Invited keynote address

Harald Ulrik Sverdup (1888–1957): celebrating the return of the *Maud* 75 years ago

Professor Walter Munk, Scripps Institution of Oceanography
Fram Museum, Bygdøy, Norway
21 September 2000

I came here to pay my respects to a man and to a scientist.

Harald Ulrik Sverdrup left Norway aboard the R/V *Maud* in July 1918 for an estimated three years to conduct a broad range of geophysical measurements in the Arctic Ocean. It was to be more than seven years before the *Maud* came out, to Seattle on 5 October 1925, 75 years ago. The experience gained in these difficult seven years was the basis of Sverdrup's entire subsequent career.

Sverdrup's father and two grandfathers were churchmen. His paternal grandfather had five sons—all of whom became churchmen—and three daughters, who married churchmen. But Sverdrup did not follow the family tradition. After a brief stint in astronomy, Sverdrup accepted one of the renowned Carnegie assistantships to Professor V. Bjerknes, under whose guidance he wrote the doctoral dissertation, *Der Nordatlantische Passat*, in Leipzig during World War I (on a starvation diet, as he later reported).

For three generations the Bjerknes family had pioneered the application of the physics of fluids to the problems of the atmosphere and oceans. V. Bjerknes called it *physikalische hydrodynamik*. This differed from conventional hydrodynamics in two essential ways: it allowed for stratification of the fluid (light over heavy) and rotation (the spin of the Earth). The Bergen School, as it was known, became the undisputed world leader in meteorology. To be a Bjerknes disciple was a unique opportunity; Sverdrup could easily have spent his life doing this. Sverdrup later recalled that "V. Bjerknes's own work centered completely around the further development of the theoretical tools" and he expected his assistants to do likewise.

Portrait of Sverdup taken in connection with the *Maud* Expedition through the North-East Passage, 1918–1925. (Norwegian Polar Institute [NPI] Picture Library.)

Above and left: Sverdrup undertook a wide range of measurements and observations during the North-East Passage Expedition. (NPI Picture Library.)

When in 1917 Amundsen offered Sverdrup the position of Chief Scientist of a north polar expedition, he accepted. At the turn of the century, Fridtjof Nansen had conducted his famous drift aboard the *Fram*. From the measurements taken and a brilliant subsequent analysis, Nansen had concluded that there was no land in the central Arctic, and that the currents entering and leaving the Arctic play a central role in climate. This was not accepted at the time. Amundsen's plans provided the opportunity to test these unpopular notions. To family friends who opposed his plans, Sverdrup wrote, "I was not cut out to be a theoretician. And not the least, if I am able to make a little scientific contribution, then it will be a contribution to Norwegian science." An element of patriotism, and an element of adventure.

Two years later found the *Maud*—having been unable to break into the ice pack—in port at Nome, Alaska, taking on fresh supplies. And one year after that she had to pull into Seattle to repair a broken propeller. Much has been said about the frustrations encountered during this long expedition, and too little about the valuable work that was done: work on 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" ("The animal and bird life on the drift ice"). Sverdrup also collected material during the eight months spent as a lone European man with the nomadic Chukchi people of north-eastern Siberia. During the port calls in Alaska, Amundsen allowed anyone to leave, and some did. Sverdrup admits to being tempted, but decided to fulfil his

The deck of the *Maud*. (NPI Picture Library.)

Sverdrup in *Maud*'s laboratory. (NPI Picture Library.)

Sverdrup and Knut Sundbeck test the compass. (NPI Picture Library.)

obligation, in spite of the immense difficulty in carrying out the observational programme.

Sverdrup later reflected: "These years were really valuable because they brought me in the closest possible contact with nature, a circumstance which to one who works in geophysics cannot be overestimated."

Upon his return, Sverdrup succeeded V. Bjerknes in the Chair of Meteorology in Bergen and became research professor at the Michelsen Institute. By then he had established his identity and his style of conducting research. The two appointments enabled him to devote most of his efforts from 1925 to 1935 towards a general account of the expedition, and to publish fifty papers on the diverse observations. He wrote two-thirds of the *Maud* expedition reports. As the most significant of the *Maud* papers I consider "Dynamics of tides on the North Siberian Shelf". The manuscript was completed on shipboard. Oceanographers will appreciate this feat.

Sverdrup and Marie, the polar bear cub Amundsen tried—unsuccessfully—to tame. (NPI Picture Library.)

But Sverdrup had not had his fill of adventure. He signed up with Nansen in 1929 to take the *Graf Zeppelin* across the pole. A developing economic

depression and Nansen's death ultimately cancelled this undertaking. In 1931 Sverdrup became chief scientist in Sir Hubert Wilkins' ill-fated attempt to explore the Arctic Ocean by submarine. Some successful observations were made, but the *Nautilus* never went under the sea. It has been claimed that the diving equipment was sabotaged by a crew member who feared that if they ever went down they would never again come up. And then in 1934 Sverdrup and Hans Ahlmann climbed a 1000 metre high plateau in Svalbard to carry out a programme of atmospheric boundary layer observations.

Of the four ventures, only the last one came even close to meeting the publicly announced goals. It is a great tribute to Sverdrup that by his hard work and com-

Right: Sverdrup on the submarine *Nautilus,* 1931. Below: the Sverdrup family at the dock in Bergen. (NPI Picture Library.)

mitment to the observational programme he could turn these efforts into scientific successes. He had married Gudrun Vaumund, *née* Bronn, in 1928, and her steadfast support was a source of great strength to him.

In 1936 Sverdrup signed up for three years as Director of the Scripps Institution of Oceanography in La Jolla, California. War broke out, and it was to be 12 years before he returned to Norway. In La Jolla he found an institute without sea-going facilities and sea-going oceanographers. After three years he and Gudrun were homesick for Norway and tempted to return (as Sverdrup confided to Ahlmann)—but, as with Amundsen on the *Maud*, he felt the obligation to stay. When he returned to Norway in 1948 he left behind a thriving institution.

I became a student of Sverdrup in 1939. Gudrun Sverdrup was glad to have a tennis partner, and when she won I was asked to join Harald, Gudrun and Anna for *fiskepudding* (fish pudding). After seven years he asked me to call him by his first name, and I will refer to "Harald" from now on. He was my teacher, my friend and my hero. I owe to him my career.

Early in the war we learned of plans of an allied landing in north-west Africa, the first allied initiative after a long series of Axis successes. Our landing craft (LCVPs) were not capable of navigating a two-metre surf, yet the expected winter wave conditions at the landing site exceed two metres on two out of three days. Harald and I set out to develop a method of predicting wave conditions, and in fact the landings took place on two relatively calm days. The method was used on all subsequent amphibious landings in the Pacific Theatre of war, and eventually on the Normandy beaches. Some lives were saved.

During his tenure at Scripps, Harald devoted much effort to writing (with Johnson and Fleming) *The oceans: their physics, chemistry and general biology.* This was to be the last comprehensive work covering all aspects of oceanography between two covers,

Original flyer announcing *The oceans.* (NPI Library.)

Prentice-Hall, Inc.

EXECUTIVE OFFICES

70 Fifth Avenue, New York

March 2, 1943

Dr. H. U. Sverdrup
Scripps Institute of Oceanography
La Jolla, California

Dear Doctor Sverdrup:

I think you will be very interested to hear of recent developments with regard to the foreign sale of your book THE OCEANS.

Each book that we feel even borders on the technical side must be sent to the Board of Economic Warfare for review. After their analysts have checked the contents the book is given a code number. This code number guides us in the exportation of the particular title. After much debate between the New York Branch of this Board and the head office in Washington, we were informed that THE OCEANS was not to be sent anywhere outside the continental United States. The following is an excerpt from a letter received by me from the Washington Office of Censorship:

".....THE OCEANS, unfortunately, is a different story. When you first inquired about this book, I queried the Washington Office of the Board of Economic Warfare, which overruled the decision of the branch in New York. After I had written you, the Washington Board of Economic Warfare informed me that it had changed its mind, and that the book should not be exported to unrestricted destinations. I then submitted the book to the Navy Department, which has just phoned me that it would be of great aid to the enemy should it fall into his hands. Therefore, in spite of my previous release of this book, I must now request you to restrict its export completely....."

They tell us that the book is so authoritative and up-to-the-minute, we must keep it definitely within the country. As you suggested sometime ago, I sent a copy of THE OCEANS to Dr. J. N. Carruthers at the Admiralty in London, along with a letter requesting his reaction to the book and his views on a possible English market. I have not as yet hear from him. I questioned the Board of Economic Warfare about the possibility of selling publication rights in England. In that way the English government through a procedure much like ours would tell the English Publisher just where he could export the book. I am awaiting their word on this, and, of course, will keep you posted.

Sincerely,

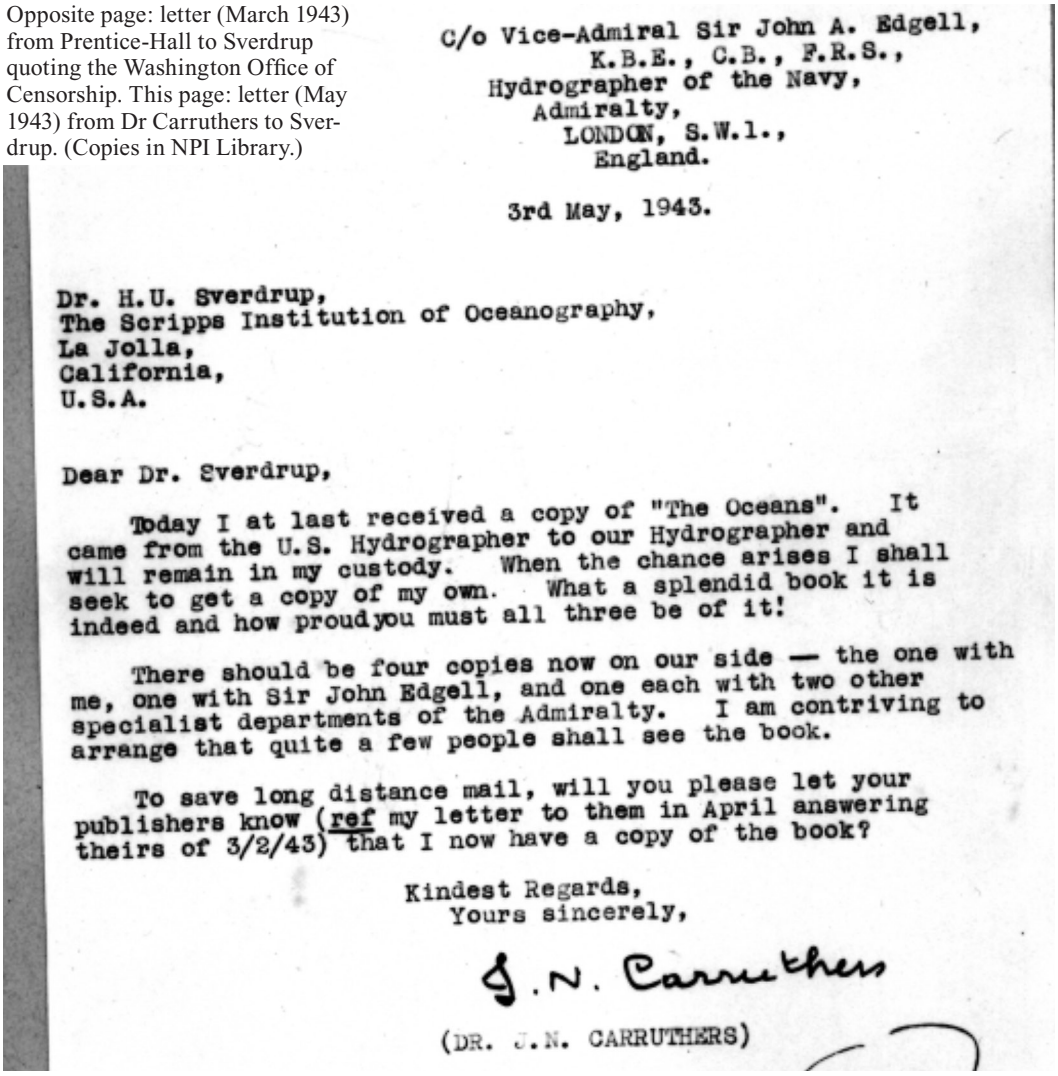
G. A. Morriss

G. A. Morriss
Foreign Department

and reflects Harald's broad exposure during his seven years in the Arctic. It is generally referred to as "the Bible"—the closest Harald came to follow the Sverdrup family church tradition. In 1942 he wrote to Ahlmann: "This textbook must be finished now, so I am working like a horse. I hope Gudrun and I both survive…But the book will be fairly good…It is a book of nearly 1100 pages, which I hope will be a useful reference for some years to come."

When published in 1942 it was considered of such military value that Washington forbade its distribution abroad, and it did not become generally available until VE day. (In fact earlier copies had been hand-carried to England by Sir George Deacon and the hydrographer Vice-Admiral Sir John Edgell, and reviewed by J. N. Carruthers.) In 1992, "the Bible" was reviewed again as if it had just been published (*Oceanogra-*

Opposite page: letter (March 1943) from Prentice-Hall to Sverdrup quoting the Washington Office of Censorship. This page: letter (May 1943) from Dr Carruthers to Sverdrup. (Copies in NPI Library.)



C/o Vice-Admiral Sir John A. Edgell,
K.B.E., C.B., F.R.S.,
Hydrographer of the Navy,
Admiralty,
LONDON, S.W.1.,
England.

3rd May, 1943.

Dr. H.U. Sverdrup,
The Scripps Institution of Oceanography,
La Jolla,
California,
U.S.A.

Dear Dr. Sverdrup,

Today I at last received a copy of "The Oceans". It came from the U.S. Hydrographer to our Hydrographer and will remain in my custody. When the chance arises I shall seek to get a copy of my own. What a splendid book it is indeed and how proudyou must all three be of it!

There should be four copies now on our side — the one with me, one with Sir John Edgell, and one each with two other specialist departments of the Admiralty. I am contriving to arrange that quite a few people shall see the book.

To save long distance mail, will you please let your publishers know (ref my letter to them in April answering theirs of 3/2/43) that I now have a copy of the book?

Kindest Regards,
Yours sincerely,

J. N. Carruthers

(DR. J.N. CARRUTHERS)

phy 5[3]). Chapter XV, on "The water masses and currents of the oceans", is a much-quoted reference today.

One of my fondest memories is when Harald would come to my door in Scripps Hall and say quietly, "Come and listen." In the middle of his office a big table was piled high with books and papers in four stacks corresponding to the Atlantic, Pacific and Indian Ocean basins, and the Southern Ocean. Harald would walk slowly around the table, pick up selected papers and speak out loud on what he thought were the essential features. This he would do many times. When he was ready he would dictate a section of the chapter without referring to any notes. To Ahlmann he wrote, "I am best suited to work with systematic observations and to make some sense of them." That was indeed his strength; he would look at a problem from all sides and then come to a *reasonable*—one of his favourite words—decision.

Harald once took me to San Francisco, where he had not been since the *Maud* days. He was proud of his good memory and good sense of direction. We took the cablecar towards Fisherman's Wharf and he said, "Oh yes, three more blocks and then we turn left." Three more blocks and we turned sharp right. Harald was stunned for a few moments. Then he said, "Oh yes, a very *reasonable* direction."

Harald used 10^6 m^3s^{-1} as a convenient unit of volume transport, and this Sverdrup unit has been widely adopted (the Gulf Stream Transport is about 30 Sv).

Very late in his California days, Harald wrote a major paper in which he interpreted the general ocean circulation in terms of the torque balance (rather than the force balance). This avoids an awkward singularity at the equator, and is now generally referred to as "Sverdrup dynamics". Yet he had written to Ahlmann, "…my strength lies in analyzing data and using the tiny bit of theory I master."

In his book, Robert Huntford quotes Sverdrup back in the early *Maud* days:

> If in conversation Amundsen would make a statement which to the best of my knowledge was incorrect, I would draw his attention to [the] mistake…One day…Amundsen flared up: "Why do you always contradict...me? Because you have a degree you seem to think that you have all the knowledge and experience…you are making me appear ridiculous…You will have to leave the expedition..." For a week he did not speak to me…[Then] I went to him. I have never intended to hurt you…in the future…I shall keep my opinions to myself until asked for...We shook hands. [1987:161]

Seven years later, after the expedition had come to an end—75 years ago this month—Harald wrote Amundsen to thank him, "not just because you provided me with a wonderful opportunity to work with things that interest me, but even more because you helped make a man of me."

Acknowledgements.—I am greatly indebted to Deborah Day for material used in this talk.

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