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ALEXANDER FORBES

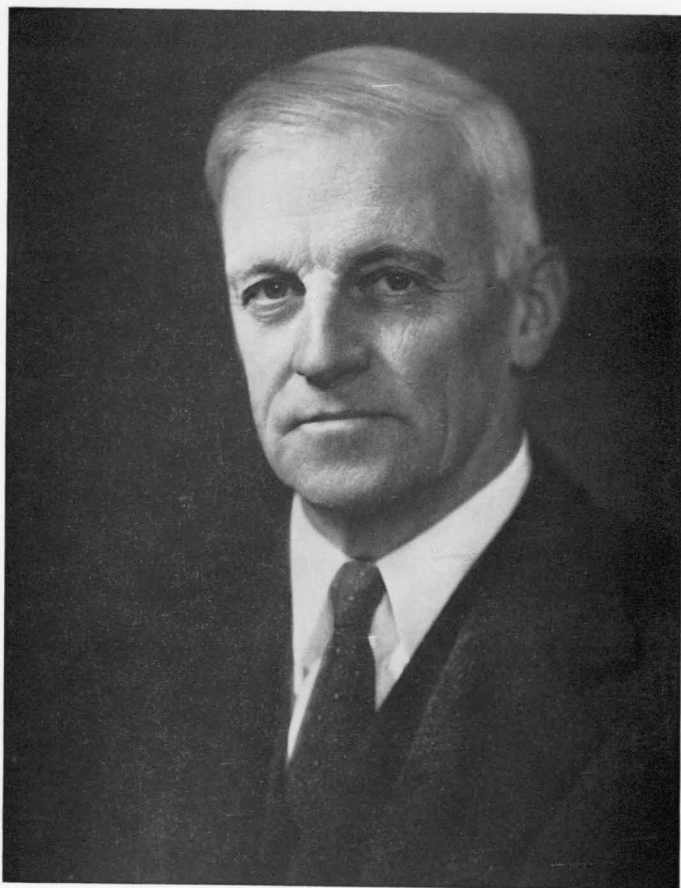
1882—1965

A Biographical Memoir by
WALLACE O. FENN

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Biographical Memoir

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WASHINGTON D.C.



Alexander Forbes

ALEXANDER FORBES

May 14, 1882–May 27, 1965

BY WALLACE O. FENN

ALEXANDER FORBES was born in Milton, Massachusetts, and died at the age of eighty-three in the same town. He was a distinguished member of a distinguished family. A great-grandfather, John Murray Forbes, was a trusted U.S. diplomat in South America, under President John Quincy Adams; and a grandfather by the same name had a business career in China, became a railroad magnate, built a cruiser for the Navy in the Civil War, helped to organize Negro regiments in Massachusetts, and was responsible for establishing the Forbes family on Naushon Island, off Woods Hole, Massachusetts, where they still live in the summer. His son, William Hathaway Forbes, was a Civil War hero who was captured by the Confederates but succeeded in effecting his escape. He became President of the Bell Telephone Company, and married Edith Emerson, the daughter of Ralph Waldo Emerson. The last and eighth child of this marriage was Alexander Forbes. An older brother was W. Cameron Forbes, who coached football at Harvard, became Governor-General of the Philippines and United States ambassador to Japan. Still another brother, Edward Forbes, was Professor of Fine Arts and Director of the Fogg Art Museum at Harvard.

Dr. Alexander Forbes married Charlotte I. Grinnell in

1910, and leaves a son, A. Irving Forbes of Exeter, New Hampshire, three daughters, Mrs. W. Andrew Locke of Milton, Mrs. Katherine F. Goodhue of Rockville, Maryland, Mrs. Joseph R. Frothingham of South Dartmouth, Massachusetts, and ten grandchildren.

It is interesting to record that Dr. Forbes met his future wife in the Adirondacks, at the Putnam Camp, founded by Henry P. Bowditch, the first Professor of Physiology at Harvard. They often visited this place in later years.

From his father, Alex probably inherited his love of the sea and his venturesome spirit, and from his mother, his warm and friendly disposition, his humanistic philosophy of life, and his liberal religious views. He once expressed his religious views in an article in the *Christian Register* (September 1951) and elsewhere he wrote: "Viewing the pageant of the universe in its entirety, and contemplating man's rise from the protozoan to his highest spiritual stature, I find in the creative force that did all this, something we can worship with all the reverence that is in us." He was a member of the Unitarian Church in Milton, and the funeral services held for him there were described as dignified and impressive, simple and natural, as befitted the man. Alex was every inch a gentleman, loyal to his many friends, considerate of others, quiet and self-controlled but confident and decisive in action. He always seemed to be in tune with his environment and always in a good humor.

A cousin of Dr. Forbes, the late Dr. John F. Perkins, Jr., characterized his relative as follows: "Love of living every minute of the day, and a sustained spirit of adventure were Cousin Alex's way of life. Yet, I realized after he died that I had never really understood how different he was from the confident, swashbuckling prototype of an adventurer on the one hand, and the absent-minded professor, which he somewhat resembled, on the other. His love of living was a love of simple

things, like the sea or the mountains, and his apparent absent-mindedness—the result of preoccupation with important matters—concealed a cool-headed clarity of thinking and acting which enabled him to fly a plane for over a thousand hours without a major mishap, and to sail his boats for tens of thousands of miles with very few groundings. In 1926, when he took up flying in earnest, at the age of forty-four, many of us feared it would be only a matter of time before he had a serious accident; yet he never did, even though in his late seventies he was flying to and from far-off physiology meetings alone in his plane. Thus, a gentle, reticent, and absent-minded manner concealed a strength of will and a calmness which came to the fore in difficult situations, such as when he was lost at the age of seventy-six, alone in his airplane, somewhere between Buffalo and Boston, but said, 'I saw the top of Mount Monadnock sticking out of the fog and then I knew where I was.' He never panicked in such difficult situations."

Dr. Forbes had a fortunate boyhood with valuable opportunities for cultivating a love of adventure and manly sports, along with more scholarly pursuits. He attended Milton Academy from 1889 to 1899, where he received Honorable Mention three times for landscape and marine photography, helped to found a Debating Society, tied for third place in the Senior Class high jump, and read "a very witty class history" at Commencement. In writing of his school experiences he stated that he "liked especially [his] courses in physics and advanced Greek, both being taught by the brilliant and versatile scholar James Hattrick Lee." Between school and college Alex took a year out "living partly on a cattle ranch in Wyoming, camping in the Big Horn Mountains, working for a time in an electro-chemical mill at Rumford Falls, Maine, then traveling in the Pacific Coast states, and during the summer, in Switzerland, France, Holland, England, and Scotland."

In 1900 he entered Harvard College and graduated with an A.B. degree in 1904. As a student at Harvard he played on his class football team and was a member of several clubs, including the Institute of 1770, the Hasty Pudding Club, Signet, and Delta Phi. His graduation was followed by a year of graduate study with Professor G. H. Parker, in zoology, where he "learned the rudiments of electrophysiology." At that time this probably meant little more in the way of laboratory technique than the use of an inductorium with which to stimulate frog muscle, and the use of a smoked drum to record the contraction. Anyhow, this represented a nice combination of his interests in physics and biology. Thus he acquired an A.M. degree in 1905 and, more important, came to realize, on the advice of Professor Parker, that what he really wanted was a career devoted to the study of the physiology of the nervous system by the use of physical techniques.

Before starting on this career, however, he spent another year mostly in Wyoming, camping much of the time with his brother in a cabin which they had built during a previous summer at Lake Solitude, far up in the Big Horn Mountains. A period of outdoor living had been recommended by a physician in the hope that it might benefit a progressing otosclerotic defect. There they engaged in a combination of work outdoors, chopping wood and shooting elk, and indoors, studying chemistry and astronomy. An intriguing account of this experience is provided in an article which he wrote for the *Sheridan (Wyoming) Press*, July 18, 1962.

The next four years were spent at the Harvard Medical School where he received the M.D. degree in 1910. Before graduating he had become author or co-author of four scientific papers, two on foreign body giant cells, one on the Mendelian inheritance of hair patterns in guinea pigs, with Professor W. E. Castle, and one with Professor L. J. Henderson on "the esti-

mation of the intensity of acidity and alkalinity with dinitrohydroquinone." This in itself was an extraordinary accomplishment. In accordance with his preconceived plan, he did not take the usual internship, but immediately after graduation, joined the Department of Physiology, as instructor, with Professor W. B. Cannon. There he spent part of his time teaching physiology to medical students, and began his long series of papers on nervous reflexes. His research work was greatly enhanced by an opportunity to spend a year (1911-1912) in Liverpool with Professor Charles Sherrington, and a short time also with Keith Lucas at Cambridge. From these experiments he derived the real inspiration for his life work on conduction in reflex pathways. Later, in 1921, he spent a happy summer working with E. D. Adrian in Cambridge, England. During that summer, according to recent testimony of Lord Adrian, he made occasional trips to Oxford to consult with Sir Charles Sherrington and take lessons in flying.

Alex returned in 1912 from his first visit to England with new ideas, new techniques, and new equipment. He soon acquired one of the new Einthoven string galvanometers, the first to be installed in the Boston area. This instrument brought a new degree of accuracy into the timing of delays and interactions in the spinal reflex centers. The initial studies with it culminated in two classical papers with Alan Gregg in 1915 and other papers later, with other collaborators, in 1923 and 1928. Other studies during this period dealt with effects of anesthesia, of fatigue, of temperature changes, and of beta rays of radium on either nerve conduction, spinal reflex action, or the electromyogram. Usually the subject of study was the decerebrate cat, but sometimes it was man, and once it was an elephant which came as part of a circus troupe to entertain the children at the Children's Hospital, just outside Alex's laboratory window. He also obtained (with McPherson) what were

probably the first photographic records of spontaneous electrical activity of the exposed cerebral cortex of an animal, although, like his predecessors with more primitive instruments, he failed at the time to appreciate their full significance. Later, he turned to problems of spinal shock and muscle tonus and also to sensory systems, notably the proprioceptive and the auditory.

Improvements in recording technique were a continuing interest. Alex pioneered in the application of the electron-tube amplifier in the days when a condenser-coupled amplifier was a new idea, and he is credited with the first reported application of an electron-tube amplifier in nerve physiology (1920), using his string galvanometer as the recording instrument. Later he (with Renshaw) was one of the first to explore the brain with microelectrodes.

Probably the best-known and most influential of Alex's papers appeared early in this period (1922) in *Physiological Reviews*. In this classical work he endeavored to analyze in minute detail the transmission of impulses through reflex centers of the spinal cord and brain, and to interpret the observed reflex delays, summations, inhibitions, and after-actions in terms of what was known concerning the physiology of isolated nerves. In this effort he set a philosophy and a goal, both for himself and for a generation of neurophysiologists. It was not that his theoretical interpretations were all correct. Many of them in fact were soon proved inadequate, some of them by Alex himself. The point was that he demonstrated the possibility of an experimentally based, self-consistent system of interpretation, and he presented one which bristled with invitations for experimental tests and further exploration. It was a superb effort and established his reputation as a leader in the field. In the opinion (1949) of Hallowell Davis, who was his chief collaborator for many years, "This article can

justly be described as one of the foundations of the new science of cybernetics." This opinion was based on the great influence which this article had on Norbert Wiener and others who were interested in theoretical problems of organization and control.

The paper which Alex himself considered his most important contribution to science was published in 1926, with H. Davis, D. Brunswick, and Anne Hopkins as co-authors. This paper showed that, contrary to the teaching at that time, a nerve impulse in a uniformly narcotized length of nerve traveled with a uniform but subnormal electrical intensity and velocity, but without that progressive diminution which was the description previously taught. That description of "conduction with a decrement," Alex had reasoned quite correctly, was a violation of the all-or-none law of nerve conduction, and it was for the express purpose of clearing up this discrepancy that the investigation was first initiated.

Alex worked a great deal on problems of excitation and inhibition in the nervous system, and he finally accepted the idea that the transmission of excitation at synapses from one nerve cell to another might not be entirely electrical in nature but might involve the participation of excitatory or inhibitory neurohumors. These he whimsically described as "soup at the synapse," a term which came into wide use among neurophysiologists. Alex was always ready to change his published views when experimental evidence required it. He used to say, "People should understand that the literature is always in a state of flux."

In general it can be said that Forbes was one of the real pioneers in applying electrical recording to the central nervous system and in developing a unified interpretation, based directly on such measurements, which would include, alike, muscle, sense organs, peripheral nerve, and the reflex activities of the central nervous system.

This brief summary of the scientific work of Dr. Forbes shows that he made substantial contributions and had an important influence on his contemporaries. He published over a hundred scientific papers and had many distinguished collaborators. He was an instructor from 1911 to 1921, associate professor until 1936, and professor until he retired as Professor Emeritus in 1948, at the age of sixty-six. Even after his retirement, however, he continued his scientific work in the Department of Biology at Harvard. There he made a study of vision in the turtle, using an electroretinographic technique, and worked part time at the Veterans Hospital on the measurement of barbiturate narcosis. He continued to attend scientific meetings with his usual zest until the last year of his life, and often participated in the discussions. He became a familiar sight at such meetings, always in the front row, with his hearing aid and his head of white hair, bent forward to catch every word. It has been remarked that he had the features of his famous grandfather, Ralph Waldo Emerson, and he certainly had a distinguished and pleasant appearance. He usually went to meetings with his wife, Charlotte, and in his own airplane, although in his later years his license prohibited him from flying at night—somewhat to his chagrin. The writer and his wife have shared many Society banquet tables with Dr. and Mrs. Forbes; at future meetings the Forbeses will be sorely missed by many friends.

In 1910 Dr. Forbes was elected a member of the American Physiological Society and served as its Treasurer from 1927 to 1936. He was honored by election to the American Philosophical Society in 1931, and to the National Academy of Sciences in 1936. He received an honorary S.D. degree from Tufts College in 1952 and an honorary D.Sc. degree from Johns Hopkins in 1954.

In addition to his scientific work, Dr. Forbes loved outdoor

life, including skiing, horseback riding, figure skating, sailing, canoeing, camping, and flying. All of these he continued almost to the last with little or no concession to his advancing years.

To prolong his glide in a ski jump he once constructed a glider-type wing which he strapped to his shoulders before going over the jump. The experiment did not go exactly as planned, and he crash-landed below the jump in a jumble of broken spars and torn fabrics. As usual, he was more concerned over the failure of the experiment than he was with his own injuries which, fortunately, were minor.

With a canoe or kayak he made fifteen trips down the rushing water and the hemlock-lined gorges of the Westfield River, between 1914 and 1932, and recorded the experiences of his venturesome group in his "Twenty Years of the Westfield River," published in *Appalachia*, June 1937. Not infrequently the canoes capsized in the white water but this did not dampen the enthusiasm of the canoeists. Alex learned to know the river intimately, its danger spots and its favorable camp sites, and he recorded the height of the water nearly every year for twenty years.

Alex was particularly fond of sailing, and he did a great deal of cruising, mostly between Naushon Island and his cottage at Harbor Island, Maine; a beautiful but wild and rugged spot. He owned at various times the schooners *Black Duck* and *Ramah*, and the ketch *Stormsvala*. On one trip, in 1933, he sailed the *Ramah* all the way to Naples, Italy, with an all-male amateur crew, including his brother Edward and various relatives. He left the ship there for the winter and returned in the summer of 1934 with a crew of seventeen including his own family, Samuel Eliot Morison, and a group of college boys, to make a six weeks' cruise of the Mediterranean. Professor Morison wrote a delightful account of that voyage in his *Spring Tides* (Riverside Press, 1965). In that book he describes Alex

as "a truly remarkable character and one of the most versatile men of our era," and, in general, as "the best all-around shipmate and the most Christlike character I have ever known, whether layman or cleric."

There is ample testimony from many sources of Alex's skill as a navigator, and this entitled him to write a book, *Offshore Navigation in Its Simplest Form* (Eastern Science Supply Co., 1935). Morison writes that "as a practical navigator with sextant and dead reckoning, few professionals are his equal . . . his hardihood and indifference to creature comforts are the constant astonishment of his friends. Two years ago he sailed a small open lifeboat from Boston to Mt. Desert just for the fun of it. The young lieutenant commander who shared the same tarpaulin and the exiguous meals admitted that it was pretty rugged, but that Dr. Forbes' company made the cruise a wonderful experience."

Dr. John Perkins contributed the following: "Enthusiasm, the enthusiasm of a boy was ever present with Cousin Alex on the many cruises I was lucky enough to go on—to Nova Scotia in 1927, when we never stopped sailing and entering harbors in spite of fourteen consecutive days of fog; to Bermuda in 1930; to Naples from Cape Cod on the *Ramah* in 1933.

"Many of Cousin Alex's best physiological works were completed after these cruises had started. He would work away on the article in the cabin, as we sailed along with the schooner heeled way over, to be greeted by an occasional dash of salt water usually from a careless deck-swabbing operation, but he would manage to finish the paper nonetheless, in these less than ideal circumstances. As John Pappenheimer has indicated in his excellent Memorial Minute to Alexander Forbes, which was read in 1965 to the Faculty of the Harvard Medical School, he always kept a daily journal, kept up the log of the schooners *Black Duck* and *Ramah*, and the ketch *Stormsvala*, and the

log of the Harbor Island Club; possibly inheriting a sense of history from his grandfather Ralph Waldo Emerson. Literally hundreds of young and older people shared these happy adventures with Alexander Forbes. I was lucky enough also to receive a complete training in piloting and navigation from him as many others did."

In his 25th-anniversary report to the class of 1904 Alex writes of his cruises as follows: "In the matter of recreations I am overstocked, since a full count reveals that I have over fifteen hobbies. Most of my recreations depend upon water, frozen or liquid. The most absorbing interest, outside of family and work, is boating, especially cruising in sailboats; and I like that best when I can combine it with family by taking my children along and teaching them the lore of the sea. Everything pertaining to ships fascinates me, especially the theory and practice of navigation. This has led me to design a mechanical interpolator which aids me in the use of tables when working up a sight of the sun or a star These cruises mean much more than recreation; indeed they are often fatiguing and taxing to one's strength, for they have all been made without paid hands of any sort. They afford constant practice in self-reliance and decision, they give intimacy with the ocean and the weather—elemental things of nature; and they have given me some of the best friendships I have, for the men who make the best sailors are usually the kind that make the most durable friends."

For the summer of 1931 Alex had planned a cruise to Labrador, largely for recreation, but by chance Dr. Grenfell suggested that the coast of Labrador needed better charts. Intrigued with the idea of such a worthy objective for his cruise, Dr. Forbes consulted with the American Geographical Society and made contact with O. M. Miller, who was developing a new technique for making charts by oblique photography from

the air. What had started out as a pleasure cruise soon developed, therefore, into a scientific expedition in the 97-foot schooner *Ramah*, with a crew of sixteen including a geologist and a botanist. Alex was owner and skipper of the ship, and did a splendid job of piloting her through uncharted, perilous waters into safe anchorages among the islands and inlets of the whole Labrador coast as far north as Cape Chidley. Two airplanes were attached to the expedition for aerial reconnaissance and photography. The ship ran aground twice without serious damage. The ship supplied a base for aerial operations and for a crew to establish fixed markers on convenient mountain tops, the positions of which were tied together by triangulation for accurate location of the aerial photographs. In spite of innumerable handicaps the expedition obtained the necessary photographs and ground markers to permit the completion of the desired maps. The survey was further extended by another expedition in 1932 in which Alex was unable to participate, but in 1935 he went north again by plane, this time as relief pilot and photographer, with only a pilot-mechanic as companion. After eleven days they completed their task of photographing the region near Cape Chidley, on the northern tip of Labrador, and returned to Boston. Just south of Cape Chidley is McLelan Strait, the western entrance to which was named "Forbes Sound" after Alex, by the Geographical Board of Canada.

Dr. Forbes served in the U.S. Navy during both world wars. He began in World War I as a Lieutenant (j.g.), commanding for two months a small patrol boat in the approaches to Newport Harbor. He was then detached for research on radio receivers for airplanes, and was appointed Radio Officer on the scout cruiser *Salem*. Eventually (in February 1918) he was assigned to radio compass duty and sent aboard a destroyer to take charge of installing and getting results with this new equip-

ment in the destroyers and cruisers operating in European waters. This was an invaluable and welcome experience which not only familiarized him with techniques of electronic amplification for later use in physiology but also stimulated his imagination. The result of the latter was a book entitled *Radio Gunner*, which he wrote and which was published anonymously by Houghton Mifflin Company in 1924. This was a fictitious account of an imaginary future world war in which a young physicist has a job in the Navy similar to the one enjoyed by Alex. In the story he also manages to maintain private communication with a Harvard classmate, who is Secretary of the Navy, and between them they have exciting adventures, and contribute substantially to the winning of the war by the skillful use of new electronic direction-finding equipment installed on the battleships. The war which Forbes described in the book turned out to be remarkably similar to the World War II which actually happened. The story had also some further basis in fact, as is illustrated by a story about Alex, kindly contributed by a Navy shipmate of those World War I years, Mr. Laurence M. Lombard.

According to this story, Alexander Forbes, then a Senior Lieutenant in the U.S. Naval Reserve, had been assigned to Queenstown, Ireland, to install the newfangled radio direction-finders on U.S. destroyers. "During the weeks that followed, Alex, with his friendliness, informality, and brilliance (and perhaps his nonmilitary appearance, even when in uniform), became an amusing and respected character among the destroyer officers. They couldn't quite make him out. Unimpressed by, but respectful of, rank, he was equally as quick to recognize ability in the seaman or the electrician 3d class with whom he might be working as in a high-ranking officer."

The scene of the episode in question was in the harbor of Queenstown. It was to be a gala day because the Assistant

Secretary of the U.S. Navy was coming to inspect the U.S. forces. The big ceremony was to take place on the U.S.S. *Melville*, which was a floating machine shop of some 20,000 tons, and officers of all the ships of the fleet were ordered to attend.

“On this particular day, apparently oblivious of the ceremony about to take place, Alex was working with his instruments down in the depths of the *Melville*. On deck the crews in their dress uniforms were lined up at attention. The inspection party headed by Franklin Delano Roosevelt, the Assistant Secretary of the Navy, was just being piped on board. The bugle was sounding, all hands were at salute, and all eyes were on the gangway where F.D.R. was stepping on board. All eyes, that is, except those of a few sailors across the deck where, emerging from a hatchway, appeared the figure of Alex Forbes, hatless, disheveled, and in loose-fitting dungarees, apparently coming up for air. Surprised at the sound of the ship’s band, the gold braid of the officers, and the lines of sailors in dress uniforms, Alex looked around in astonishment. At just this moment the eyes of F.D.R. and his Harvard classmate met. ‘Why, hello, Alex.’—‘Hello, Franklin.’ The tension was broken, all hands could smile as the Assistant Secretary of the U.S. Navy shook hands and chatted with Lieutenant Forbes. And, as the Lieutenant in dungarees was introduced to the First Lord of the British Admiralty, Alex’s stock went up another notch in the eyes of the Queenstown flotilla.”

At the close of that war, Alex returned to his post in the Department of Physiology at Harvard, interrupted only by his summer survey of the coast of Labrador. When World War II broke out he joined the Navy again, at the age of fifty-eight, this time as Lieutenant Commander, and was first assigned to the Pensacola Navy Laboratory to investigate the use of electroencephalography (brain waves) as a test for airplane pilots. Shortly thereafter, however, because of his familiarity with Lab-

rador he was assigned as "technical adviser" to a reconnaissance expedition in that region commanded by Captain Elliott Roosevelt. The purpose was to select locations for airfields so that fighter planes could fly under their own power to England via Iceland, to avoid the risks of submarine attack. This expedition lasted about three months and three different sites were recommended.

On his return to Washington he brooded over the navigational difficulties of ships trying to reach the sites selected for the construction of airports, and wrote a memorandum to the War Department recommending an expedition to chart the necessary channels. He had special concern for the site chosen on the Koksoak River flowing north into Ungava Bay. The result of this memorandum was that he was assigned to the Army Corps of Engineers for survey duty on the Koksoak River, but the orders were changed after his departure, and he ended up with four months in the approaches to the Frobisher Bay station. He spent the next few months exploring the bay, charting the channels, and piloting big ships to their destination through those perilous waters.

Back again in Washington, he spent the winter helping to put his data to use in making maps, and he even had his wife helping in drawing the charts. By June 1943, however, he was again flying north to the Koksoak River station, as officer in charge of a hydrographic survey. This was a most unusual assignment for a medical officer, but one which he was well fitted to undertake. Here the problem was to set up a network of tripods on the shore which could be located accurately by triangulation, and to make soundings of the channel. Part of the time he was sleeping in uncomfortable little tents on the shore, with swarms of mosquitoes, and one night he spent in an army MT boat, stuck on the rocks until the tide came in. In the boat there was no place to sleep, but he reports that

"I stuffed myself part way down the hatch and toward sunrise managed to doze a bit." By the end of summer he was back in Frobisher Bay for another hydrographic survey, returning to Washington in October.

The account of his rugged seafaring experiences on this trip was published in his book *Quest for a Northern Air Route* (Harvard University Press, 1953). In that book he writes, "Few indeed are the fields of human endeavor in which real manhood is displayed to better advantage than in good seamanship." The statement was intended to express his admiration for one of the skippers with whom he worked, but, according to this criterion, Dr. Forbes himself easily met the test of "real manhood" in every way. Airports were actually built as a result of this effort, but it was a little frustrating for the participants that in the end they were never actually used very much for the purpose for which they were built.

Back in Washington, Alex continued working in the Hydrographic Office, collecting better instruments for making maps from the mass of data which he had collected in the north, and sometimes preparing maps for emergency military landings in the Pacific, or preparing a "ponderous" report on the dissipation of smoke screens. This report, like others from Labrador, was never used during the war, and Forbes wrote in his book, "It was my lot, I believe, to be involved in more of these fortunate futilities than any other man in the Navy."

Then came the end of the war and the atom bomb test at Bikini. Alex was sent out on the Operation Crossroads mission to apply his familiar techniques to mapping and measuring the waves generated by the explosion. In a book by David Bradley, describing these tests (*No Place to Hide*, Little, Brown and Co., 1948), a story is told of the day when Alex set out to inspect the various cameras set up to record the explosion. A "big, burly, somewhat overfed Marine photog-

rapher" who was assigned to accompany "the white-haired gent" came back at the end of the day prostrated with exhaustion, for as soon as he reached a wharf Alex "leaped ashore and headed straight cross-country, taking the dense underbrush at an easy lope. Up the first tower he scrambled as though taking in the topsails for a squall. By the time the puffing Marine had struggled to the top, Dr. Forbes had finished inspecting the cameras and their radio-control mechanisms, and was on his way down." And so it went for the rest of the day. Similarly, in the log of the schooner captain in Labrador, Alex was referred to as "O.G.," which stood for "old gent." With his white hair and hearing aid he looked older than he acted.

His years of duty in the Navy terminated in Washington in 1946. He was promoted to Commander in 1943 and to Captain in 1945. He returned to Boston in time to be retired as Professor Emeritus in 1948. In spite of all the excitement of his years in military service he found no difficulty in resuming his work in physiology with the same zest as before, and completed the publication of eighteen more scientific papers with eighteen different young collaborators, mostly on the electrical changes in the retinas of frogs, turtles, and lizards when exposed to lights of varying wavelengths. He also had an opportunity at this time to record for the first time a slow change in potential of one millivolt in the human mammary gland when stimulated either by the act of nursing or by the injection of pituitrin.

Although Dr. Forbes was never very active in civic and political affairs, he often was concerned enough regarding political issues to write hot letters to newspapers, to congressmen, and to his old friend and classmate, Franklin Delano Roosevelt, during the latter's Presidency. (It is reported that he never voted for F.D.R.) He did, however, become very much

interested in the George Junior Republic in Freeville, New York, and spent many hours and much money in helping that institution to train boys and girls for responsible citizenship. He continued his interest in the institution until his death, and was President of the Board of Directors for thirty-six years. In 1964 he was presented with a testimonial of admiration and gratitude from the institution, dedicated to "a great, good, and lovable man as he begins his sixtieth year of deep commitment to the unchanging purposes of this organization."

Dr. Forbes's own appraisal of the George Junior Republic can best be described in his own words as follows: "This educational project, founded by William R. George in 1895, has had a most profound influence on educational methods in training adolescent boys and girls by placing the responsibilities of self-government and self-support squarely on their shoulders. Thus it was the chief pioneer in pointing the way toward such self-government as has been adopted in schools throughout the land. The success of this method as a therapeutic measure in the case of certain maladjusted young people has awakened the interest of psychiatrists as well as educators. Most noteworthy of all has been its contribution to responsible citizenship." Alexander Forbes was not blind to social problems and civic responsibilities.

Alex was always the life of the party in any gathering anywhere, and seemed to be as much at ease in the White House as in an Eskimo hut in Labrador. His rich and varied experiences gave him a wealth of material for good stories which he told with great good humor. Mixing as he did good solid science with a love of somewhat risky and ambitious undertakings on the high seas, on the mountain peaks, or high above the clouds in an airplane, he represented a type which is seldom encountered in the world today. He tells of picking up a

textbook of physiology in an isolated outpost in Labrador in which he found an account of some of his own earlier work on reflex conduction. He writes that he found great difficulty under those circumstances in recognizing himself as the scholar who could have carried out the investigations which were recorded. The scientific and the adventurous were, however, the two sides of his character. With less opportunity for such colorful but useful adventures he would have contributed even more to science than he did, but his total contribution to his friends and to the country would have been far less. We loved him for what he was, and will never forget his enduring enthusiasm which seemed so easily to overcome all the obstacles that lay before him and endeared him to all who knew him.

ACKNOWLEDGMENTS

IN PREPARING this biography I have borrowed freely from less extensive memoirs previously published by Dr. H. Davis (*J. Neurophysiol.*, 28:986, 1965, and *Electroencephalog. Clin. Neurophysiol.*, 1:139, 1949), by Dr. John R. Brooks (*Harvard Medical Alumni Bull.*, May 1959), by Dr. Richard H. Miller (*Harvard Medical Alumni Bull.*, 1949), by Lord Adrian (*Electroencephalog. Clin. Neurophysiol.*, 19:109, 1965), and by Professor John R. Pappenheimer and the members of his Harvard Medical School Committee who prepared the official memoir for the University (*Harvard University Gazette*, 61:32-33, 1965). I have had access also to the autobiographical statements which Dr. Forbes himself wrote for his Harvard Class of 1904 reports and for the National Academy of Sciences (unpublished). For help in the collection of pertinent material, may I thank also Mrs. Joseph R. Frothingham, daughter of Dr. Forbes; my brother, Roger C. Fenn, of Concord, Massachusetts, and my nephew, Donald Duncan, of Milton Academy; as well as other friends mentioned in the text: Laurence M. Lombard, John R. Perkins, Jr., and especially Hallowell Davis, who has been particularly helpful in amplifying my account of the scientific work of Dr. Forbes.

BIBLIOGRAPHY

KEY TO ABBREVIATIONS

- Am. J. Physiol. = American Journal of Physiology
 Electroencephalog. Clin. Neurophysiol. = Electroencephalography and
 Clinical Neurophysiology
 Fed. Proc. = Federation Proceedings
 J. Appl. Physiol. = Journal of Applied Physiology
 J. Med. Res. = Journal of Medical Research
 J. Neurophysiol. = Journal of Neurophysiology
 J. Opt. Soc. Am. and Rev. Sci. Instr. = Journal of the Optical Society of
 America and Review of Scientific Instruments
 J. Physiol. = Journal of Physiology
 Photogrammet. Eng. = Photogrammetric Engineering
 Physiol. Rev. = Physiological Reviews
 Proc. Nat. Acad. Sci. = Proceedings of the National Academy of Sciences
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