quite different causes. The field of education has been included as a separate field because of its overwhelming magnitude, representing as it does almost one-third of the total social sciences, arts, and humanities composite. The field of social sciences has been here defined to include geography, archeology, anthropology, sociology, economics, statistics (other than mathematical statistics), history, political science, and public administration. In the arts and humanities subgroup have been included business and commerce, international relations, area studies (only one case in 20 years), linguistics, all languages and literature (both English and foreign), speech, writing and journalism, library science, law, home economics, arts, music, architecture, philosophy, religion, and theology. The segregation of any particular field into one or the other of these two general categories—social sciences or humanities—may be rather arbitrary. It does not appear, however, that the shift of any field about which there is disagreement from one to the other of these two categories would profoundly alter the general trend of the data.

New Procedure

The figures and tables here given raise many questions regarding reasons for various trends and changes in trends and regarding educational policies and actions at local, state, and national levels that might bear on these production figures. For answers to most of these questions, more data are required. For example, information on trends in the demand for Ph.D. degrees and on kinds and levels of support available for students in the various fields is needed. More information with respect to the individuals included in the doctorate records is also needed. To meet this latter need, a change was made at the beginning of 1957 in order to secure much more information regarding the educational experience, age, marital status and dependents, and future employment and educational plans of each new recipient of the doctoral degree. With the accumulation of these data, it should be possible to answer many questions raised by the present study. The new data-collection procedure instituted in 1957 should also make it possible to process the data more rapidly and to bring production curves up to date more quickly in the future. Additional papers dealing with significant aspects of doctorate production and related questions will be published from time to time as appropriate. A fourth volume of the "Baccalaureate Origins" series (see *1*) is scheduled to appear in the late spring or early summer of 1958. When it is available, it will extend the data here presented through the calendar year 1956.

References and Notes

1. *The Baccalaureate Origins of Science Doctorates Awarded in the United States 1936–1950* (Office of Scientific Personnel, National Research Council, Washington, D.C., June 1948); *Baccalaureate Origins of Science Doctorates Awarded in the United States 1936–1950*, Office of Scientific Personnel, National Academy of Sciences–National Research Council, Publ. No. 382 (Washington, D.C., 1955); *Baccalaureate Origins of Doctorates in the Arts, Humanities, and Social Sciences Awarded in the United States 1936–1950*, Office of Scientific Personnel, National Academy of Sciences–National Research Council Publ. No. 460 (Washington, D.C., 1956).
2. D. E. Scates, B. C. Murdoch, A. V. Yeomans, *The Production of Doctorates in the Sciences: 1936–1948*. A report of a project sponsored by the Manpower Branch, Human Resources Division, Office of Naval Research (American Council on Education, Washington, D.C., 1951).

C.-G. Rossby, Leader of Modern Meteorology

The sudden death of Carl-Gustav Arvid Rossby at his office in Stockholm, Sweden, on 19 August 1957, at the age of only 59, ended the career of a man who had shaped the development of modern meteorology in America as it rarely has fallen to the lot of one man to do in any scientific field.

Carl Rossby arrived in this country on a Scandinavian-American fellowship in early 1926, a young man of 27, bursting with that keen enthusiasm for his chosen work which has proved so stimulating to great numbers of students and professional colleagues and to many others who have been associated with him. Besides his training in theory at the University of Stockholm and three years of practical experience in forecasting in the Swedish Weather Bureau, Rossby had behind him the benefit of a year's sojourn at the Geophysical Institute in Bergen, during the early period of the creative development of the polar front theory by the Norwegian meteorologists under the inspiration of V. Bjerknes. In addition, he had made an extended visit at the Geophysical Institute in Leipzig.

At the time of Rossby's entry on the American meteorological scene, the science in this country was coasting along on the long-spent momentum gained from such American pioneers in the field as Ferrel, Abbe, and Bigelow. Professional activity in the science was limited to the Weather Bureau (primarily agricultural), the Navy, the Signal Corps of the Army, and the geography departments of a few universities. Professional training in modern meteorology did not exist; a career in the field could be entered upon only through one of the afore-mentioned Government services or as an adjunct to the study of geography and climatology in a few universities. Meanwhile, the first strong stirring of civilian and military aviation was beginning to call for a new deal in American meteorology and weather forecasting. Conditions were ripe for the incendiary spark which was Carl Rossby.

My friendship with Carl began in the Weather Bureau in Washington during 1926, where he was enthusiastically promoting the discussion and synoptic application of the new polar front theory of weather map analysis (which, up to that time, had been practically unheard of in this country), and attempting model tank experiments to prove the practical validity of the theory. His genius for stimulating creative scientific activity was quickly recognized, and he was selected, in 1927, by the Daniel

Guggenheim Foundation for the Promotion of Aeronautics, to be the chairman of its new Committee on Aeronautical Meteorology. In this capacity he organized for Western Air Express of California, during 1927 and 1928, the first airways service in North America, modeled after the airways services on the European airlines in those countries where the development of commercial aviation at that time was far ahead of commercial aviation in this country. In 1928 Rossby was appointed associate professor of meteorology at Massachusetts Institute of Technology, to organize, in the department of aeronautical engineering, with Guggenheim support, the first professional course in modern meteorology in America. I joined him there in February 1929.

In the course of the next 10 years, under Rossby's inspiring leadership, first the course in meteorology and then the department of meteorology at M.I.T. rapidly assumed a leading role in the development of American meteorology —a role whose influence was felt also in the field of oceanography through Rossby's close cooperation with the Woods Hole Oceanographic Institution. During this period Rossby's particular interests ranged from problems of applied thermodynamics and eddy viscosity to the vertical and horizontal structure of wind and water currents and the mechanics of the large-scale flow patterns of the atmosphere and oceans. Most notable, perhaps, was his theory for the movement of the long circumpolar waves in the middle troposphere, depending on the latitudinal variation of the Coriolis parameter.

The two outstanding traits which were probably primarily responsible for Rossby's broad impact on the science of meteorology, during his years at M.I.T. and subsequently, were, first, his exceptional ability to think clearly both in terms of abstract theory and of practical application—that is, to combine dynamic theory and synoptic practice—and, second, his remarkable success in always attracting to himself and in stimulating to creative activity a group of able students and colleagues. It was the students he trained at M.I.T., and subsequently at Chicago, that left the permanent imprint of Rossby's genius on American meteorology.

After 10 years at M.I.T., Carl Rossby found the department of meteorology to be running so smoothly that he felt the need of a change of scene, with new problems to challenge his restless energies. The opportunity for such a change was offered in 1939 by an appointment to the U.S. Weather Bureau as assistant chief for research and education, which he accepted. However, he found that the academic milieu was better suited to his particular genius for self expression, so in 1941 he accepted a professorship at the University of Chicago and later, a distinguished service professorship, which he held until 1951. At Chicago, Rossby repeated his earlier achievement at M.I.T. by building around himself an outstanding scientific department in which theoretical and applied research were most successfully merged, and which continued the Rossby tradition of turning out exceptional leaders in the field of meteorology—no longer, however, without competition from other American universities. His group at Chicago took on an increasingly international flavor. Likewise his research associateship at the Woods Hole Oceanographic Institute, which had first been established in 1932, continued to be fruitful throughout his years at Chicago and right up to the time of his death.

During World War II, as expert consultant in the Office of the Secretary of War, and consultant on weather problems, Office of the Commanding General of the U.S. Army Air Force, Rossby took a leading advisory part in the crash program for training weather forecasters and for developing and applying the latest principles of forecasting to meet the needs of the armed services.

It was during his earlier years at Chicago that Rossby first applied the theoretical concepts which today are perhaps considered to constitute his most important contribution to meteorology. This consists, essentially, of the application of the barotropic vorticity principle to the determination of the large-scale horizontal motions of the atmosphere, to explain hydrodynamically the changing pattern of the general circulation in its larger features. The success of this approach to the forecasting, by numerical computation, of the upper-level flow patterns of the atmosphere is perhaps amazing in view of its strictly two-dimensional character. It is the basis of nearly all practical application of numerical weather prediction today. Pioneer work in this field was performed by Von Neumann's group at the Institute for Advanced Study in Princeton, in close cooperation with Rossby.

Although Rossby's professorship at Chicago was not terminated until 1951, the increasingly international scope of his work and interests brought him back to a professorship at the university of his native Stockholm in 1947. For some years his leadership or stimulating influence was exercised almost on a commuting basis between Stockholm, Chicago, Princeton, and Woods Hole. His last years were devoted increasingly to his International Meteorological Institute in Stockholm, established with the support of the United Nations Educational, Scientific, and Cultural Organization, where he succeeded once more in attracting to himself and leading an international group of young and active scientists. During these last years Rossby's interest in many world problems in meteorology continued strong and active; to the list of these was added at this time atmospheric chemistry.

Carl Rossby's sudden death removes from the world scene probably the strongest and most inspiring leader in the field of meteorology today. His greatness lies, not primarily in his written contributions, but in his amazing success in generating fruitful ideas and in developing and inspiring enthusiasm and creative effort among the many students and younger colleagues who have felt his influence. The place which he has left vacant will not be quickly filled.

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