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HARALD ULRIK SVERDRUP—AN APPRECIATION

As a young man Harald Sverdrup spent seven years on Amundsen's MAUD expedition in the icy wastes of the Arctic Sea. The observations he collected during this period form the basis of fifty published papers and constitute much of our factual knowledge about geophysical phenomena in the Arctic. Nevertheless, those years of voluntary exile would be of relatively small interest to his colleagues were it not for their effect on his personal and scientific qualities, and the insight which they give into his character.

The most significant of the MAUD papers, *Dynamics of Tides on the North Siberian Shelf*, was completed for publication during the last winter in the Arctic, without adequate literature and without the benefit of discussion with colleagues. Such an accomplishment was possible only because Sverdrup had developed, to a remarkable degree, internal harmony and simplicity during the long years on the ice. These gave him an objective confidence in his own thinking and the ability to bring his thoughts to well rounded, definite conclusions. Internal harmony between the diverse aspects of a complex personality, between the explorer and the scholar, the naturalist and the theorist, the teacher and the administrator, is still Sverdrup's outstanding characteristic.

Yet the achievement during the expedition of which Sverdrup is most proud is not scientific: after seven years on the MAUD he parted friends with his shipmates. Such a feat must have required all the humor, kindness, insight and self-discipline which characterize him today. Behind that self-discipline one occasionally glimpses a Norse emotionality, intensity and recklessness.

Sverdrup is impatient with the making of observations unless they are directed toward a definite problem. In all his papers he attempts to wring the last bit of understanding out of each number in a set of data. This frugality must derive partly from the extreme difficulty of taking field observations in the Arctic; partly it reflects his upbringing as a minister's son. Sverdrup's maternal grandfather was a professor of theology, while his paternal grandfather, a minister of the church, had five sons, all of whom became ministers, and three daughters, who married ministers.

Sverdrup was born on November 15, 1888, in Sogndal, Norway, of a family which had long been prominent in the political, religious and

scientific life of the country. His cousin Otto Sverdrup was a well known explorer and captain of Nansen's ship FRAM. After a boyhood spent in various parts of western Norway, Harald Sverdrup graduated with honors from the Gymnasium, then spent one year at the Academy of War where he finished as top man in athletics. In 1908 he enrolled at the University of Oslo with the intention of majoring in a subject called "Physical Oceanography and Astronomy,"—with emphasis on the latter. Three years later he was offered a job as assistant to Professor V. Bjerknes, who, with the support of an annual grant from the Carnegie Institution of Washington, was working on the application of hydrodynamics to problems in meteorology and oceanography.

During the next six years Sverdrup published twenty papers, some dealing with dynamic meteorology, others with rather formalistic properties of scalar and vector fields, and one with the radioactivity of sea water in a Norwegian fjord. The outstanding paper of this period is his doctoral dissertation, *Der Nordatlantische Passat*, which gave the first consistent picture of the dynamic and thermodynamic structure of the North Atlantic trade winds. Most of the work on his dissertation was performed while Sverdrup was distractingly hungry. He had accompanied Professor Bjerknes to Leipzig during the war and food was scarce.

At this time Sverdrup agreed to take charge of the scientific work on Roald Amundsen's North Polar Expedition on the MAUD, with additional duties as navigator and part-time cook. He was 29 years old, had spent the last six years on theoretical work, discussing observations taken by others, and was anxious for a change. The expedition left Norway in July 1918, planning to come home in three or four years. Sverdrup did not return to Norway until December 1925.

Upon his return he succeeded V. Bjerknes in the Chair of Meteorology at the Geophysical Institute in Bergen, Norway. In 1931 he became research professor at the Christian Michelsen Institute. Both appointments were made with the understanding that Sverdrup could devote himself to the analysis of his MAUD observations, an activity which occupied the greater part of his time up to 1933.

Among Sverdrup's published papers dealing with the cruise of the MAUD are a general account of the expedition, a popular book on his personal experiences during eight months spent as a lone white man with the nomadic Chukchi tribe of northeastern Siberia, special papers dealing with meteorological observations, tides, currents, physical properties of sea water, sea ice, marine geology, aurora polaris, gravity magnetism, atmospheric electricity, astronomic observations, and *Das Tier- und Vogelleben im Treibeis*. These reports represent a

general advance in many fields rather than a far reaching penetration along a narrow scientific salient. The geophysical studies reveal consummate skill in the handling of numerical data, together with a rare degree of ability to recognize physical principles underlying the data and to demonstrate these principles quantitatively by an inelegant and simple yet powerful mathematics. The strength of Sverdrup's later work lies in just this approach: the interpretation and synthesis of numerical measurements. His work is not typically characterized by interpretation of qualitative observations, nor by the development of fundamental theory.

While Sverdrup was engaged in the analysis of the MAUD data, he spent two half-year periods at the Department of Terrestrial Magnetism of the Carnegie Institution of Washington and participated in the analysis of oceanographic data collected on the seventh cruise of the CARNEGIE. In 1928 he married Gudrun Bronn Vaumund. In 1931 he was in charge of the scientific work on the Wilkins Ellsworth North Polar Expedition aboard the submarine NAUTILUS.

Sverdrup spent two months in 1934 with the glaciologist H. W. Ahlmann in the high-lying snow fields of Spitzbergen. This work in glaciology, though brief, resulted in the first quantitative study of the heat budget of glaciers and in several other important investigations. In 1936 he accepted, for a limited period, the Directorship of the Scripps Institution of Oceanography of the University of California, and accordingly took leave of absence from the Michelsen Institute for three years. He did not permanently return to Norway until March 1948.

The twelve years Sverdrup spent in California confronted him with many new problems. He had administrative responsibilities, which he discharged with thoughtfulness and distinction; he gained opportunities to teach, an activity which he enjoys and does exceedingly well. When he first came to California he had one or two students at a time; by the end of the war the need for more trained physical oceanographers had become evident, and Sverdrup organized the first systematic course in oceanography. More than two dozen students who have taken these courses will make his influence felt long after he has left the United States.

Sverdrup's effectiveness as a teacher is due only in part to the clarity and simplicity of his presentation; in larger measure it results from his modesty and his interest in human beings. He makes colleagues of his students rather than subordinates. His cultural interests outside of his work reflect the same humanism—he is concerned primarily with those works of man which give insight into the human heart.

Much of Sverdrup's research in La Jolla was directed toward problems dealing with the air-sea boundary, turbulence in the atmosphere and ocean, and upwelling. He also studied the oceanography of the Pacific, particularly the regions off southern California, and organized an expedition into the Gulf of California. His adaptability to new influences led him to become interested in the inter-relationship between marine biology and physical oceanography, and he collaborated on several papers dealing with marine biology. As an outgrowth of this widened range of interests he became senior author of a comprehensive 1100-page volume, *The Oceans, their Physics, Chemistry, and General Biology*; some of the chapters written by him were rewritten and published in a smaller companion volume, *Oceanography for Meteorologists*. In many ways Chapter XV of *The Oceans*, entitled "The Water Masses and Currents of the Oceans," is his outstanding achievement. In this 157-page chapter Sverdrup's "feeling" for data, his common sense interpretation of physical laws, his experience and remarkable memory are brought to bear upon the problem of dealing with all oceans from a common point of view. In this, as in all his work, he shows a canny judgment in selecting a productive approach to the data and in rejecting the vastly greater number of approaches which at first may seem equally promising but which lead only to inconclusive frustration.

At the outbreak of the war Sverdrup was engaged at the University of California Division of War Research on work dealing with underwater sound. Soon he had to devote his entire energy to the expanding military activities at the Scripps Institution. Among the research problems in which he personally played a leading role were the construction of current charts for life rafts, and the development of methods for predicting sea and swell for amphibious operations.

During his earlier years at Scripps, Sverdrup had been elected a member of the National Academy of Sciences and had received the Agassiz medal. At the end of the war new honors were bestowed upon him. He was elected President of the International Association of Oceanography, Vice-President of the American Geophysical Union, President of the International Commission on Polar Meteorology, and he received the LL.D. degree from the University of California. At the height of his success in America he was invited by the Norwegian Government to assume the Directorship of the new Norwegian Polar Institute. He found it very difficult to make a decision. His acceptance was based, in his own words, on his desire "to assist that small nation . . . during a period when it is struggling to get back on its feet after five years of oppression."

Thirty years ago, as a young man, Harald Sverdrup embarked for the Arctic. Now, at the age of sixty, still young in heart and mind, he

is returning to those forbidding Polar regions which have given so many of their secrets to him and have played such a large part in molding his character and his scientific career. The contributors to this volume are but a few of his friends in America who wish him continuing happiness and achievement.

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June 15, 1948.

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