"sinks," no selective action, then the most likely path is a geodesic. If we do have "sinks" they act as propulsive forces and we encounter the following generalization of the theory of differential equations. At each point, instead of having a definite direction of motion assigned, as by differential equations, we have a pencil of directions (or an (n–1)-parameter family of directions) with a function, which will be a normal error function, giving the probability that the direction of motion will lie between any assigned limits. This enables us to assign to the curves joining two points a distribution of a species of probability. For fixed end points the selection of the most probable curve is a problem in the calculus of variations. If g_{ij} is the fundamental tensor and φ_i a vector giving the most probable direction we shall in fact minimize

$$\int_{t_1}^{t_2} \sum_{i,j=1}^{n} g_{ij}(\dot{x}_i - \varphi_i)(\dot{x}_j - \varphi_j)\, dt,$$

where $\dot{x}_i = dx_i/dt$.

The minimizing equations for the integral may be interpreted as the differential equations of a dynamical system. Indeed we may consider the most probable path as the trajectory of a particle shooting through the curved space under a field of force. However, the form of the integral shows that the force will in general depend upon the direction of motion, as with an electrical charge moving in a magnetic field.

The derivation of the criterion that the integral shall be minimized is a simple generalization of a derivation in the article on "Differential Equations subject to Error, and Population Estimates,"[2] in which I use the same considerations in their simplest form to obtain estimates of intercensal populations. That was in one dimension, but it may readily be generalized by considering a system of variables having correlated changes, such as the population of a city, the number of children in its schools, the number of telephones and so on. The leading difficulty in applications of this kind is to arrive at the tensor g_{ij}.

There is nothing to prevent empirical determination from measurements of parents and offspring of the fundamental biological tensor giving the distance element which we have defined. In fact all the measurements which have been made in the study of heredity may be regarded as steps in this enterprise. As a sufficient accumulation of data makes the hypothesis of flatness untenable we shall be driven to look for some other kind of space, as simple as is possible without contradicting the data. A space which in some sense or other has constant curvature will be wanted as a second approximation, and mathematicians will be asked to supply equations of suitable type, with parameters for biological workers to determine empirically and check by tests of goodness of fit.

This problem which biology is approaching has already been faced by physics. The hypothesis of Euclidean space-time as a matrix of physical events served adequately for several centuries; but more refined measurements have required its modification. Mathematical physics has been grappling with the problem of supplying as simple a statement as possible of the properties of the world-order without contradicting known facts. Such a statement is indeed what we call an explanation. It is altogether likely that the considerations of simplicity which led Einstein to his cosmological equations may some day cause the same equations to appear as the foundation of biology.

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[2] *Journal of the American Statistical Association*, September, 1927, pp. 283–314.

PAUL HEINRICH VON GROTH

IT is with deep regret that we record the death of Professor Paul Heinrich von Groth in Munich, Germany, on December 2, 1927. With the passing of Professor Groth the Mineralogical Society of America has lost one of its most distinguished honorary life fellows, the science of mineralogy one of its greatest leaders and the world of science a courageous pioneer, an ardent investigator, an energetic and efficient author and editor and an inspiring teacher.

Paul Heinrich von Groth was born on June 23, 1843, at Magdeburg, Germany. His father was a portrait painter. The training for his life's work Professor Groth obtained at the school of mines in Freiberg, at the college of engineering in Dresden and at the University of Berlin, at which institutions he spent the years 1862 to 1870. The degree of doctor of philosophy was conferred upon him by the University of Berlin in 1868.

From 1870 to 1872 Professor Groth was a member of the teaching staffs of the Technische Hochschule in Charlottenburg and of the University of Berlin. When the University of Strassburg was being reorganized, shortly after the close of the Franco-Prussian war, Groth was called to the chair of mineralogy, for he had already acquired a splendid reputation as an investigator of great promise, especially in the field of chemical crystallography, to the development of which he subsequently contributed so extensively.

Groth held the professorship at Strassburg from

1872 to 1883. During this period he not only supervised the construction of a new laboratory, which set a very high standard for that time, and completely reorganized the mineral collections, but he also carried on extensive researches and published a long list of papers. Moreover, it was while at Strassburg that Groth began his notable career as an author and editor, for during that period he wrote two text-books and a guide to the mineral collections and founded the *Zeitschrift für Kristallographie und Mineralogie.*

Thus, in 1874, the first edition of his "Tabellarische Übersicht der Mineralien" was published, which later appeared in four German editions and in 1904 was translated into French. Two years later, in 1876, his "Physikalische Kristallographie und Einleitung in die Kenntnis der wichtigen Substanzen" appeared. This soon became the standard text in the field of physical crystallography, and later passed through four German editions. In 1910 this important text-book was made more directly available to English-reading students, when portions of it were translated into English by Jackson. The third book to be written by Groth while at Strassburg was the excellent guide to the mineral collections of the university, published in 1878.

As already indicated, the *Zeitschrift für Kristallographie und Mineralogie* was founded by Groth. It was first issued in 1877. As sole editor Groth published 52 volumes of the *Zeitschrift* and three more as joint editor with Professor E. Kaiser, making a total of 55 volumes during the years 1877 to 1920. As is well known, since 1921 the *Zeitschrift* has been under the editorship of Professor P. Niggli, of the University of Zürich. Upon the occasion of Groth's eightieth birthday, in 1923, the 58th volume was issued as a Groth Festschrift, and contained 32 papers by his friends and former students.

In 1883 Professor Groth was called to the University of Munich as the successor to Professor Franz von Kobell. His tremendous energy was at once transferred to that institution, and he soon reorganized the instruction in mineralogy and installed in new quarters the extensive royal Bavarian mineral collections, of which he was made custodian. Under Groth's leadership the Mineralogisches Institut of the University of Munich became one of the chief centers for crystallographic and mineralogical study, advanced students being attracted from all over the world, particularly from the United States.

During his professorship at Munich Professor Groth stimulated and supervised many investigations dealing with various phases of crystallography and mineralogy. He also continued to write text and reference books and 13 additional volumes were placed to his credit, of which only the following will be mentioned: "Grundriss der Edelstein-Kunde" (1887), the monumental work on "Chemische Kristallographie" in six volumes (1904 to 1919), "Elemente der physikalischen und chemischen Kristallographie" (1921), and "Die Entwickelungsgeschichte der mineralogischen Wissenschaften" (1926). The last book was published after his retirement from active teaching and when he had all but lost his eyesight.

Professor Groth's contributions to the mineralogical sciences were widely and most favorably recognized for he was elected to honorary membership in many learned societies. Since he had had many students from the United States and Canada it, indeed, was fitting that he should have been elected an honorary life fellow of the Mineralogical Society of America in 1926. Prominent universities also gladly testified to Professor Groth's preeminent position among the world's leading scientists of his period, the Universities of Cambridge and Geneva having conferred upon him the honorary degree of doctor of science and the University of Prague that of doctor of philosophy.

Professor Groth's activities were so varied and many of his contributions so fundamental and far-reaching that they exercised a profound influence not only upon the development of mineralogy but also upon certain phases of chemistry and physics. Accordingly many of his views on morphotrophy and isomorphism and on chemical crystallography in general have become firmly embodied in chemical literature. Furthermore, the remarkable advances in our knowledge of crystal structure as the result of the development of X-ray analysis, dating from 1912, are in large measure due to Groth's long and enthusiastic advocacy of the point system theory of crystal structure.

Until the very last Professor Groth was keenly interested in American mineralogy. In 1893 he came to the United States and served as a member of the jury of awards for the division of Mines and Minerals of the World's Exposition held in Chicago that year. While in this country he visited some of our leading universities, museums and mining and mineral localities.

In March, 1926, I was privileged to visit Professor Groth twice in his home in Munich. Although he was then in his eighty-third year and nearly blind, he displayed the same enthusiasm for his beloved science and still retained the alertness of mind that had attracted so many students to him and inspired them to achievement. At that time he eagerly inquired about his friends and former students in this country and Canada.

During the 60 years of Groth's activity, crystal-

lography has passed by various stages of development from the list of the more or less descriptive sciences to that of the exact sciences permitting of precise measurements. To this advance Professor Groth and his many students contributed in no small measure.

EDWARD H. KRAUS

UNIVERSITY OF MICHIGAN

SCIENTIFIC EVENTS

THE ELLA SACHS PLOTZ FOUNDATION FOR THE ADVANCEMENT OF SCIENTIFIC INVESTIGATION

DURING the fourth year of the Ella Sachs Plotz Foundation for the Advancement of Scientific Investigation the total number of grants made was twenty-four. Seventeen of the new grants were made to scientists in countries outside of the United States. In the four years of its existence the foundation has made fifty-five grants and investigators have been aided in the United States, Great Britain, France, Germany, Austria, Hungary, Switzerland, Italy, Sweden, Esthonia and Czechoslovakia.

The list of investigators and of the researches which have been aided in the current year is as follows:

Dr. William deB. MacNider, University of North Carolina Medical School, $500 a year for two years for further studies on experimental nephritis.

Dr. W. W. Swanson, University of Minnesota, $500 for an investigation of the osmotic pressure of the plasma proteins in nephritis.

Professor Dr. W. Weichardt, Erlangen, $250 for an investigation on a scientific basis for nonspecific therapy.

Professor Dr. W. Schlayer, Berlin, $250 for a study of the exchange of various substances, including indican and uric acid, from the tissues to the blood.

Dr. Leo Hess, Vienna, $200 for a study of the biology of jaundice.

Dr. Hermann Sternberg, Vienna, $250 for physiological, pharmacological, histological and pathological investigations of the respiratory tract, particularly as concerns hay-fever, asthma and vasomotor rhinitis.

Dr. David Scherf, Vienna, $250 for animal experiments on arrhythmia of the heart.

Dr. Alfred Neumann, Vienna, $280 for a study of the chemical and biological characteristics of the granules of leucocytes.

Dr. Leon Asher, Berne, $250 for a study of the mechanism of the so-called autonomic poisons or drugs.

Professor O. Loewi, Graz, $500 for researches on the mechanism of insulin effect and diabetes.

Professor Dr. Ernst Loewenstein, Vienna, $1,000 for a study of the chemotherapy of infectious diseases, especially of tuberculosis.

Dr. Waldemar Gohs, Vienna, $279 for researches on bacteriophage.

Professor Maurizio Ascoli, Catania, $1,000 for research on the prevention of Malta fever.

Dr. R. Wartenberg, Freiburg, $200 for continuation of encephalographic and myelographic studies.

Dr. Andrea Andreen Svedberg, Stockholm, $550 for research on intermediary metabolism of carbohydrates with special reference to diabetes in dogs and men.

Dr. Robert Chambers, Cornell University Medical School, $750 for a study of the reaction of protoplasm under various physiological, pathological and pharmacological conditions.

Dr. Charles Hruska, Ivanovice, $500 for a study of immunity in anthrax.

Professor Leon Blum, Strasbourg, $1,000 for researches on nephritis and study of the therapeutics resulting from them.

Dr. Erwin Becher, Munich, $300 for investigations in uremia.

Dr. Henry G. Barbour and Dr. R. Glenn Spurling, University of Louisville School of Medicine, $750 for investigations on the prevention of fluid loss from the circulation.

Dr. M. S. Dooley, University of Syracuse, $700 for studies on the direct and indirect effects of drugs, including anesthetics, upon the medullary centers.

Dr. Ernst Weichmann, Cologne, $250 for a study of permeability of cells.

Thorndike Memorial Laboratory, Boston City Hospital, $500 a year in recognition of Dr. Peabody's services.

Dr. James E. Dawson, Edinburgh, $250 a year for two years (made in 1926) for investigation on the pathology of the breast.

THE JOURNAL OF THE SWEDISH FORESTRY SOCIETY

WITH the volume of 1927 *The Journal of the Swedish Forestry Society* (Svenska Skogsvardsföreningens Tidskrift) completes its 25th year. During the last quarter century it has taken a leading place among the technical forestry journals of the world, and the growing interest during the past decade for Swedish forestry has been due no little to the excellence of this publication in presenting the results of research to the world. Recognizing the increasing international interest in forestry, and forest research in particular, the editors announce the following new policy, beginning with the 1927 volume:

1. The journal will be devoted exclusively to reports of scientific forest investigations and papers on forest policy and forest economics. Book reviews will be included, but all notices, etc., of local interest only will be published in the popular bimonthly organ "Skogen" ("The Forest").

2. All articles will be accompanied by full résumés in French, German or English.

3. Papers of more general international interest will be published *in extenso* in one of these languages.

In embarking on this policy, the editors are following the custom of other scientific journals of international appeal. In view of the changes which now