. About this rate of decrease has continued into the present decade, as far as can be judged from available data.

The picture thus presented by Sweden is essentially characteristic of most of the leading civilized countries. Thus, England and Wales recorded birth rates of 32 to 35 per thousand until 1881-1885, but from that time on exhibited an almost uninterrupted decline, until in 1933 bottom was reached with a birth rate of 14.4. One would have to be very optimistic to ascribe any serious significance to the

slight rise to 14.8 in 1934 and 14.7 in 1935.

Two of the major civilized countries stand a little apart. Italy, though it has shared in the general downward movement of the birth rate, still registers such figures as 24 and 25 per thousand. And France forms an important exception because the major decline in the birth rate here took place at an earlier period of history. The period 1920 to 1925 was one of almost stationary birth rate, and the decline since then—from 19.0 in 1925 to 15.2 in 1935—though serious enough, has not been so severe as in England and Wales, for example. Particularly abrupt has been the decline in Germany, from 20.7 in 1925 to 14.7 in 1933. The sudden rise in 1934 to 18.0 per thousand which is reported, is ascribed to the effects of the special efforts of the present administration to encourage marriage and larger families. How successful these efforts will be in the long run remains to be seen. Their immediate

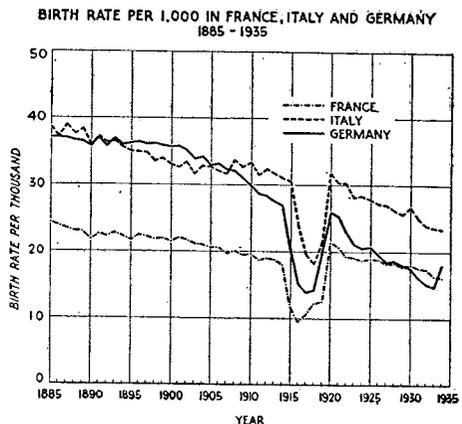


FIGURE 1

TABLE I—BIRTH RATES IN SELECTED COUNTRIES OVER AVAILABLE CALENDAR PERIODS

Period	Sweden	England and Wales	United States*	Italy	France	Germany
1749-1750.....	35.10	....	....	....	....	....
1751-1755.....	37.09	....	....	....	....	....
1756-1760.....	34.29	....	....	....	40.0	....
1761-1765.....	34.60	....	....	....	....	....
1766-1770.....	33.75	....	....	....	....	....
1771-1775.....	31.34	....	....	....	40.0	....
1776-1780.....	34.65	....	....	....	38.8	....
1781-1785.....	31.76	....	....	....	38.8	....
1786-1790.....	32.14	....	....	....	....	....
1791-1795.....	33.88	....	....	....	....	....
1796-1800.....	32.76	....	....	....	....	....
1801-1805.....	31.35	....	....	....	33.3	....
1806-1810.....	30.38	....	....	....	31.7	....
1811-1815.....	32.92	....	....	....	31.7	....
1816-1820.....	33.69	....	....	....	32.0	....
1821-1825.....	35.84	....	....	....	31.5	....
1826-1830.....	33.50	....	....	....	30.5	....
1831-1835.....	32.39	....	....	....	29.6	....
1836-1840.....	30.59	....	....	....	28.4	....
1841-1845.....	31.28	32.3	....	....	28.1	36.7
1846-1850.....	30.93	32.8	....	....	26.7	35.6
1851-1855.....	31.81	33.9	....	....	26.1	34.6
1856-1860.....	33.72	34.4	....	....	26.6	36.0
1861-1865.....	33.20	35.1	....	....	26.7	36.8
1866-1870.....	29.68	35.3	....	....	25.9	37.5
1871-1875.....	30.66	35.5	37.0	36.8	25.5	39.0
1876-1880.....	30.32	35.3	34.9	36.9	25.3	39.2
1881-1885.....	29.36	33.5	33.2	38.0	24.7	37.0
1886-1890.....	28.78	31.4	31.9	37.5	23.1	36.5
1891-1895.....	27.44	30.5	30.8	36.1	22.3	36.3
1896-1900.....	26.86	29.3	29.8	34.0	22.0	36.0
1900.....	27.00	28.7	....	33.0	21.4	35.6
1901.....	27.03	28.5	....	32.6	22.0	35.7
1902.....	26.48	28.5	28.8	33.4	21.7	35.1
1903.....	25.70	28.5	....	31.7	21.1	33.8
1904.....	25.75	28.0	....	32.9	20.9	34.1
1905.....	25.66	27.3	....	32.7	20.6	32.9
1906.....	25.70	27.2	....	32.1	20.6	33.1
1907.....	25.53	26.5	27.7	31.7	19.7	32.3
1908.....	25.70	26.7	....	33.7	20.1	32.1
1909.....	25.58	25.8	....	32.7	19.5	31.0
1910.....	24.66	25.1	....	33.3	19.6	29.8
1911.....	23.99	24.4	....	31.5	18.7	28.6
1912.....	23.80	24.0	26.4	32.4	19.0	28.3
1913.....	23.16	24.1	....	31.7	18.8	27.5
1914.....	22.88	23.8	....	31.1	17.9	26.8
1915.....	21.59	21.8	25.1	30.5	11.6	20.4
1916.....	21.22	21.0	25.0	24.0	9.5	15.2
1917.....	20.91	17.8	24.7	19.5	10.5	13.9
1918.....	20.31	17.7	24.6	18.1	12.2	14.3
1919.....	19.76	18.5	22.3	21.4	12.6	20.0
1920.....	23.61	25.5	23.7	31.8	21.4	25.9
1921.....	21.54	22.4	24.2	30.3	20.7	25.3

TABLE I—Concluded

Year	Sweden	England and Wales	United States	Italy	France	Germany
1922.....	19.59	20.4	22.3	30.2	19.3	23.0
1923.....	18.92	19.7	22.2	28.2	19.1	21.1
1924.....	18.11	18.8	22.4	28.4	18.7	20.5
1925.....	17.58	18.3	21.5	27.8	19.0	20.7
1926.....	16.82	17.8	20.7	27.2	18.8	19.5
1927.....	16.09	16.6	20.6	27.0	18.2	18.4
1928.....	16.01	16.7	19.8	26.2	18.3	18.6
1929.....	15.15	16.3	18.9	25.6	17.7	17.9
1930.....	15.37	16.3	18.9	26.7	18.0	17.5
1931.....	14.80	15.8	18.0	24.9	17.5	16.0
1932.....	14.53	15.3	17.4	23.9	17.3	15.1
1933.....	13.69	14.4	16.6	23.6	16.3	14.7
1934.....	13.67	14.8	17.1	23.4	16.1	18.0
1935.....	13.76	14.7	16.8	23.1	15.2	18.9

\* 1872-1912 estimated, *Jrl. of Amer. Statistical Ass'n*, Vol. 20, 1925, p. 318. 1915-1935 observed.

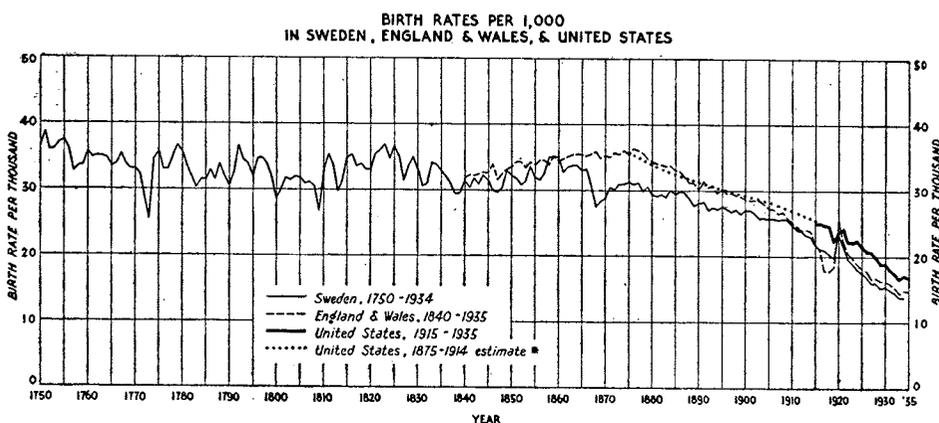
effects, up to the present, we shall briefly consider in a later section.

Here in our own United States we have birth statistics only from 1915 on, though indirectly an estimate can be made (which bears internal evidence of reliability) back to about 1875. The picture thus presented by the American birth rate is shown in column 4 of Table I and in the corresponding curve in Figure 2. Short as our series of observations is, even when supplemented by indirect esti-

mates, it exhibits much the same characteristic decline in the birth rate observed in Sweden, England and Wales, and most of the major civilized countries.

DEEPER IMPLICATIONS

Such are the *surface* indications: rapidly declining trends in the birth rates of most of the major civilized nations. But the *deeper* implications are even more significant. A population may, for the moment, sustain or



\* *Journal of the American Statistical Association*, 1925, Vol. 20, page 318.

FIGURE 2

even increase its numbers by a balance of annual births over annual deaths, while yet it may be failing to reproduce itself. This apparent paradox arises from the fact that the birth rate is the resultant of two influences, namely, first, the fertility of that part of the population which is in the reproductive period of life; and second, the prevailing age distribution, which determines what proportion of the total population thus contributes to the annual progeny. Hence the effect of a relatively low fertility may be masked by the influence of a relatively high proportion of individuals of reproductive ages in the total population. But it can be shown that such a situation is necessarily temporary—that eventually it is the fertility and not the birth rate that decides the issue, because the age distribution, no matter what may be its original character, tends in time to approach a definite “stable” form which itself depends on the age schedule of fertility and of mortality. When this definite stable age distribution is reached, the birth rate and the death rate assume correspondingly definite values, which it is convenient to speak of as the stable birth rate and the stable death rate under the given age schedules of fertility and mortality. These stable values commonly differ from the prevailing rates, because the age distribution differs from the stable distribution; for the existing age distribution is the historical outcome of a period of past declining fertility, whereas the stable distribution is that which would result after a lapse of time under the régime of the actually prevailing fertility.

#### EARLY AND MODERN APPROACHES TO THE PROBLEM

The necessity for dealing with the age specific fertilities and mortalities

instead of crude general birth rates and death rates was recognized years ago by R. Boeckh.<sup>1</sup> He computed for a cohort of 1,000 newborn females what would be their total number of children in the entire course of their life, under the prevailing conditions of mortality and fertility. Thus for Berlin, according to the conditions prevailing in 1879, he found that 1,000 females would in the course of their life have 2,172 children, of whom 1,060 would be daughters. The daughters therefore exceeded the original cohort of females by 6 per cent. Boeckh drew the conclusion: “The reproduction in Berlin would therefore be at a rate of increase of 6 per cent.”<sup>2</sup>

This of course is not the rate of increase as we ordinarily understand it, namely, per annum. Neither Boeckh nor any of his followers seem to have given any thought to the question what relation the rates computed by his method might have to the annual rate of increase of the population.

Meanwhile the problem was being attacked from another angle. A. J. Lotka in 1907 suggested that under constant conditions a population tended to approach a definite fixed age distribution with correspondingly definite birth rate and death rate.<sup>3</sup> He gave one example of a population—that of England and Wales in 1871–1880—which actually conformed closely to the fixed age distribution, birth rate and death rate calculated

<sup>1</sup> *Statistisches Jahrbuch der Stadt Berlin*, 1884, pp. 30–34.

<sup>2</sup> Similar computations and conclusions were subsequently made by Boeckh and some of his students at different epochs.

<sup>3</sup> “Relation Between Birth Rates and Death Rates,” *Science*, Vol. 26 (1907), pp. 21–22; “Studies in the Mode of Growth of Material Aggregates,” *Amer. Jrl. of Science*, Vol. 24 (1907), pp. 199–210; “A Natural Population Norm,” *Jrl. of the Washington Academy of Sciences*, Vol. 3, 1913.

on the basis of the *observed* rate of natural increase. Another example was given in 1911 by L. Bortkiewicz,<sup>4</sup> namely, the population of Germany in 1890, which also was found to agree very fairly with the calculations similarly based on the *observed* rate of natural increase.

These are exceptional cases, in which the population already exists in essentially the stable age distribution. For these the stable age distribution is easily computed (so as to compare it with the observed) because the "stable" rate of natural increase, which must be known before the computation is made, is simply assumed to be the rate actually observed, and the justification of this assumption is then found in the concordance of the computed with the observed age distribution.

But in the general case of any population which has not attained the stable age distribution, the stable rate of natural increase is different from the observed rate, and the determination of this stable rate is an entirely separate problem, which was left open by the publications of Lotka (1907) and Bortkiewicz (1911). Its solution was given by Sharpe and Lotka in 1911,<sup>5</sup> who established the formal

<sup>4</sup>"Die Sterbeziffer und der Frauenüberschuss in der stationären und in der progressiven Bevölkerung," *Bulletin de l'Institut International de Statistique*, Vol. 19, Part I, pp. 63-138. Quite recently another instance, the population of Sweden in 1910, has been noted by H. Cramer, "Über die Vorausberechnung der Bevölkerungsentwicklung in Schweden," *Skandinavisk Aktuarietidskrift*, 1935, p. 39.

<sup>5</sup>"A Problem in Age Distribution," *Phil. Mag.*, Vol. 21 (1911), p. 435. The problem has subsequently been treated also by A. J. Lotka, *Proceedings of the National Academy of Science*, Vol. 8 (1922), p. 147; J. B. S. Haldane, *Proceedings of the Cambridge Philosophical Society*, Vol. 23 (1927), pp. 607-609; H. T. J. Norton, *Proceedings of the London Mathematical Society*, Ser. 2, Vol. 28 (1927), pp. 21-25; Bonz and Hilburg, *Zeitschr. f. angew. Math.*

proof that a population with given age schedule of fertility and mortality, no matter what its original age distribution, will eventually approach a stable distribution, and gave the requisite formulæ for determining that age distribution and the corresponding stable rate of natural increase. These formulæ were then applied to the population of the United States by Dublin and Lotka in 1925 in a paper entitled "On the True Rate of Natural Increase as Exemplified by the Population of the United States, 1920." And here the highly significant fact became apparent that the stable or true rate of natural increase was materially less than the observed rate; in fact, at that time almost exactly one half of this. The figures were 10.9 for the observed rate, but only 5.4 for the true rate.

#### TRENDS SHOWN BY INVESTIGATIONS

It thus became very obvious that observed birth rates, death rates, and rates of natural increase were a very inadequate and actually a misleading index of the balance struck, in a population, between fertility and mortality. In fact, it was clear that cases might arise in which, in spite of an excess of annual births over deaths, the population was actually not reproducing itself; that is, where each generation of births was less numerous than its predecessor. That such cases were actually present among the modern nations was then illustrated by a wealth of statistical material brought together and analyzed by R. Kuczynski in his *Balance of Births and*

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*und Mech.*, Vol. 11 (1931), pp. 237-243; v. Mises, *Blätter für Versicherungsmathematik*, Vol. 2 (1933), pp. 359-371; S. Wicksell, *Skandinavisk Aktuarietidskrift*, 1931, pp. 125-157; L. R. Connor, "Fertility in Marriage and Population Growth," *Jrl. of the Royal Statistical Society*, 1926, p. 537.

*Deaths*,<sup>6</sup> using for the most part the method of Boeckh, that is, the computation of the ratio of total births in two successive generations. Evidently whenever this ratio, which for brevity we may speak of as the Boeckh ratio, is greater than unity, fertility more than balances mortality; and whenever it is less than unity, fertility fails to balance mortality. If this latter situation continues, the population is headed for extinction. Kuczynski, in his first publication and in others that have followed, has given the results of the computation of the Boeckh ratio for a considerable number of countries.

A selection of some of the principal values thus computed is shown in Table II, which also exhibits the corresponding values of the true rate of natural increase whenever these were readily available.<sup>7</sup>

A glance at this table brings out at once the fact that a very critical situation exists, which one author expresses in the title of one of his articles "Sterben die Weissen Völker?" (Are the White Races Dying Out?—Burgdörfer).

The Boeckh ratio falls below unity, and accordingly the true rate of natural increase is negative at the present time, for many of the leading countries, among them England and Wales, France, Germany, Sweden, and the United States.

#### AMERICAN POPULATION HEADED FOR A DECLINE

In the figures for the United States we have special interest. It appears

<sup>6</sup> Vol. 1, 140 pp., New York: Macmillan Co., 1928; Vol. 2, 165 pp., Washington: The Brookings Institution, 1931; *The Measurement of Population Growth*, 255 pp., London: Sidgwick and Jackson, 1935.

<sup>7</sup> The values of the Boeckh ratio are obtained incidentally as an intermediate step in the computation of the true rate of natural increase.

that our population must have passed the deadline from the black into the red on the ledger of population balance about the time of the last census, 1930, or very soon after. Our birth rate still exceeds our death rate, and will undoubtedly continue to do so for yet a number of years. But unless a marked change occurs in our national habits, the deficit in our vital account, which as yet is not apparent on the surface, will emerge from obscurity and become plainly visible as an adverse balance of annual births as against annual deaths. For it lies in the nature of the situation that not only the birth rate but the death rate also is deceptive.

We have long been accustomed to a diminishing general death rate, thanks to the advances of medical and sanitary science, and to the rise in standards of living. But in the readjustment of the age distribution which will inevitably take place, with an increasing proportion of persons at the older ages, the general death rate is bound to rise, even though the mortality at each age may register further improvements. That our present low death rate of about 10 per thousand cannot possibly continue as the population approaches the stationary state is evident from the fact that in a stationary (life table) population, a death rate of 10 per thousand would correspond to an average length of life of 100 years. Actually, we may reasonably hope to see an average length of life of about 70 years established.<sup>8</sup> This in a stationary population would correspond to a death rate of 14 per thousand, and towards this figure one must be prepared to see our death rates tending in decades to come.

<sup>8</sup> The current figure is 59.1 for white males and 62.7 for white females (Life Table 1929-1931).

But present indications are still even a stationary population when accounts are ultimately squared. For current effective fertility of American computation shows that if the stable women is not adequate to guarantee age distribution corresponding to

TABLE II—NET REPRODUCTIVITY (BOECKH RATIO) AND RATE OF NATURAL INCREASE FOR SELECTED COUNTRIES AT DIFFERENT EPOCHS

Country; year	Net Reproductivity <sup>a</sup> (Boeckh Ratio) <i>R<sub>0</sub></i>	Rate of Natural Increase	
		True <i>ρ</i>	Crude <i>r</i>
England and Wales			
1921.....	1.087	2.81	10.3
1933.....	.735	-10.21	2.1
France			
1898-1903.....	.979	-.73	.3
1908-1913.....	.930	-2.55	.9
1920-1923.....	.977	<sup>b</sup>	2.8
1925-1927.....	.929	<sup>b</sup>	1.6
Germany			
1881-1890.....	1.448	12.23	11.7
1891-1900.....	1.513	13.81	13.95
1901-1910.....	1.480	13.23	14.25
1925.....	.908	-3.38	8.8
1929.....	.818	<sup>b</sup>	5.3
1931.....	.748	<sup>b</sup>	4.9
Sweden			
1816-1840.....	1.411	10.88	9.72
1841-1850.....	1.394	10.31	10.51
1851-1860.....	1.343	9.12	11.10
1861-1870.....	1.380	9.96	11.24
1871-1880.....	1.454	11.64	12.21
1881-1890.....	1.456	11.71	12.12
1891-1900.....	1.435	11.43	10.78
1901-1910.....	1.429	11.48	10.88
1911-1915.....	1.287	8.19	9.05
1916-1920.....	1.110	3.41	6.63
1921-1925.....	1.058	<sup>b</sup>	7.08
1926-1930.....	.857	<sup>b</sup>	3.83
United States			
1920.....	1.166	5.47	10.99
1925.....	1.128	4.27	9.8
1926.....	1.084	2.87	8.6
1927.....	1.096	3.23	9.4
1928.....	1.049	1.70	7.8
1930.....	1.079	2.82	7.7
1931.....	<sup>b</sup>	<sup>b</sup>	6.9
1932.....	.997	-.10	6.4
1933.....	.940	-2.06	5.9
1934.....	.980	-.59	6.1

<sup>a</sup> Figures in this column, except those for the United States, are adapted from Kuczynski, *The Balance of Births and Deaths, op. cit.*, Vol. 1, p. 51, and *The Measurement of Population Growth, op. cit.*, p. 212.

<sup>b</sup> Not computed.

*present* conditions<sup>9</sup> becomes established, the birth rate will be 15.6 per thousand, and the death rate will have risen above that corresponding to the stationary state, and will assume a value of 16.2, so that the rate of natural "increase" will be negative; that is, it will be a rate of natural *decrease*. And all this is on the assumption that there is henceforth no further decrease in the fertility of our women—an assumption in which we might have been encouraged by the fact that the birth reports for 1934 showed a rise over the previous year from 16.6 to 17.1 per thousand. But provisional figures for forty-two states of the Union at the time of writing give for 1935 a rate of 16.8, practically the same as that for the entire forty-eight states in 1933. It is with great curiosity that we shall await further developments.

#### INFLUENCE OF THE MARRIAGE RATE

In the meantime, it is to be noted that the birth rate is a more elastic figure than the death rate. It depends among other things on the marriage rate, which in turn is responsive to economic conditions. This raises the question, assuming the age-specific fertility of married women to remain unchanged at its present level, how much increase in the marriage rate would be required to restore a favorable balance against the prevailing mortality?

The answer seems at first sight reassuring. Computation shows that, even starting from the low level of 1933, when the true rate of natural *decrease* was over 2 per thousand, an increase in the marriage rate of less than 4 per cent would be sufficient to bring the population back to reproduc-

<sup>9</sup>The computation relates actually to 1934, the latest date for which satisfactory data are available.

tive equilibrium, assuming no increase whatever in the age-specific fertility of the married woman.

It may appear that an increase of less than 4 per cent in the marriage rate might be attainable without great difficulty. But closer examination of the facts will make us less optimistic. In the first place, an increase of 4 per cent in the marriage rate, if uniformly distributed over the whole range of life, would lead to marital ratios so near to unity that one is led to doubt if such a situation can reasonably be expected. In the actual population the highest marital ratios are only of the order of 80 per cent.

Another argument leads in the same direction. Following a suggestion of S. W. Wicksell, we may compute the maximum marriage rate for a stationary population, on the assumption that every girl surviving to age 18 marries at that age. On the basis of the latest life table for the United States it is found that the resulting annual marriage rate in a stationary population would be 7.2 per thousand for first marriages, and 7.7 per thousand for all marriages. In a population growing constantly according to the compound interest law at a rate of 10 per thousand (a rate quite out of our reach today), the corresponding marriage rate would be 8.4 per thousand for first marriages and 9.2 for all marriages. It should be observed that the figures thus computed relate to a *steadily maintained* marriage rate. Temporarily, of course, considerably higher rates may well occur in a population in which persons of marriageable age have been accumulating during a time of depressed marriage rates. However this may be, the actual observed marriage rates in the United States as shown in Table III have for many years past (except since the economic depression) been so high as

compared with those in other countries, and as compared with the hypothetical maximum rates computed as just described, that one does not feel encouraged to expect in the future any considerable increase in these figures beyond the levels to which we have been accustomed in the past.

reduction in mortality characteristic of past decades would in itself, if uncompensated by diminishing birth rate, have produced a very high rate of natural increase. Sooner or later this could not have failed to result in serious overcrowding which could have been arrested only by an ultimate rise

TABLE III—ANNUAL MARRIAGES PER 1,000 PERSONS IN SELECTED COUNTRIES

Year	Sweden	England and Wales	United States	Italy	France	Germany
1910.....	6.0	...	10.3	...	...	7.7
1911.....	5.9	...	10.2	...	...	7.8
1912.....	5.9	...	10.6	...	...	7.9
1913.....	5.9	...	10.6	...	...	7.7
1914.....	5.8	8.0	10.5	7.0	5.1	6.8
1915.....	5.8	9.7	10.1	5.1	2.3	4.1
1916.....	6.1	7.4	10.7	2.9	3.3	4.1
1917.....	6.2	6.9	11.2	2.7	4.8	4.7
1918.....	6.7	7.7	9.7	3.0	5.5	5.4
1919.....	6.9	9.9	11.0	9.2	14.0	13.4
1920.....	7.3	10.1	12.0	14.0	16.0	14.5
1921.....	6.7	8.5	10.8	11.5	...	11.8
1922.....	6.2	7.9	10.3	9.5	...	11.1
1923.....	6.3	7.6	11.0	8.5	...	9.4
1924.....	6.2	7.7	10.5	8.0	...	7.1
1925.....	6.2	7.6	10.4	7.7	...	7.7
1926.....	6.3	7.2	10.3	7.5	8.5	7.7
1927.....	6.4	7.8	10.2	7.6	8.2	8.5
1928.....	6.6	7.7	9.9	7.1	8.2	9.2
1929.....	6.8	7.9	10.1	7.1	8.0	9.2
1930.....	7.2	7.9	9.2	7.4	8.2	8.8
1931.....	7.0	7.8	8.6	6.7	7.8	8.0
1932.....	6.7	7.6	7.9	6.4	7.5	7.9
1933.....	7.0	7.9	8.4 <sup>a</sup>	6.8	7.5	9.7
1934.....	7.8	8.5	9.7 <sup>a</sup>	7.4	7.1	11.1
1935.....	...	8.6	....	6.6	6.8	9.7

<sup>a</sup> 26 states.

SOCIAL SIGNIFICANCE OF THE DECLINING BIRTH RATE

So far we have been considering certain facts and the methods by which we have learned to construe them. Let us now, in conclusion, examine these facts as to their implications. Where do they lead and what are we going to do about it?

A declining birth rate is not in itself necessarily an evil. The continued

in mortality to bring the population increase to a standstill. This would hardly have been a desirable solution of the population problem, but as A. Landry<sup>10</sup> points out, the process would at least have had the virtue of leading to a stable equilibrium.

The other alternative, the one that has been chosen by most of the lead-

<sup>10</sup> *La Révolution Démographique*, 227 pp., Paris: Librairie du Recueil Sirey, 1934, p. 53.

ing civilized nations, is to reduce the birth rate. There is much to be said in favor of having fewer children born and fewer of them die. But the process of seeking equilibrium in this way has one very serious fault: There is nothing to guarantee that it moves toward a stable condition. If equilibrium had been approached by the first described method, when the mortality had gone up far enough to meet the birth rate further increase in mortality presumably would have ceased. But in the second method of seeking equilibrium, when the birth rate has diminished sufficiently to meet the mortality, there is nothing to prevent it from going down farther, and we are quite uncertain as to the limit towards which the birth rate may descend under the plan that is now being followed.

#### DIFFERENTIALS IN THE DECLINE OF THE BIRTH RATE

If the decline in the birth rate were universal among all nations, its continued downward trend would seem to be pointing towards the total extinction of the human race. This, of course, is not the actual situation. There are still a number of countries with decidedly high birth rates and with a relatively slight decline in the birth rate. Thus we have today in Spain a birth rate of 26.3; in Poland, 26.5; in Bulgaria, 30.0; and in Rumania, 32.4. It is true that even in these countries an appreciable decline has taken place since 1920, though at a relatively low gradient, as will be seen from Table IV. Perhaps these nations are only beginning to travel the road which we in the United States, and a number of European countries, have followed to greater length. Indeed, it is only about twenty years ago that we, here in the United States, still registered figures of this order.

However that may be, any continued wide divergence in the birth rates of different nations, especially when some of them fall below the level required for their numerical maintenance, must inevitably lead to a change in the composition of the total population. Possibly to an onlooker wholly impartial to the situation, this might appear as an interesting fact, but one to be observed as other scientific facts, without emotional reaction. To us, such a wholly objective point of view is impossible. We are directly and personally concerned. If, then, we want to step beyond merely playing the part of onlooker, and if we desire to become definite agents in controlling events, the question arises, what is to be done about it?

#### ADMINISTRATIVE MEASURES TO ARREST THE DECLINE

In facing this question, others have anticipated us. Especially in Germany and in Italy, definite constructive steps have been taken in the effort to arrest the declining birth rate. At the time of writing, the precise effect of these efforts is a little uncertain. So far as Italy is concerned, there seems to be little doubt that the measures initiated have produced a result which by their own promoters would be considered quite inadequate. The birth rate in Italy has continued to go down each year until the very last report. The rate of decline may have been somewhat slowed down, but it has not been stopped.

As regards Germany, the most recent figures leave us in doubt as to the probable course of events in the near future. The total live births in 1935 numbered 1,261,273 as against 1,196,740 in 1934, an increase of about 5 per cent. Thus the remarkable gain of 1934 over 1933 has been essentially maintained as far as the total births

TABLE IV—BIRTH RATES IN SELECTED COUNTRIES WITH HIGH FERTILITY II.

Country	Year															
	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
Bulgaria.....	39.9	40.1	40.5	37.7	39.8	36.9	37.4	33.2	33.1	30.6	31.3	29.4	31.3	29.2	30.0	26.2
Japan.....	36.2	35.1	34.2	34.9	33.8	34.9	34.8	33.6	34.4	33.0	32.4	32.2	32.9	31.6	.....	.....
Yugoslavia.....	35.5	36.7	34.4	34.9	34.8	34.2	35.3	34.3	32.7	35.6	35.5	33.6	32.8	31.3	.....	.....
Poland.....	32.2	32.8	35.5	36.0	35.0	35.7	33.6	32.1	32.6	32.3	32.3	30.2	28.7	26.5	26.5	26.1
Rumania.....	34.7	38.2	37.2	36.4	36.7	35.2	34.8	34.1	34.7	33.0	35.0	33.3	35.9	32.0	32.4	30.7
Russia (Europe).....	.....	.....	.....	38.8	42.9	44.7	43.7	43.2	41.8	.....	.....	.....	.....	.....	.....	.....
Spain.....	29.3	30.3	30.5	30.5	30.0	29.4	30.0	28.6	29.7	28.9	29.0	28.3	28.3	27.8	26.3	25.7

<sup>11</sup> Sources: Where not otherwise stated, the figures are cited from the official publications of the respective countries. The following sources are exceptions: Bulgaria, 1933 to 1934, *League of Nations Statistics of Notifiable Diseases*; Japan, 1927 to 1929, *Statistisches Jahrbuch des Deutschen Reichs*, 1930 to 1933, *Statistical Yearbook of the League of Nations*; Yugoslavia, 1920 to 1930, data from *Office international d'hygiène publique*, 1931 to 1933, *League of Nations Statistics of Notifiable Diseases*; Russia, figures cited from Kuczynski, *The Balance of Births and Deaths*, op. cit., Vol. 2, 1931, p. 135; data for 1935, *Revue de l'Institut International de Statistique*, The Hague, 1936.

are concerned. It so happens that the total deaths in 1935 were somewhat more than in 1934, namely, 791,912 deaths as against 724,666, so that the excess of births over deaths was somewhat less in 1935 than in 1934, namely, 469,361 as against 472,074. Moreover, whether this be significant or not, the fourth quarter of the year 1935 fell below that of 1934, the total number of live births being 290,700 in the former as against 308,547 in the latter.

It remains to be seen whether Germany can maintain for any length of time the high levels in the birth rate of 1934 and 1935, or whether the effect is merely a transitory one, arising from the catching up on arrears in the marriage rate. Many marriages have been postponed on account of the economic depression. There must have accumulated an excess of marriageable population, which can to some extent be encouraged to matrimony by the financial assistance offered by the government. When this accumulated reserve of marriageable persons has been more or less exhausted, shall we find the birth rate dropping back towards the levels of 1933 and preceding years? Not only Germany but the whole world will watch with keen interest to see how events will turn.<sup>12</sup>

#### IMPORTANCE OF ADEQUATE STATISTICS

Here in the United States we have not yet reached the point where there is any general alarm regarding the situation, or any general disposition to initiate governmental action to raise the birth rate, unless, indeed, the income tax exemptions to persons mar-

<sup>12</sup> According to P. K. Whelpton the rise in the birth rate in Germany is due largely to a reduction in the practice of abortion, against which stern measures have been taken by the present régime. "Why the Large Rise in the German Birth Rate?" *Amer. Jrl. of Sociology*, Vol. 41 (1935), pp. 299-313.

ried and supporting dependent children are to be regarded in this light. But if we have not yet reached the stage of planning direct constructive action, we certainly have every reason to weigh very carefully those steps which must be preliminary to such action, namely, the gathering and analyzing of necessary information. In the years through which we are passing and in the years to come, we are and shall be more than ever in need of the best statistical information on demographic phenomena that it is possible to obtain.

Our registration of births and our enumeration of the youngest age classes, especially children under one and two years of age, are still far from perfect. It has been estimated that about 8 or 9 per cent of births in the United States escape registration, and our enumeration of children under three is probably about 9 per cent short in the white and 25 per cent in the Negro population.<sup>13</sup> There are some gaps in the information as published by the Bureau of the Census. For example, the annual birth reports show the number of births by age and color of mother, but in the case of the father the information is only by age. Again, there is information in the reports regarding the births during the year, classified by age of mother and order of child, but corresponding information regarding the age of father is not published. And we need statistics of fecundity in relation to duration of marriage.

We are passing through a critical period in population history; the need of accurate and as nearly as possible complete vital statistics was never more urgent than it is today. To the specialist these facts are apparent.

<sup>13</sup> E. Foudray, *United States Life Tables 1919-1930*, 84 pp., Washington: Government Printing Office, 1923, p. 9.

But he is dependent on material gathered at public expense and with the coöperation of the public. Greater accuracy in reporting could be obtained if each person were made to feel that he or she can coöperate and that it is worth while to do so.

Since the public's money is being spent to do the job, let the job be well done. In these days of newspapers, radio talks, and moving pictures, there should be no difficulty in finding the means to awaken the public to the importance of these things.

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