

THE EXPEDITIONS OF
HARALD ULRIK SVERDRUP:
CONTEXTS FOR SHAPING
AN
OCEAN SCIENCE

by Robert Marc Friedman



Published by Scripps Institution of Oceanography (University of California San Diego), through the auspices of the William E. and Mary B. Ritter Memorial Fellowship.

The Fellowship was established in 1986 by Robert L. and Bettie P. Cody. Mr. Cody is a grandnephew of Mary Bennett Ritter. The Fellowship biennially provides financial support to an internationally recognized scholar in the history of marine science. The recipient spends time at Scripps Institution of Oceanography to interact with scientists and historians, and present lectures, one of which is open to the public. This was the second lecture of the Fellowship, presented by Robert Marc Friedman on October 29, 1992.

Series Editor: Elizabeth N. Shor

Layout by Georgia Ratcliffe

Photos from Norwegian Polar Institute unless otherwise credited.

THE EXPEDITIONS OF
HARALD ULRIK SVERDRUP:
CONTEXTS FOR SHAPING
AN
OCEAN SCIENCE

by Robert Marc Friedman

November 1994

Scripps Institution of Oceanography
University of California, San Diego

The Expeditions of Harald Ulrik Sverdrup: Contexts for Shaping an Ocean Science

Who was Harald Ulrik Sverdrup? And how might we keep his legacy alive? Sverdrup is recognized as one of the leading oceanographers of this century and under whose guidance from 1936 through 1948 Scripps Institution of Oceanography emerged as a world leader in this field. In Scripps mythology he was a man who, in his fifties, could stand on his head or do a backward flip at a dinner party. He, with the help of two colleagues, wrote the so-called Bible of oceanography—"4 pounds and all muscle"—which even today, fifty years after its publication, remains a fundamental text. At Scripps Sverdrup is remembered as an oceanographer. Elsewhere he is also thought of as a meteorologist, geophysicist, polar researcher, and explorer. Those who worked with him admired him and grew fond of him. When he died he left only friends.¹

Sverdrup's career sheds light on the emergence of oceanography as a science and professional discipline. Today young women and men can consider studying oceanography at a university and following a defined career path. But, for most of Sverdrup's career, much of what we recognize as professional oceanography did not exist. Sverdrup's ability to define oceanographic research problems and to carve a professional niche for himself was shaped by larger forces in society. Oceanography entailed "Big Science" even during the decades prior to World War II. Changing political, economic, and cultural circumstances provided opportunities and constraints for Sverdrup to pursue an ocean science. Neither the present contours of the science nor its relations with society are inevitable or natural. Through Sverdrup's career we can glimpse some of the social processes as well as human drama that entered into constructing the complex discipline known as oceanography.

Harald Ulrik Sverdrup was born in 1888 in the west Norwegian town of Sogndal.² His father was a teacher, but more significantly he was also a minister of considerable Lutheran piety. Young Harald's world was largely circumscribed by religion—virtually all his

uncles were clergymen. To serve communities in need of a religious leader, his father moved the family to small villages on the stormy west coast. Sverdrup was taught by a governess until the age of 14. When he finally was sent off to school in Stavanger, he was met with the usual problems that might confront a frail provincial boy coming to the city. He was teased and bullied; the students gave him a nickname based on a mischievous toying with his name: from Sver-drup or large-drup, the diminutive Harald was called Little-[Lille-] drup. At home he came across a Danish popular science series. He read about Darwin's theory of evolution; he was distraught over discrepancies with the Bible. But it was astronomy that fascinated him most. Because he had no idea that astronomy could be studied as a subject and because he seemed condemned to follow family tradition into theology, he chose in secondary school the classical curriculum based on Latin and Greek. He graduated with an A plus average (Fig. 1). He then enrolled in 1906 at the Royal Frederik's University (now University of Oslo) and while taking the obligatory first year philosophy courses discovered that astronomy existed as a university subject. To be able to study science and to fulfill obligatory military service, he enrolled in the Norwegian war academy. Here he could take prerequisite mathematics and science courses; equally important, as it later turned out, he could train his body. Sverdrup graduated with top honors in physical fitness and then returned to the university.

How did this hardworking, exceedingly intelligent, and independent-minded young man come into contact with geophysical science? Let us imagine two concurrent scenes. First, we see a small lecture room in the cellar of an old university building; street cars rumble by, momentarily drowning out the enthusiastic lecturer. It is 1908, Norway has been an independent nation for three years and Norwegians are determined to show the so-called civilized world that they too can contribute to the advance of culture. The lecturer, Vilhelm Bjerknes, is presenting to a handful of students—including Sverdrup—his visionary project to establish an exact physics of atmospheric and oceanic motions.³ His enthusiasm is contagious. Let's cut to another scene, not too far away: a group of

gentlemen smoking cigars in a fashionable drawing room. They are discussing Roald Amundsen's lecture at the Royal Geographical Society. Amundsen proposed repeating Fridtjof Nansen's legendary expedition across the polar sea. Amundsen also has a vision: that of drifting with the arctic ice, perhaps right across the north pole itself.⁴ For Sverdrup these two visions proved momentous.

Bjerknes' lectures prompted Sverdrup to abandon astronomy for geophysical science. In 1912 he began his first expedition, of sorts—that toward becoming a researcher and, more geographically, moving to the University of Leipzig, where Bjerknes had been called to direct a new geophysical institution. Sverdrup followed as a research assistant and doctoral student. He joined Bjerknes' massive project by working on the dynamics of geophysical motions, and in particular by factoring in the effects of friction, turbulence, and energy balance. He authored or coauthored 20 articles during his five years in Leipzig. His doctoral dissertation, completed in 1917, on the structure, dynamics, and thermodynamics of the north Atlantic trade wind became a classic. Sverdrup's studies with Bjerknes provided a general set of



Figure 1.
Harald Ulrik
Sverdrup, 1906.

research interests and analytic skills that later informed much of his scientific production. On the one hand he focussed on general large-scale circulation in the atmosphere and oceans, and on the other hand he sought to elucidate the micro- and meso-scale factors mediating energy and heat transfer that drive hemispheric circulation.

Sverdrup was off to a bright start in research. He was also astute enough to be assessing the question that most doctoral students ask: what on earth am I going to do when I'm finished? No job was waiting for him. When approached by Roald Amundsen to join his much-delayed expedition as scientific leader, Sverdrup responded affirmatively. Now, why would a most promising young scientist agree to spend what was projected to be four or more years drifting in the arctic ice? We might speculate. But to family friends who opposed his plans he wrote the following (Fig. 2):



Figure 2.
Sverdrup in
1916.

*For me this is to be presented with a large, interesting, and also honorable job, which if all goes well, can make the basis for my future. . . . And not the least, if I am now able to make a little scientific contribution, then it will be a contribution to Norwegian science. If I get home safely, then I will be connected to Norway, which is the grandest fatherland anyone can find.*⁵

To colleagues he noted that he had worked almost exclusively with theoretical problems. In his characteristic overly modest style, he confessed that he "was not cut out to be a theoretician"; he sought hands-on practical experience and direct contact with nature. Adventure was also an attraction.⁶ After receiving some training in practical oceanographic methods from Bjørn Helland-Hansen, Sverdrup sailed on the *Maud* in July 1918 toward the arctic, thus beginning a unique expedition, which largely defined his future career.⁷

The *Maud* expedition should be recognized as part of Scandinavian polar interests. In the 1880s, following the Swedish triumph by Adolf Nordensköld of sailing through the northeast passage, a young Norwegian zoologist Fridtjof Nansen decided to show the world



Figure 3.
Fridtjof Nansen.

what his nation could achieve (Fig. 3). First he crossed Greenland on skis, carrying sledges up over 9,000-ft. high glaciers in temperatures below -40 . The world's attention turned to this man. Next he proposed building a ship with a reinforced and rounded bottom to resist the pressure of ice. He sailed north of Siberia and intentionally locked the ship in the pack-ice to allow it to drift with the ice across the central arctic and emerge north of Spitsbergen. Around the world explorers and geographical experts scorned Nansen's plan, which they roundly claimed would result in catastrophe. Few, if any, believed that a ship could withstand the pressure of the churning ice field; moreover, many experts believed that the central arctic entailed a large, as yet undiscovered, land mass. When after having disappeared without a trace for three years, Nansen and his ship returned in 1896, having attained the furthest northerly human presence to date, he became an international celebrity. He also became an oceanographer, as he began analyzing the numerous data collected and, subsequently, devising new instruments to improve the precision of this fledgling science. Nansen concluded that no land exists in the central arctic, that the polar sea is extremely deep, and that the currents entering and leaving the arctic play a fundamental role in hemispheric ocean circulation. Again, few researchers accepted these claims. He therefore welcomed Amundsen's plan to repeat the drift,⁸ but now with vastly improved instrumentation.



Figure 4.
Roald Amundsen.

Amundsen (Fig. 4) planned to sail the *Maud* through the northeast passage and enter the pack-ice north of the Bering Strait before winter. During the ensuing three years the *Maud* was to be a floating laboratory collecting measurements of terrestrial magnetism, atmospheric electricity, weather conditions near the surface and aloft, oceanic conditions, northern lights, and virtually anything else that might be of scientific and cultural interest. The crew of nine shared the daily practical duties and most attempted to assist in the scientific program. As the *Maud* proceeded eastward along the Siberian coast they discovered that the ice floes were much more extensive than previously encountered by explorers (Figs. 5, 6). By early September they were locked in the coastal ice near Cape Chelyuskin. They spent the winter making improvements on the ship and on their scientific equipment (Fig. 7). The initial disappointment of getting delayed for at least one year



Figure 5.
The *Maud*
navigating ice
fields.



Figure 6.
The *Maud*
expedition's
progress,
1918-1920.

was compounded by a series of accidents that befell Captain Amundsen. First, one of the expedition's large dogs knocked him overboard onto the ice, resulting in a badly broken arm; then while investigating some strange sounds on the ice in a dense fog he encountered a polar bear and in the ensuing race received a swipe from the bear's paw which knocked him down and removed a bit of his buttocks (Fig. 8). Sometime later, he suffered a heart attack. All in all, it was not a good start for a long expedition.

In the summer the ice scarcely broke along the coast. The scientists used explosives to continue pressing eastward, but reached only as far as Ayon Island before the winter set in. Here they encountered a



Figure 7.
Sverdrup
adjusting a
theodolite, 1919.



Figure 8.
Revenge!
Sverdrup to the
left of the polar
bear.

tribe of natives about whom virtually nothing was known. The Chukchi, being reindeer nomads, spent the summer on the coast and the winter inland. Amundsen suggested that Sverdrup spend the winter with them making ethnographic studies of their language, beliefs, and customs. So for the next eight months Sverdrup lived among the Chukchis and adapted, as far as possible, their life style. He lived, as they did, exclusively on reindeer—eating its meat, fat, muscle, organs, blood, as well as the contents of the stomach—and not much else. He learned their language in which many words are pronounced quite differently when spoken by a man or a woman. Because at first he was left in camp with the women, he mistakenly learned the female variant, much to the amusement of the men. He nevertheless made friends, and even managed to make geophysical and astronomical observations in the Siberian interior.⁹

In the summer of 1920 the ship broke out of the ice, but Amundsen took it to Nome, Alaska for fresh supplies. There he allowed those members of the crew who had had enough to return home. Two years had gone by and at best three more years would be required for the drift across the polar sea. Most of the men abandoned the ship. Sverdrup was despondent. When he was confronted with the choice of calling it quits or continuing, we find a personal trait that repeatedly came to the fore during the rest of his career: a very keen sense of duty—a sense of obligation toward those who were counting on him. He had given his word; as long as he was physically healthy, he had no right to abandon his position (Fig. 9).

Back to the *Maud*. Amundsen tried to reach the pack ice that same summer, now with a reduced crew. But again, unusually thick ice stopped them as they reached the Siberian coast. There was another winter of waiting; during this time Sverdrup spent time with a different tribe, the non-nomadic coastal Chukchis. When, together with the first mate, in one of the very warm airtight Chukchi tents, saturated with fetid odors of boiled reindeer and unwashed bodies, Sverdrup pulled off his underwear to compete as to who had more lice running about, the first mate roared with amusement, "Your mother should only see you now,

Sverdrup!"¹⁰ Using dog sleds they trudged through raging blizzards to complete a magnetic survey of the area.

Summer of 1921: the explorers discovered that the *Maud's* propeller had broken. Now, they had to sail to Seattle for repairs. Through the stormy north Pacific, Sverdrup showed great skill and courage as he helped the vastly understaffed crew navigate southward. Back in civilization, Sverdrup learned about the revolution in meteorology that Bjerknes and his young assistants had effected during the past three years. When Bjerknes moved to Bergen in 1917 and later considered establishing an experimental weather forecasting service, he had hoped that Sverdrup could lead this endeavor. In his place others paved the way and in so doing used the opportunities to overhaul meteorology. Sverdrup was filled with regret. Greatly agitated, he admitted that had he had an inkling as to what was to happen on the expedition, he would never have joined.¹¹ But he might as well try making the best of the situation. While waiting for repairs during the winter, Sverdrup arranged to stay in Washington, D.C. at the Carnegie Institution's Department of Terrestrial Magnetism. Here he analyzed the preliminary magnetic observations, borrowed considerably better instruments, and established a rapport with the staff that would later prove significant for many cooperative ventures.



Figure 9.
Sverdrup,
about 1919.

Back to the *Maud*, back to the polar sea.¹² But this time Amundsen left the ship to attempt flying over the North Pole from Alaska. On August 8, 1922 the *Maud* finally entered the pack-ice and finally began drifting to the west-northwest. The expedition had at last truly begun. They had a ship full of instruments, as well as kites, captive balloons, and a small airplane. Sverdrup could exploit the rich possibilities yet further, now that he had obtained a scientific assistant, the Swede Finn Malmgren. In addition Sverdrup could count on the services of Odd Dahl, who although recruited primarily to pilot and service *Maud's* airplane, could also apply his brilliant talents for instrument-making to assist the scientific program. They also had canned provisions for up to seven years, coffee for 12 years. Supplies of fresh meat and fat would be dependent on shooting seals, walrus, and polar bears (Figs. 10, 11).

Based on a strict regime of discipline and innovative instrumental practices, Sverdrup set up a comprehensive geophysical observatory on the drifting ice. He overcame the seemingly insurmountable difficulties of making reliable precision measurements in a most hostile environment. Frost instantly formed on the eye-pieces of measuring instruments while needles had an unfortunate tendency to freeze in place; sounding balloons had to be made visible in the weeks of perpetual darkness; means had to be devised for launching instrument-carrying kites and then bringing them down from several thousand feet in stiff breezes at sub-zero temperatures; holes in the ice for



Figure 10.
The hunt for
fresh meat:
walrus.



Figure 11.
The hunt for
fresh meat: seal.

oceanographic instruments had to be re-cut every several hours (Fig. 12).

The adventures were many: the ice suddenly opening on the side of the ship, carrying off instruments and dogs on a voyage of their own (Fig. 13); or giant mounds of ice being forced upward by the shifting currents and threatening to capsize the ship. The scientists witnessed extraordinary blizzards, skies aflame with northern lights, and the relentless monotony of the summer fog above which the sun never set. All the while three sledges with provisions for 40 days always stood ready for quick escape (Fig. 14). At any time churning waves of ice could capsize the ship, possibly in the middle of a winter night when gale winds were whistling through the masts and thick snow was lashing their eyes in sub-zero temperatures.

But what of their drift across the polar sea (Fig. 15)? In September 1923 they were buoyed by the prospect of crossing on a path north of Nansen's, but



Figure 12.
An Ekman
current meter
fitted for arctic
duty.



Figure 13.
In search of
drifting dogs and
instruments.



Figure 14.
Maud and
provisions for
emergency
escape.



Figure 15.
The drift of the
Maud, 1921-
1925.

then strong winds began to blow from the north. Day after day they helplessly watched as the wind blew the ice and the entrapped *Maud* further and further to the south. Despair (Fig. 16)—great despair. Now their path would likely be longer and less interesting scientifically. They avoided descending into extreme depression and personal antagonism through strict work discipline and keeping contact to a minimum. No longer did they finish Saturday evening toddy drinking with a gramophone sing-along of “It’s a long way to Tipperary.” Finally in February 1924 Amundsen sent a message by wireless to abandon the attempt to cross the arctic and to try returning home. Try to return. They were locked in the ice; if during the summer the ice did not open sufficiently toward the south to allow an escape, they could remain adrift for yet three or four more years. As it happened they did escape, and eventually proceeded east along the coast. But then again, unusual ice conditions blocked them from reaching the Bering Strait. Another long winter of waiting. Sverdrup began analyzing data and began writing what later was published as “Dynamics of Tides on the North Siberian Shelf,” in which he proves, among other important findings, that no major land mass exists in the central arctic.¹³ Finally, on October 5, 1925 the *Maud* arrived in Seattle and the expedition came to an end. Sverdrup later noted on many occasions that the greatest achievement of the voyage was that the men departed as friends. He thanked Amundsen: “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.”¹⁴



Figure 16.
On the *Maud*:
monotony in the
arctic.

To the general public Amundsen's expedition was nothing less than a complete fiasco. One opportunity did exist to save its honor and for Sverdrup to justify the many years on the ice, which was to convert the enormous amount of observation material into scientific reports.¹⁵ But how? This was a task requiring many years of intensive work, as well as considerable publishing subsidies. After all, around the world but a handful of experts existed who might make use of this material. Bjerknes wrote to Sverdrup that the economic situation could scarcely be worse, but he and oceanographer Bjørn Helland-Hansen would do everything possible to assist him.¹⁶ They and others felt that Sverdrup had sacrificed much for the glory of Norway. The country owed him. Fortunately, Helland-Hansen and Bjerknes had, during the years of the expedition, established in Bergen a major Geophysical Institution. Bjerknes, as already noted, had effected a revolution in meteorology; now he wanted to return to Oslo. Helland-Hansen was making major strides in developing physical and dynamic oceanography. His small ocean-going research vessel, *Armauer Hansen*, allowed relatively inexpensive cruises into the Atlantic and North Sea for systematic data collection. Now, to reward Sverdrup and to maintain Bergen's prominence in geophysics, they appealed to the government to maintain the vacated professorship in theoretical meteorology after Bjerknes' departure. Sverdrup could then use this position primarily for analyzing the *Maud* observations and editing the expedition reports.¹⁷

Although Sverdrup assumed the role of a professor, he was not finished with polar dreams (Fig. 17). The *Maud* had never left the continental shelf; the deep waters of the polar sea and the extent of the polar sea remained unexplored. In 1926 he learned of Nansen's plans to explore the arctic with a giant Zeppelin airship.¹⁸ Amundsen and Ellsworth had just taken a small airship across the north pole (Fig. 18); Sverdrup regretted that he could not join them.¹⁹ Now, Nansen and a number of European, especially German, polar researchers considered the possibility of using a huge Zeppelin airship with which large teams of scientists and tons of supplies could be transported to inaccessible parts of the arctic. Sverdrup announced his interest in participating to Nansen, who in turn

noted that nobody would be better qualified to join him than Sverdrup. But he wondered, hadn't Sverdrup had his fill of drifting ice for now?²⁰ Apparently not.

When in 1928 the *Graf Zeppelin* successfully flew around the world, they realized that here was an airship capable of serious polar work. Nansen, Sverdrup, and others in this international endeavor began drawing plans for a trial voyage during the summer of 1929 or 1930.²¹ Delay followed delay. Plans for meeting the financial obligations were seriously undermined in 1930 following Nansen's death, the onset of world economic depression, and the tragic crash of the British airship *R101*.²² Sverdrup was asked to lead the entire massive enterprise, but declined.²³ When finally a trial voyage was secured for the summer of 1931, Sverdrup again had to decline. He had already made plans to partake in another expedition: Hubert Wilkins' attempt to use a reconverted American World War I submarine, christened *Nautilus* after Jules Verne's tale, to cross the polar sea under the ice.²⁴

Sverdrup understood that few opportunities remained for extensive scientific expeditions in the depressed economic situation. Media financing of sensational endeavors remained one of the only sources of funding. Hubert Wilkins had already shown a flare for sensationalism when he had flown across the arctic; now he caught the public's eye and the Hearst newspaper empire's purse by planning to reach the north pole by submarine. Wilkins also genuinely wanted the expedition to support scientific research; he asked Sverdrup to be scientific leader and promised ample support for equipment. Sverdrup enthusiastically accepted.²⁵



Figure 17.
Professor Harald
Ulrik Sverdrup in
Bergen.

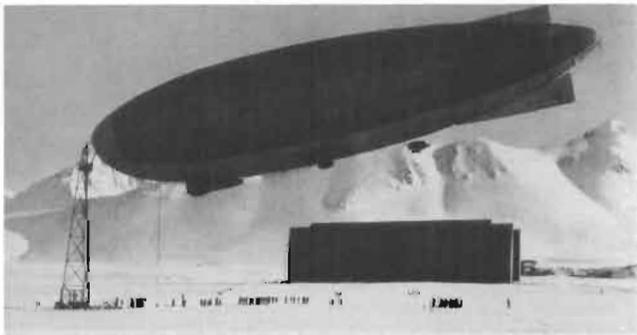


Figure 18.
Spitsbergen:
jumping-off
point for airship
voyages across
the arctic.

Most of the public, including most of Sverdrup's colleagues, considered Wilkins' plans to be nothing less than scatterbrained and immensely dangerous. Walfrid Ekman begged Sverdrup not to go; oceanography, he implored, could not afford to lose him; moreover since 1928 Sverdrup had a family, which he ought take into account.²⁶ Sverdrup commented to Ekman that "it's very enticing to have the possibility to pursue the oceanographic work that we didn't get a chance to accomplish with 'Maud', accomplish it in 6-7 summer weeks rather than in the course of several years."²⁷ Sverdrup began planning the many details of the scientific program with Wilkins, while in the background—much to his dismay—media hype amplified the sensationalism with headlines such as: Lady Wilkins, a former actress, planning to join her husband at the North Pole by airplane, or, Expedition to seek Atlantis under the Arctic ice.²⁸

Well, how would this adventure turn out?²⁹ Mechanical problems on the trip from Brooklyn to Norway resulted in delays and worries. Sverdrup waited restlessly in Bergen. July: still no *Nautilus*. Finally, Wilkins and the *Nautilus* arrived in Bergen (Fig. 19).



Figure 19.
The *Nautilus* in
Bergen.

After installing the scientific equipment and after waving goodbye (Fig. 20), they headed north to Spitsbergen, toward the arctic ice pack—and adventure. Sverdrup's excellent physical condition and self-discipline helped immensely. The quarters were extraordinarily cramped (Fig. 21). The submarine rolled and rocked when cruising on the surface, the smell of diesel oil pervaded, smoke frequently found its way into the narrow corridor, the drinking water was discolored while also tasting and smelling wretched, water for washing was oily, and perhaps worst of all, far in the rear, accessible only by climbing through endless crates of supplies as the ship mercilessly rocked and swayed, there in the back, was the ship's only toilet!

Once the *Nautilus* entered the waters north of Spitsbergen, Sverdrup began a successful program of making observations from a pressurized diving chamber. They reached 82 degrees north and climbed onto the ice for water, air, and magnetic observations (Figs. 22, 23). Then, finally, Wilkins gave the signal to submerge under the ice. But, the diving rudder didn't respond. Into a diving suit and into the freezing water, a crew member investigated. What he found did not make Wilkins happy. The diving rudder had disappeared. Either it had fallen off or had been sabotaged by one of the crew. In despair Wilkins decided to submerge the front of the boat under the ice to test equipment as well as to make the first under-ice photographs and light



Figure 20.
Off to arctic
adventure!



Figure 21.
Sverdrup's living
quarters on the
Nautilus.

Figure 22.
At last, fresh air
and freedom of
movement!



Figure 23.
Scientific practice
at 82 degrees
north: outdoor,
terrestrial
magnetic
measurements.



measurements. Wilkins then agreed to zig-zag back to Spitsbergen, allowing Sverdrup to continue the oceanographic research (Fig. 24).

Again, another major expedition ended in public ridicule. Sverdrup still believed that submarines were ideal for systematic study of the arctic; the *Nautilus* was just the wrong ship for that purpose.³⁰ Using the extensive observations made during the short cruise, Sverdrup arrived at a number of important findings, which included a convincing depiction of the branching of the Gulf Stream up into the polar sea.³¹

Back in Bergen Sverdrup was finally finishing the last of the *Maud* observations. He became restless (Fig. 25); he needed new data to analyze. Work from the *Maud* expedition focused his attention on problems of heat and energy transfer between the atmosphere and the ocean, especially the role of turbulence.³²



Figure 24.
Scientific practice at 82 degrees north: indoor, Sverdrup titrating seawater.

Laboratory and theoretical studies provided some clues; Sverdrup wanted direct measurements. Although he began devising instruments for making measurements at the ocean surface, he recognized that a better approach entailed first studying in excruciating detail the heat budget above and below a layer of smooth snow. Sverdrup and his Swedish friend, glaciologist Hans W:son Ahlmann, proposed spending a summer camped on top of a glacier high in the mountains of Spitsbergen, where conditions should be ideal for a number of experiments. In an otherwise bleak time for obtaining funds, they capitalized on Norwegian arctic territorial disputes. Legitimizing territorial claims came through maintaining an active presence, such as through scientific work, surveying, and commercial activities. Through the assistance of Prime Minister Johan Ludwig Mowinckel, they received a relatively substantial grant through the Ministry of Commerce, which had jurisdiction over Svalbard matters.³³



Figure 25.
Thinking polar dreams?

Sverdrup arranged transport on a freighter up to Svalbard for himself, Ahlmann, and two assistants.³⁴ The district governor helped them get dropped off on the desolate northwest coast where the sea meets the glaciers. Then with the help of 17 Greenland huskies, they trekked with over a ton of equipment and provisions up 3,000 feet and 20 miles inland to the Isachsen Plateau (Fig. 26). Although a relatively minor expedition, all contingencies had to be covered. Sverdrup had again called upon his virtually unique organizational abilities for planning expeditions. On the list of essential provisions, Sverdrup drew neat columns of supplies and quantities, such as cans of fish balls, crackers, and dried reindeer meat, but also, scrawled across the top of the page, in what appears to be a sudden last-minute revelation—circled to ensure not to be forgotten again—the all important, yes—toilet paper!

And once again extraordinary discipline permitted them to obtain exceedingly valuable data. Every hour was accounted for; they collected over 20,000 observations (Figs. 27, 28, 29). Although the sun never set, the temperature often hovered at freezing while dense fog swirled around them for days on end (Fig. 30). They experienced only one major mishap. On the way down from the glacier the ice had developed a glass-like consistency; the dogs sliced open their paws, leaving a trail of blood behind them. Some had to be put out of their misery; others were saved by placing them on top of the equipment while the men negotiated the sledge down to the coast.



Figure 26.
Spitsbergen
1934: Sverdrup
in his element.
*Courtesy Royal
Swedish
Academy of
Sciences.*



Figure 27.
Sverdrup and
Ahlmann
preparing the
base camp.



Figure 28.
Round-the-clock
hourly
observations
begin: research
assistant Hilding
Olsson.



Figure 29.
Sverdrup and
Ahlmann: 20,000
observations
later...

Figure 30.
Ahlmann, base
camp, and arctic
fog.



The data thrilled Sverdrup. He collected hourly readings of temperature, humidity, and wind velocity at different levels between the surface of the snow and up to an altitude of 5 to 7 meters, to determine the exchange of heat and water vapor between the air and snow. "I have enough data to keep me out of mischief during the coming winter," he wrote.³⁵ Among other findings, he extended the theory of geophysical turbulence and began to plan further studies on transport of heat and water vapor at the ocean surface.³⁶

Then he was asked whether he would accept becoming director of Scripps Institution of Oceanography.³⁷

Sverdrup had previously received offers to come to America. He had acquired an international reputation for being exceptionally hard-working and exceptionally talented; many scientists considered the scientific results of the *Maud* expedition to be the most valuable, at least for geophysical sciences, of any polar expedition.³⁸ One American wrote to him, "But how do you do it? You get out so much work of the highest quality, and yet with you there are only 24 hours to the day, the same as over here with us! Even if you were twins, I still would marvel at the amount of work you do."³⁹ In 1928 the Carnegie Institution tried to recruit him as scientific leader of its Department of Terrestrial Magnetism, which was then committed to expanding its activities in physical oceanography. Sverdrup was tempted to accept.⁴⁰ But in the end his loyalty to Norway and especially to Bergen geophysics prevailed.⁴¹ To ensure that he remained, Helland-Hansen arranged that Sverdrup receive the first research professorship

at the new Christian Michelsen Institution in Bergen.⁴² Much to Sverdrup's consternation just when this arrangement was being made in 1930, he received an intriguing letter from Henry Bigelow. The American oceanographer related how, finally, money was in place to incorporate the new Woods Hole Oceanographic Institution. Bigelow clearly stated his reason for writing to Sverdrup:

We are wondering if you would still be at all interested in a position with the new institution, . . . All I can do at present is to ask . . . whether you would care at all to consider the position as Chief Oceanographer . . . if our plans mature we can at least promise that there will be a comfortable lab, well equipped; a ship (120 feet long or so) of a type fit to go anywhere, and perhaps personal freedom for research.⁴³

Tempting, very tempting. But Sverdrup had already searched his soul for principles by which he might live in peace with himself: he preferred to work where he could be of greatest assistance. And as long as he felt needed he would remain in Norway.⁴⁴ A few years later California beckoned.

Thomas Wayland Vaughan, the director of Scripps since 1924, hoped to retire in 1936; he sought a successor who might strengthen the institution's physical oceanographic research.⁴⁵ He had long admired Sverdrup's work. When in 1935 Helland-Hansen visited Scripps, he indicated that Sverdrup might be willing to come, at least for a few years. In March 1936 the University of California formally invited Sverdrup to accept the directorship: "It is felt that your coming will mean a renewed impetus to studies in physical oceanography and that such a program will yield results of importance to future work in biological oceanography."⁴⁶ Helland-Hansen then urged Sverdrup to embark on an expedition to Scripps for three years.

What awaited Sverdrup when he arrived in La Jolla in late summer, 1936? What was this institution that was first established as a marine biological

station in 1903, that joined the University of California in 1912, and that added the word oceanography to its name in 1925? Sverdrup's impressions during the first months were decidedly negative.

The Scripps Institution was oceanographic in name only. Sverdrup observed, in a series of letters to colleagues back in Scandinavia, that land-based laboratories dominated and no possibilities existed for systematic work at sea. The institution's one vessel, the 64-foot *Scripps*, was not capable of venturing beyond the immediate coastal waters. His heart sank when he first set foot on its scraped-up and dried-out deck; it was nothing but "a filthy cramped washtub." Prior to arriving in La Jolla, Sverdrup was inclined to believe that SIO required a real ocean-going ship.⁴⁷ Now he understood that to comprehend even the immediate coastal waters required greater insight into the currents further out in the ocean. "Either the university must make the institute a real oceanographic research institution or else turn it into a marine biological station—and then I leave for home."⁴⁸

Sverdrup was not a person who spoke negatively about others, but his distress over the situation evoked criticism: Vaughan wasn't trained as an oceanographer and therefore didn't have the preconditions to lead ocean research. Without a clear oceanographic mission the institution merely developed as an umbrella for a number of independent specialties housed in separate laboratories. Vaughan had never held an academic appointment, which often led to friction with the rest of the University of California faculty and administration; moreover, Scripps' pedagogical program was clearly deficient. Nor did Vaughan have the best colleagues. "With all respect to [G. F.] McEwen as a mathematician: McEwen is not a geophysicist. He has no sense for observations. And there was no other oceanographer."⁴⁹

Vaughan wanted to do the right thing, but, according to Sverdrup, he went about it all wrong. The former director had asserted that the institution should aim at exploring the eastern Pacific—a sector as large as the entire north Atlantic. He therefore

considered using only large research vessels that could accommodate major surveying cruises. But he could not raise funds to acquire such a ship. With no other choices for systematic research, Vaughan sought cooperation with the U.S. Navy and the U.S. Coast and Geodetic Survey, on which he placed great emphasis.⁵⁰

Prior to his arrival, Sverdrup had also anticipated expeditions and had also thought of cooperative ventures with these organizations. But upon closer inspection he found these arrangements highly problematic. "The Navy, when you get right down to it, doesn't care about oceanographic research."⁵¹ He also quickly discovered that the Coast and Geodetic Survey was using water bottles that leaked, and thermometers that were faulty: "The data they sent us was completely worthless."⁵²

Sverdrup also learned that his predecessor was something of a tyrant, who did not tolerate criticism or complaints.⁵³ This attitude contributed decidedly to creating a poor internal institutional culture. Personal relations within were not good. To Sverdrup it appeared that the scientific staff suffered from "expedition syndrome"—that is vulnerability and suspicion.⁵⁴ Compounding the situation the isolated community of researchers was housed on the Scripps campus in sub-standard accommodations. These shacks, according to Sverdrup and his wife Gudrun, were simply a "disgrace for the university." Nor did he appreciate the local La Jolla characterization of Scripps as "the group of shacks marking the entrance to the fishing pier."⁵⁵

But there was another side to Scripps that Sverdrup quickly appreciated:

I like the men here very well. They are easy to work with, willing and helpful. They aren't all top notch but many are talented, and most are enthusiastic about expanding the scope of the institute to the ocean. . . . The group here is more than helpful and competent. It is largely a collection of unusually pleasant people, who have done everything possible to make us

*feel at home. Therefore it would be especially satisfying to do something for them: get them better housing, increase contact with the university, bring in bigger and more interesting problems for discussion. Whether I can accomplish this I don't know.*⁵⁶

Sverdrup believed that by showing good will he might make greater headway than his predecessor.⁵⁷

Sverdrup received help in unexpected ways. First, shortly after his arrival an explosion ripped through the institution's ship while docked at the San Diego yacht club. It caught fire and sank. If it wasn't for the fact that the two crewmen were badly burned, Sverdrup would have been ecstatic.⁵⁸ He hated the ship. But the question remained: how to raise money both to buy a sea-worthy vessel and to sustain an active-at-sea research program? In early February 1937 Sverdrup arranged a meeting with Robert Gordon Sproul, president of the University of California, and Robert P. Scripps, who managed the Scripps estate in relation to SIO. Together they discussed the institution and especially the problem of acquiring a research vessel. The chemistry among the three seems to have been just right. Within two weeks Robert Scripps gave an agent the job of finding a suitable vessel. Sverdrup joined him in San Pedro, but did not like what he saw. Then as they ate lunch at the Los Angeles Yacht Club, Sverdrup spotted a schooner



Figure 31.
The *Serena*, soon to become the *E. W. Scripps*.

moored in front of the club-house. The ship, the *Serena*, belonged to actor Lewis Stone and by chance was up for sale (Figs. 31, 32). After inspecting the 104-foot ship, Robert Scripps bought it, provided funds for Sverdrup's desired renovations, and indicated a willingness to match University of California funds for maintaining a crew and operations. In addition insurance on the sunken *Scripps* yielded funds for scientific equipment. Sverdrup had but one thing to say: "Hurrah!"⁵⁹

The next unexpected good fortune involved sardines. In March 1937 Sverdrup arranged to use the California Fish and Game Commission's ship, the *Bluefin*. He aspired to obtain the first systematic study of the ocean off the coast in order to understand the conditions at the time the sardines are spawning, which in turn had significant consequences for the economic livelihood of many Californians. He and Scripps personnel made three cruises during the spring at the same locations. On each cruise four sections at right angles to the coast were obtained by occupying at least 30 stations. In addition over 20,000

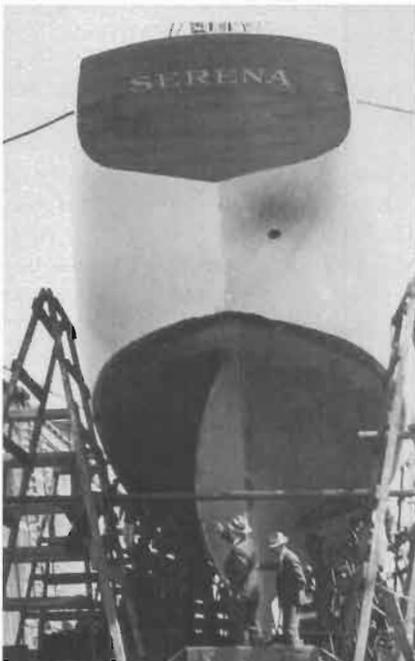


Figure 32.
Inspecting SIO's
new hope for
becoming truly
oceanographic.

drift bottles were thrown into the sea. Almost immediately they realized the importance of this investigation, which provided clear insight into the nature of upwelling, even allowing them to follow the mixing of different waters in detail.⁶⁰ Consequently, Sverdrup recognized how he might transform the institution. First, as he had suspected all along, the ocean right outside their door posed a vast wealth of interesting problems. The great differences in surface layers and the life histories of these currents must certainly be reflected in the biological conditions. Sverdrup decided that when the new ship, renamed the *E. W. Scripps*, was ready, it should be used not for long expeditions, but rather to concentrate on a limited area many times during the year. Moreover, the study of this limited but scientifically interesting area could be used as a research program to unify SIO. The whole institution could be mobilized to “work according to a plan in which individual problems mutually reinforce one another” and consequently establish an overall picture. He decided to immerse himself in biological oceanography in order to better coordinate the different investigations, and “not the least to make physical and chemical oceanography useful to the biologists.”⁶¹ And possibly also to California fishing interests.

Sverdrup was making progress toward reforming Scripps. He instituted regular collective lunch sessions at which any and all concerns could be informally discussed. He arrived at a plan by which the rental income from housing would be placed into a separate budget to be used exclusively to upgrade living conditions. And indeed he soon found personal relations within the institution improving, as were relations with the university. President Sproul, it turned out was “a damned nice man and [has] a sweet wife”—in fact, so nice “they could . . . almost be Norwegian.”⁶² Everything was fine except for a terrible decision that had to be confronted.

Sverdrup had become painfully homesick. He could not find somebody to take over after his self-imposed three-year term expired. Helland-Hansen suggested that perhaps the young Roger Revelle might be a possibility. Sverdrup noted: “Revelle is an excellent man in many respects, but has a number of striking

weaknesses: he has great difficulty in bringing anything to completion, he doesn't look after his correspondence—and he of course has not as yet the scientific weight that such a director ought to have."⁶³ . . . "Do you think he is mature? I have my doubts. I prize him immensely as a person, but I doubt that he is suitable to be director, in any case not yet. Then ZoBell is more suitable, but he isn't sufficiently well rounded." Despairing over the lack of candidates, he wistfully imagined that perhaps the excellent Albert Defant in Berlin, who was less than happy with the Nazi regime, could be recruited: "That he can't speak English to any extent could perhaps be surmounted."⁶⁴ With time the problem only got worse: on the one hand everything at Scripps was beginning to fall into place; on the other hand both he and his wife desperately missed Norway. "It's sad that it's not possible to live at least two lives simultaneously!"⁶⁵

To his friend Hans W:son Ahlmann, Sverdrup revealed the depths of his distress. In part he regretted not being the type of person who can avoid getting involved. Had he simply come and worked on his own projects, he could simply pick up, say thank you, and return home.

*But I guess I'm not made that way.
Instead I've worked away—and you
don't do that without getting punished.
You give something of yourself. . . . In
all my work here—in all my plans—I
can't constantly think that this is an
intermezzo. But often I long so damned
to be home—to the land and friends; I
have a feeling of living in exile. . . . Oh
no, this is not at all easy. "An
expedition," Bjørn [Helland-Hansen]
said. No, it's not that at all, because
the institution here is something
permanent—with a group of people
whose trust I think I've won—and who
gladly will hold on to me.*

He conceded that the longer he should stay, the more difficult it would be to extricate himself and return home.⁶⁶

And then a new unexpected development complicated the matter yet further, one that placed Sverdrup “between the devil and the deep blue sea” [or in direct translation: “between the bark and the wood”].⁶⁷ Robert Scripps, age 42, died. He had been devoted to the institution; support from the Scripps estate now decreased substantially. Some other sources of funding could be found, but, in virtually all these instances the patronage depended upon whether Sverdrup would be staying at SIO. He feared that the reduction would lead to cutting back the plans for using the new ship and with that a general decline. In anguish and confusion he noted to Ahlmann that he could not just turn his back and see everything dwindle away. “I’m being overtaken by a nemesis, which will make every decision difficult.”⁶⁸

Complicating matters further, Sverdrup admitted that his working conditions at home were actually far from favorable. In Bergen he had experienced the irony of having a position at an institution devoted to “pure research” where the scholar was “free” to follow his curiosity. Such rhetoric might well serve as cultural ideology, but it certainly did not serve an oceanographer well. Sverdrup needed access to a research vessel or the data collected regularly on one, if he was to follow his curiosity. He confessed—perhaps overmodestly:

At home I was a “free lance” . . . I am best suited to work with systematic observations and to make some sense of them. I’m not sufficiently a theoretician to be able to work solely theoretically. . . . my strength lies in analyzing data and using the tiny bit of theory I master. At home I tried several times to get my fingers on the massive oceanographic material that Bjørn has collected through the years. But Bjørn would not let me get hold of it. . . . To put it bluntly: to be a geophysicist without being able to get hold of the data one wants results in leading an uncertain and doubtful existence.

In contrast, at Scripps, he was the leader: "Here I can plan and have an influence on others' work . . . and can draw upon all my earlier experiences."⁶⁹ Finally, he agreed to stay an additional two years at Scripps, until the end of 1941.

When the European war began, Sverdrup understood that he would have to remain in La Jolla longer than 1941. After the Germans invaded and then occupied Norway in April 1940, Sverdrup wrote to President Sproul and requested that which the University of California had always wanted to give him: a permanent position. He also, with great sadness, began measures to become an American citizen. Fortunately he had a project that could keep his thoughts from straying to the depressing world situation and to his own forced exile. As part of Sverdrup's desire to bring the many specialties dealing with the oceans into a greater scientific and institutional unity, he embarked in 1939, with the help of two colleagues Richard H. Fleming and Martin W. Johnson, to write a comprehensive textbook for oceanography. The task of preparing this volume was enormous. Some glimpses into his life:

September 1940:

*I have a . . . busy summer behind me and an even worse autumn in front of me. This textbook . . . must be finished now, so I'm working like a horse. I hope Gudrun and I both survive the finishing. But the book will be fairly good, I hope, even though it will not resemble any prior existing textbook.*⁷⁰

December 1940:

*I'm having a short breathing spell. Have now two big ms. One is really big; that is the oceanography book which has hung as a sword of Damocles over my head for several years and has nearly made me a stranger to Gudrun.*⁷¹



Figure 33.
 “Four pounds and
 all muscle.”
 Courtesy of S. I. O.
 Archives.

January 1943:

I am kept busy. Before Xmas the big book appeared on which two of my colleagues here and I have been at work for 4 years: The Oceans, their physics, chemistry and general biology. It is a book of nearly 1100 pages, which I hope will be a useful reference book for some years to come (Fig. 33).⁷²

Again January 1943:

I am not out of work after the book appeared. More busy than ever—and now and then I have the feeling that I am doing something which may help to bring an end [to the war].⁷³

Christmas 1944:

I am still busy as ever. It is nearly 3 and 1/2 years since I had a vacation and, now and again, I am pretty tired.⁷⁴

Much of what ensued at Scripps during the war and the immediate postwar is surely still quite alive as part of SIO’s institutional memory: the mobilization for the war effort of first-rate research teams, the training of many new oceanographers, and the embarking on innovative research programs with the help of generous government funding. And most notably Sverdrup and Walter Munk’s pioneering work on the prediction of swell and breakers, which proved significant for many critical military operations. After the war the Navy awarded Sverdrup its highest honor for a civilian: the Distinguished Public Service Award. Sverdrup, in turn, never failed to underline that his excellent assistants and colleagues made the entire scientific program possible.⁷⁵

Once peace was restored Sverdrup again had to confront his and his wife’s longing to return home. In his letters he reveals a continued inner struggle to find a just and satisfactory solution. A man of principle, Sverdrup decided that he would remain in California because he did not want to be a burden on Norway while it was rebuilding its infrastructure. He would

consider returning only if Norway had a specific use for him and if his return did not compromise a younger person's professional advancement.⁷⁶ Moreover, he knew full well that the time had arrived for oceanography to emerge as a truly vigorous discipline. Wartime experience had shown the importance of physical and dynamic oceanography for the nation. Plans were underway around the country to create departments of oceanography; funding would remain at levels inconceivable prior to the war. Scripps' budget was expected to double within the first year alone. Sverdrup was the central oceanographer in a country that was about to invest heavily in studying the oceans.⁷⁷ All this certainly made the prospect of staying longer a bit more palatable. But his real reason for staying entailed, again, a sense of duty to individuals who were counting on his aid (Fig. 34). When Ahlmann suggested that indeed opportunities might exist for him in Norway, Sverdrup responded:

*If I was not now sitting here with the feeling of responsibility—especially a duty to a number of talented young men, who expect that in the next year or two to be supervised in their studies by me—yes—then I would leave for home immediately. In spite of all the years here . . . in spite of all the good hearted persons I've met, in spite of all the good fortune I've had, I long for Norway—the people, friends, and the land. I am not at peace with myself now. Being here a few more years, then I might miss the possibility to come home . . . But if I leave for home now, I'll have a bad conscience for years because here I gave promises that I didn't keep.*⁷⁸

And yet within one year, he indicated that he would be leaving, but not until he secured all of his personal obligations. What changed his mind? Why, as a Norwegian journalist asked him, why did he leave "paradise" in southern California?⁷⁹



Figure 34.
Sverdrup out of
the office.

We must change scenes: the Soviet Union. Immediately following victory in Europe, Sverdrup's friend Ahlmann attended a celebration at the Russian Academy of Science. He became alarmed over the extraordinary measures being taken to step up polar research, exploration, and colonialism. He also knew that during the war the Americans had dramatically increased their engagement in the arctic. Ahlmann feared for the Nordic nations; he especially feared for Norway's vital interests in the arctic and antarctic. Territorial claims were still disputed; only vigorous activity could legitimize these claims. In discussions with Prime Minister Gerhardsen and more extensively with cabinet ministers Trygve Lie, Lars Evensen, and especially Halvard Lange, as well as with key members of parliament, Ahlmann advocated establishing a major institution to oversee research, surveying, and commercial activity in the polar regions. And such an institution must be led by an internationally respected scientist: Harald Ulrik Sverdrup (Fig. 35).⁸⁰



Figure 35.
Sverdrup: leader
of postwar
oceanography.
*Courtesy of S. I.
O. Archives.*



Figure 36.
Sverdrup in the
antarctic, 1951.

In 1948 Sverdrup returned home to lead the Norwegian Polar Institute and to take over the planning of the Norwegian-Swedish-British Antarctic Expedition (Fig. 36). Although missing much of the excitement at Scripps and following closely the ever-changing political and personnel situation — he supported Revelle as director of Scripps⁸¹ — he also expressed a joy of ending his twelve-year longing for a Norwegian spring.

His unusual capacity to work continued; he found it difficult to say no to tasks for which he felt qualified to help. He finally reached the antarctic in 1951, although he later confessed that he still preferred the arctic. He led Norway's aid program to India in 1952. He was named adjunct professor of geophysics at the University of Oslo, and soon became dean for the natural science faculty. He believed that educational reform was too important to leave to inexperienced persons and began a major campaign to change the science education from a German to an American

model. Sverdrup lectured publicly on his optimism that Science would help mankind—if only the peoples of the world could learn to live in peace. He also freely admitted that science is not a solution in itself: he called for greater efforts in the humanities to tackle questions that the sciences have no claim to answer.⁸² Friends in America constantly urged him to visit. A group of colleagues hoped to bring him back to Scripps in 1958 or 1959; they promised that students and scientists from all over would flood the Scripps campus to follow his lectures and consult with him. But administrative duties were reducing his research time to almost nothing.⁸³ Then, on August 21, 1957 he died from a heart attack at age 69.

How might we keep Sverdrup's legacy alive? I will leave you to decide for yourselves. For myself, I am greatly appreciative to the Scripps Institution of Oceanography and Heritage Committee for providing me the opportunity to become acquainted with Harald Ulrik Sverdrup.⁸⁴ This lecture represents but a fraction of my preliminary findings from my Ritter-Memorial-Fellowship expedition; further research and analyses will be forthcoming.

But over and beyond traditional historical scholarship on the development of ocean science, I feel a great personal enrichment through my contact with Sverdrup. History is of course as much about the present as it is about the past. The great University of California to which Sverdrup belonged is now beset by many difficult problems. I do not mean simply our budgetary crisis, but coupled with this threat are other weaknesses, which Sverdrup would surely recognize and find distasteful. Sverdrup believed in duty and obligation to institutions and to students. We find today all too many of our colleagues concerned much too exclusively with their own careers and their own egos. Sverdrup believed in service; Sverdrup was a devoted teacher. He also recognized and welcomed the need for science to serve a broader society than merely a group of specialists. Sverdrup developed and perfected instruments to guide him on his expedition through life: modesty, duty, kindness, and personal sacrifice.

NOTES:

The following abbreviations are used in the notes:

BFP Bjerknæs Family papers
 GIB Geophysical Institute, University of Bergen
 HH Bjørn Helland-Hansen papers (multiple locations)
 HUS Harald Ulrik Sverdrup papers (multiple locations)
 HWA Hans W:son Ahlmann papers
 NP Norsk Polarinstitutt, Oslo
 RA Riksarkivet [National Archive], Oslo
 SIB Statsarkivet i Bergen [Regional Archive in Bergen]
 SIO Scripps Institution of Oceanography, La Jolla, Calif.
 UBO Universitetsbiblioteket i Oslo [Univ. of Oslo Library]

¹ For standard background accounts of Sverdrup's life and career see Olav Devik, "Minnetale over Professor Harald Ulrik Sverdrup," *Det Norske Videnskaps-Akademi i Oslo. Årbok 1958*, 49-73 (includes bibliography); Devik, "Sverdrup, Harald Ulrik," in *Norsk Biografisk Leksikon*, 15: 379-87; Roger Revelle and Walter Munk, "Harald Ulrik Sverdrup—an appreciation," *Journal of Marine Research*, 1958, 7:127-38.

² Harald Ulrik Sverdrup, "Informal Autobiography," unpublished paper prepared for National Academy of Sciences, 6 Feb 1948. SIO Archives, SIO Office of the Director (Sverdrup), Box 1, 82-56, Folder: Biographical File; Sverdrup, "Harald Ulrik Sverdrup," *Studentene fra 1906* (Oslo, 1931), 334-35; John Giæver, "Fra Prestegården til Polhavene og så til Travancore-Cochin [based on interview with Sverdrup]," *Magasin for Alle*, 1953, 41-42:10-12, 27-28; "En Sporty Videnskapsmann: Rommann, oseanograf, kokk og oppfinner. Professor Harald Ulrik Sverdrup arbeider på et 1000 siders oseanografisk verk," *Aftenposten*, 7 June 1941. On the Sverdrup family history, see, S. H. Finne-Grønn, *Slegten Sverdrup. Kortfattede Genealogisk-Personalhistoriske Oplysninger med Prospekter og Portrætter* (Christiania: Det Mallingske Bogtrykkeri, 1923).

³ On Bjerknæs and his work see Robert Marc Friedman, *Appropriating the Weather: Vilhelm Bjerknæs and the Construction of a Modern Meteorology* (Ithaca and London: Cornell University Press, 1989; 1993). Letter, Fridtjof Nansen to W. C. Brøgger, 8 November 1909 describes Bjerknæs' working conditions at the university; in Steinar Kjærheim, ed., *Fridtjof Nansen Brev*, III 1906-1918 (Trondhjem, 1963), 135-6.

⁴ Amundsen's lecture and discussion are published in *Norsk geografisk tidsskrift* (1908).

⁵ Letter, Harald Ulrik Sverdrup to provsten Eilert Patrick Juul, 6 October 1916, Sverdrup biographical files, NP.

⁶ Letter, Sverdrup to Olaf Devik, 11 April 1917. Devik papers, Privatarxiv #686, RA. He later repeated on several occasions that he did not care for or feel particularly gifted in purely theoretical work. For example Sverdrup to Vern O. Knudsen, 1 February 1938 recalls, "My inclinations were not towards theoretical work, but I always wanted to analyze actual data from the field and discuss them on the basis of physical principles. On an arctic expedition I would . . . obtain experience in performing observations and, later, on the basis of these experiences I could know the accuracy of various methods and the limits of errors which would have to be considered"; copy, Scripps Family, Box 1, 92-38. File "Scripps Institution of Oceanography, 1938", SIO Archives.

⁷ Helland-Hansen had encouraged Sverdrup to join Amundsen from the first signs of a possible expedition and also encouraged him to begin learning oceanographic methods during summer 1916. Just prior to the expedition he provided systematic training for Sverdrup; see letters, Helland-Hansen to Sverdrup, 7 August 1916, copy, and Sverdrup to Helland-Hansen, 1 July 1917, HH/SIB.

⁸ Bjørn Helland-Hansen, "Nansen og hans videnskapelige innsats," *Det Norske Videnskaps-Akademi i Oslo. Årbok 1930*, 65-84; Søren Richter, "Fridtjof Nansen som polarforsker," *Naturen* (Bergen), 1961, 85: 422-46; Håkon Mosby, "Fridtjof Nansen som oseanograf," *Ibid.*, pp. 462-75; Sverdrup, "Fridtjof Nansen som videnskapsmann," *Norsk Geografisk Tidsskrift*, 1931, 306-313.

⁹ Roald Amundsen, *Nordostpassasjen* (Kristiania: Gyldendalske Boghandel, 1921); Sverdrup, "Blandt rentsjuksjere og lamuter," in *Ibid.*, pp. 257-391; Sverdrup, "Maud-ekspeditionens videnskabelige arbeide 1918-1919 og nogen av dets resultater. (Skrevet ombord i 'Maud' juli 1919)," *Naturen* (Bergen) 1922, 46:5-32, 65-88; Sverdrup, "General Report of the Expedition," *The Norwegian North Polar Expedition with the 'Maud' 1918-1925, Scientific Results*, Vol. 1, No. 1 (Bergen: John Griegs Boktrykkeri, 1933), 3-22; *Ibid.*, "Narrative of the Expedition, 1918-1925," Part VI, 514-524.

¹⁰ Quoted in "En Sporty Videnskapsmann," *Aftenposten*, 7 June 1941. An account of Sverdrup's ethnographic observations of the various native tribes can be found in his: "Blandt rentsjuksjere og lamuter," in Amundsen, *Nordostpassasjen*, 257-391; "Customs of the Chukchi natives of northeastern Siberia," *Journal of the Washington Academy of Sciences*, 1922, 12: 208-12; *Tre År i Isen med 'Maud'* (Oslo: Gyldendal, 1926), 285 pp.; *Hos Tundra-Folket* (Oslo: Gyldendal, 1938), 175 pp.; and *Among the Tundra People* (translation of preceding, edited by Marston C. Sargent, Elizabeth N. Shor, and Kittie C. C. Kuhns; Scripps Institution of Oceanography, 1978, 228 pp.).

- ¹¹ Letters, Sverdrup to Vilhelm Bjerknes, 27 September 1921 and 22 May 1922, BFP Collection 469B, UBO; Sverdrup to Bjerknes, 1 January 1922, Vilhelm Bjerknes files, GIB.
- ¹² The following is based upon the following sources: Sverdrup, *Tre år i isen med 'Maud'*; Sverdrup, "'Maud'-ekspeditionens vidensabelige arbeide 1922-1925," *Naturen* (Bergen), 1926, 50:161-180; Sverdrup, "General Report of the Expedition," *The Norwegian North Polar Expedition with the 'Maud' 1918-1925*, Vol. 1, No. 1, 3-22.
- ¹³ Sverdrup, "Dynamics of tides on the North Siberian shelf," *Geofysiske publikasjoner*, 1927, Vol. 4, No. 5, 1-75.
- ¹⁴ Letter, Sverdrup to Roald Amundsen, 18 August 1926, Roald Amundsen papers, 480B, UBO.
- ¹⁵ Sverdrup links the analyses of the observations to preserving the honor and memory of the *Maud* expedition in letter, Sverdrup to Amundsen, 20 July 1926, Amundsen papers.
- ¹⁶ Letters, Bjerknes to Sverdrup, 4 October 1925, copy, BFP 469B; Helland-Hansen to Sverdrup, 21 November 1925, HH/GIB; Helland-Hansen to Sverdrup, 9 September 1925, HH/SIB.
- ¹⁷ Relevant documents and correspondence can be found in the Ministry for Church and Education files for the Bergen Museum at the National Archives [RA, KUD, kontor D, Bergens museum - personale].
- ¹⁸ Letter, Sverdrup to Fridtjof Nansen, 16 May 1926, copy, HUS/GIB.
- ¹⁹ Sverdrup to Amundsen, 20 July 1926.
- ²⁰ Letter, Nansen to Sverdrup, 5 June and 6 August 1926, HUS/GIB.
- ²¹ Sverdrup, "Polferden med 'Graf Zeppelin'," *Naturen* (Bergen), 1929, 53: 353-67. Sverdrup was on the board of the international organization, "Aëroarctic: Internationale Gesellschaft zur Erforschung der Arktis mit Luftfahrzeugen."
- ²² Letter, Walther Hauptmann Bruns to Sverdrup, 20 October 1930, GIB/SIB, Box "Sverdrup 1929-1931."
- ²³ Letter, Bjørn Helland-Hansen to Sverdrup, 21 May 1930, copy, HH/GIB (relates what he read in newspaper interview with Georg Wegener concerning the future of the expedition).
- ²⁴ Letter, Sverdrup to Bruns, 19 September 1930, copy, GIB/SIB, Box "Sverdrup 1929-31."

- 25 Correspondence between Sverdrup and Wilkins including details of planning the expedition can be found in HUS/UBO, Collection 634E, 3 folders.
- 26 Letter, V. Walfrid Ekman to Sverdrup, 5 October 1930, HUS/UBO 634A.
- 27 Letter, Sverdrup to Ekman, 9 October 1930, copy, HUS/UBO 634A. On Sverdrup's expectations for the voyage, see interview, "Med Wilkins Under Isen: Prof. Sverdrup berättar om, hur Jules Vernes 'Nautilus'-saga blir verklighet," *Vecko-Journalen*, 1930, 81 nr. 36:13.
- 28 Some newspapers clippings are preserved in the Wilkins file in HUS/UBO. Additional information on the planning of the expedition and the early setbacks can be found in Sverdrup's correspondence with Wilkins and with John A. Fleming at Carnegie Institution's Department of Terrestrial Magnetism, copies in Sverdrup papers at UBO and SIB. His annoyance over journalistic hype and irresponsibility is clearly stated in a letter to Bigelow, 24 February 1931, HUS/UBO 634A.
- 29 The following is largely based on Sverdrup's account in *Hvorledes og Hvorfor med 'Nautilus'* (Oslo: Gyldendal, 1931), 183 pp.
- 30 Letter, Sverdrup to John A. Fleming, 9 January 1932, copy, HUS/UBO 634A.
- 31 Sverdrup, "Arbeider i luft-og havforskning," *Christian Michelsens Institutt for Videnskaps og Åndsfrihet. Beretninger 1932*, Vol. 2, No. 5, 3-20.
- 32 Letter, Sverdrup to Theodor Hesselberg, 11 November 1929, copy, HUS/UBO 634A. Reference to Sverdrup's interest in the mechanics of heat and energy transfer can be found scattered in his correspondence, research proposals, and lectures during the early 1930s.
- 33 Letters, Hans W:son Ahlmann to Sverdrup, 16 September 1933, HUS/UBO 634K; Sverdrup to Theodor Hesselberg, 25 October 1933, copy, HUS/UBO 634A. The stakes for Norway in the arctic are put forth in Adolf Hoel, "Trues våre arktiske interesser?," *Samtiden*, 1931, 42:233-246. On the general political situation with respect to Svalbard, see, Sven G. Holtmark, *A Soviet Grab for the High North? USSR, Svalbard, and Northern Norway 1920-1953*, in *Forsvarsstudier* 1993, No. 7 (Oslo: Institutt for Forsvarsstudier, 1993) and Rolf Tammes, *Svalbard og stormaktene: Fra ingenmannsland til Kald Krig, 1870-1953*, in *Forsvarsstudier* 1991, No. 7 (Oslo: Inst. for Forsvarsstudier, 1991).

- ³⁴ Details of the planning for the expedition can be found in HUS/UBO, 634K, 3 folders.
- ³⁵ Letter, Sverdrup to W. J. Humphreys, 31 August 1934, copy, HUS/UBO 634B.
- ³⁶ Sverdrup, "Temperaturen i Vest-Spitsbergens breer," *Naturen* (Bergen), 1935, 59: 239-48; Sverdrup, "The eddy conductivity of the air over a smooth snow field. (Results of the Norwegian-Swedish Spitsbergen-Expedition in 1934)," *Geofysiske publikasjoner*, 1936, Vol. XI No. 7, 1-69; Sverdrup, "Turbulensforskning i laboratoriet og i naturen," *Beretninger fra Chr. Michelsens Institutt*, 1936, Vol. VI No. 5, 3-21.
- ³⁷ Letter, Robert G. Sproul (President, University of California) to Sverdrup, 20 March 1936, HUS/UBO 634A, which contains the text of Sproul's telegram of 19 March; see also letter from T. Wayland Vaughan to Sverdrup, 26 March 1936, HUS/UBO 634A.
- ³⁸ See, for example, letter, Erik Palmén to Sverdrup, 19 February 1934, HUS/UBO 634B.
- ³⁹ Letter, W.J. Humphreys to Sverdrup, 28 July 1934, HUS/UBO 634A.
- ⁴⁰ Letters, Sverdrup to Bjerknes, 25 September 1928, BFP 469B; John A. Fleming to Sverdrup, 20 December 1928, copy, HH/GIB.
- ⁴¹ Letters, Sverdrup to Fleming, 23 October 1928, copy, and 13 March 1929, copy, GIB/SIB.
- ⁴² Letter, Helland-Hansen to Sverdrup, 19 March 1930, HH/GIB.
- ⁴³ Letter, Henry Bigelow to Sverdrup, 22 January 1930, HUS/UBO 634A.
- ⁴⁴ Letter, Sverdrup to Bigelow, copy, 7 February 1930, and Sverdrup to Fleming, 23 October 1928, copy, HUS/UBO 634A.
- ⁴⁵ On the Scripps Institution during this period see Helen Raitt and Beatrice Moulton, *Scripps Institution of Oceanography. First Fifty Years* (Los Angeles: Ward Ritchie Press, 1967), Eric L. Mills, "'Useful in many capacities'. An early career in American physical oceanography," *Historical Studies in the Physical and Biological Sciences*, 1990, 30:265-311; Mills, "The oceanography of the Pacific: George F. McEwen, H. U. Sverdrup and the origin of physical oceanography on the west coast of North America," *Annals of Science*, 1991, 48:241-266; Elizabeth N. Shor, "The role of T. Wayland Vaughan in American oceanography," in Mary Sears and Daniel Merriman, eds., *Oceanography: The Past*,

Proceedings of the Third International Congress on the History of Oceanography... (New York: Springer-Verlag, 1980), 127-137.

⁴⁶ Sproul to Sverdrup, 20 March 1936; Vaughan also wrote privately to Sverdrup, 26 March 1936, that University of California wished to make SIO one of the leading oceanographic institutions in the world and that all members of the SIO staff, except for one biologist opposed to the oceanographic program, expressed pleasure over the appointment. Wayland Vaughan did not put forth Sverdrup's name to the university officials until Helland-Hansen sent a telegram 10 December 1935 stating that Sverdrup was willing to consider the appointment, Vaughan to Helland-Hansen, 11 December 1935, HH/GIB.

⁴⁷ Letter, Sverdrup to Helland-Hansen, 13 August 1936, HH/GIB.

⁴⁸ Letter, Sverdrup to Helland-Hansen, 17 November 1936, HH/GIB; Sverdrup to Bjerknes, 20 February 1937, BFP 469B.

⁴⁹ Letter, Sverdrup to Helland-Hansen, 2/3 January 1938, HH/GIB.

⁵⁰ *Ibid.*

⁵¹ *Ibid.* Amazing what a world war would eventually do to change that situation!

⁵² *Ibid.*

⁵³ Letters, Sverdrup to Hans W:son Ahlmann, 10 April and 25/28 December 1937, HWA, K. Vetenskapsakademien, Stockholm.

⁵⁴ Sverdrup to Ahlmann, 25/28 December 1937, referring to the situation when he first arrived.

⁵⁵ Sverdrup to Helland-Hansen, 17 November 1936; Sverdrup to Ahlmann, 28 December 1937.

⁵⁶ Sverdrup to Helland-Hansen, 17 November 1936.

⁵⁷ Sverdrup to Ahlmann, 10 April 1937.

⁵⁸ Sverdrup to Helland-Hansen, 17 November 1936; Sverdrup to Bjerknes, 20 February 1937.

⁵⁹ Sverdrup to Ahlmann, 10 April 1937; see also, letters, Sverdrup to Helland-Hansen, 30 March 1937 and Helland-Hansen to T. Wayland Vaughan, 30 March 1937, copy, both in HH/GIB.

- ⁶⁰ Letters, Sverdrup to Helland-Hansen, 10 March, 3 June, and 27 August 1937, HH/GIB; Sverdrup to Ahlmann, 25/28 December 1937, HWA; Sverdrup to Devik, n.d. [June 1937], Devik papers, RA. Sverdrup had earlier expressed skepticism about the SIO reports of upwelling off the California coast.
- ⁶¹ Sverdrup to Bjerknes, 20 February 1937; Sverdrup to Ahlmann, 28 December 1937.
- ⁶² Sverdrup to Ahlmann, 28 December 1937. Sverdrup quoted his wife, Gudrun, on the Sprouls' 'Norwegian' attributes.
- ⁶³ Letter, Sverdrup to Devik, 28 June 1938, Devik papers.
- ⁶⁴ Sverdrup to Helland-Hansen, 2 January 1938.
- ⁶⁵ Letter, Sverdrup to Devik, 3 April 1939, Devik papers.
- ⁶⁶ Sverdrup to Ahlmann, 25/28 December 1937; see also, Sverdrup to Helland-Hansen, 2 January 1938.
- ⁶⁷ Letter, Sverdrup to Devik, 24 July 1938, Devik papers.
- ⁶⁸ Letter, Sverdrup to Ahlmann, 25 May 1938, HWA.
- ⁶⁹ *Ibid.* Sverdrup felt that Helland-Hansen considered every attempt to get involved with his data to be a criticism of his ability to bring things to a conclusion. Sverdrup's "free-lance" activities had included analyzing, among other data, oceanographic observations from the Pacific taken by the *Carnegie* and from the Antarctic taken on the *Discovery* expedition.
- ⁷⁰ Letter, Sverdrup to Ahlmann, 22 September 1940, HWA.
- ⁷¹ Letter, Sverdrup to Ahlmann, 15 December 1941, HWA.
- ⁷² Letter, Sverdrup to Ahlmann, 19 January 1943, HWA.
- ⁷³ *Ibid.*
- ⁷⁴ Letter, Sverdrup to Ahlmann, 27 December 1944, HWA.
- ⁷⁵ Letters, Sverdrup to Admiral Glover, 22 July 1948, copy; Sverdrup to Comdr. William B. Porter, 27 July 1948, copy; Charles S. Thomas [Secretary of the Navy] to Sverdrup, 27 February 1957; Sverdrup to Thomas, 29 March 1957, copy; all in HUS/UBO 634P. Sverdrup received the Distinguished Public Service Award in 1948, but received the actual accessories of the award in 1957.
- ⁷⁶ Letter, Sverdrup to Ahlmann, 18 November 1945, HWA; Sverdrup specifically was concerned not to hinder Håkon Mosby or Jonas Ekman Fjeldstad from obtaining appropriate positions.

⁷⁷ Letter, Sverdrup to Helland-Hansen, 16 January 1946, HH/GIB, discusses immediate impressions of the Navy's investing in ocean research. He gives an overview of the impact of the war and immediate postwar situation on oceanography at SIO and in general in a number of newspaper interviews, such as, "Scripps Probing Pacific Mysteries with War-Developed Instruments, *Los Angeles Times*, 20 July 1947, and "Ny og voldsom interesse i Amerika for havforskning," *Aftenposten*, 26 April 1948. On the need for establishing new educational facilities for meeting the acute shortage of oceanographers, see Committee on Geophysical Sciences of the Research and Development Board, Panel on Oceanography, "Preliminary report of working group on training in oceanography," 5 March 1948, TS., HUS/UBO, 634O, file "1947-1948."

⁷⁸ Letter, Sverdrup to Ahlmann, 31 January 1946, HWA.

⁷⁹ Interview with Sverdrup, *Arbeiderbladet*, 10 September 1955.

⁸⁰ Letters, Ahlmann to Sverdrup, 7 February 1946; Ahlmann to Statsråd Lars Evensen, 28 December 1945 and 28 January 1946, copies, HWA. Ahlmann noted that the Russians considered Sverdrup the greatest authority on the north polar sea after Nansen. I plan a separate article on Ahlmann's role in establishing the Norwegian Polar Institute.

⁸¹ Letter, Sverdrup to Jakob Bjercknes, 6 March 1950, copy, HUS/UBO 634A. Sverdrup felt that if Revelle shared the directorship with a competent administrator, he could be an excellent leader.

⁸² Sverdrup, "Naturvidenskapens verdier," *Teknisk Ukeblad*, 1952, 99: 579-581; Sverdrup, "Rekkevidden av de eksakte naturvitenskaper," *Fra Universitetets talerstol*, 1956: 23 pp.; Sverdrup, "Verden er full av muligheter," *Arbeiderbladet*, 8 July 1957.

⁸³ Letters, Jakob Bjercknes to Sverdrup, 18 August 1956 and Sverdrup to J. Bjercknes, 27 August 1956, copy, HUS/UBO 634A.

⁸⁴ I would like to thank for their generous assistance: Deborah Day at Scripps Institution of Oceanography Archives; Julia Lindqvist and Urban Wråkberg at the Center for History of Science, Royal Swedish Academy of Sciences; Odd H. Sælen and staff at Geophysical Institute, University of Bergen; Susan Barr at Norwegian Polar Institute; Ralph Jewell at Dept. of Philosophy, University of Bergen; as well as helpful staff at: Division for Manuscripts, University of Oslo Library, Norwegian National Archive, and Regional State Archive in Bergen. I am indebted to the Centre for Technology and Culture [TMV], University of Oslo, for institutional support while conducting research in Norway.

Biography of Robert Marc Friedman

Robert Marc Friedman is associate professor of history and member of the Science Studies Program at the University of California, San Diego. He joined UCSD in 1989, and from 1991-93 served as director of the interdisciplinary Science Studies Program, an innovative effort to integrate history, philosophy, and sociology of science. He is also adjunct professor of history of science at the University of Oslo, Norway. His research primarily focuses on the cultural and social history of modern physical and geophysical sciences.

Dr. Friedman was born and raised in Brooklyn, New York. In high school he was selected to exhibit art work at the annual presentation of "New York's Most Promising Young Artists"; his sculpture was stolen from the exhibition. At New York University he earned a B.S. degree in meteorology and oceanography, while also completing a minor in theater and drama. In an effort to combine his interests in the humanities with those in the natural sciences, he turned to history of science. After receiving the Ph.D. degree from Johns Hopkins University in 1978, based on a dissertation on Vilhelm Bjerknes and the Bergen school of meteorology, he moved to Norway to continue studying the path-breaking Scandinavian transformation of meteorological theory and practice. His subsequent full-length study, *Appropriating the Weather: Vilhelm Bjerknes and the Construction of a Modern Meteorology*, analyzes this chapter of scientific change within a broad economic and social context, including the advent of aviation and the political-economic dislocations brought about by World War I. For this book he received the American Meteorological Society's Louis J. Battan Author's Award. He also wrote a screenplay for a one-hour dramatization of Bjerknes' life, which was produced in 1983 by the Norwegian Broadcasting Company. From Norway Dr. Friedman moved east to Sweden where he began a historical study of the awarding of the Nobel science prizes. His early results have been published as a series of articles, including "Nobel physics prize in perspective," *Nature*, 1981, 292: 793-98.

During the first half of 1994 he was in Sweden as holder of the Torgny Segerstedt Visiting Chair in the History and Sociology of Higher Education and Learning and Fellow of the Swedish Collegium for Advanced Studies in the Social Sciences. He is finishing research for a book on the disciplinary politics of the Nobel science prizes, and more broadly, the changing meanings and uses of the prize and of "excellence" in science.