at the request, and under executive order, of the same great President, in order to develop more fully and effectively purposes stated and implicit in the charter of the academy, which in course of time had resulted in functions so various and important that a special executive branch of the academy was needed for their proper performance.

Prior to the current year the presidency of the academy and the chairmanship of the National Research Council were held by different persons, and for the first time during the current year these two offices have been united with the aim of bringing about closer correlation of operation between the academy and the council. I think it may be said that this aim has been to some extent realized. The proper performance of both duties, however, presupposes a degree of vigor and activity that only a younger person could hope to possess; and it therefore seems indicated that as soon as possible a separation of these offices should again take place.

The current year has also been marked by the union of the Science Advisory Board with the Committee on Government Relations of the National Academy of Sciences with the idea of centralizing the performance of our charter obligations to the government which had become scattered among two or three bodies of the academy and the council. The distinguished services of the Science Advisory Board are well known and are permanently recorded in its published reports. The benefit of these services has carried over; and, during the current year, not only have certain of the committees of the Science Advisory Board been continued, but new requests for aid and advice of the academy have been received from the departments of commerce, agriculture and the navy, and also from the National Resources Committee, which are now in process of examination.

An unusually enjoyable and well-attended autumn meeting of the academy was held at the University of Virginia last November, when the pleasures of Southern hospitality were experienced to the full. The academy has accepted an invitation from the University of Chicago to hold its next autumn meeting in November of this year in those equally delightful, but very different, surroundings. The autumn meetings of the academy carry the message of the academy to different regions of the country in successive years.

For the rest I can only say that the academy remains firmly founded on the bed-rock of scientific research, and serene in confidence in orderly thought, whether for the understanding or control of the processes in nature and in man. If any change of attitude is to be noted, it is in an increased state of consciousness of public and social responsibility, which developed rapidly under the stress of the great war, and of these recent times of economic depression, stimulated by an awakened public confidence and interest in science. There is no present danger, in our country at least, that scientific discovery and thought should be underestimated or suppressed; this condition should heighten our sense of responsibility to see that its power and authority are not exaggerated. The true friends of science recognize that limitations are set in nature and in the mind itself to scientific progress. We can not predict its rate, direction or extent for any considerable period of time. Yet I think that experience should give us confidence to claim that the conquering spirit of science is one of the strongest components of ideal social processes; and always will be.

MEDALS OF THE NATIONAL ACADEMY OF SCIENCES

PRESENTATION OF THE AGASSIZ MEDAL TO DR. THOMAS WAYLAND VAUGHAN

THOMAS WAYLAND VAUGHAN, long a member of the academy, is so well known to most of you here tonight that there is no occasion to outline his biography, or to dwell on his many scientific publications; my privilege is, rather, to present to you the essence of why he has been adjudged most worthy recipient of the Agassiz Medal for eminence in the science of the sea. The oceanographer is constantly reminded that understanding of the margins of the oceans, and of the parts of the earth's crust on which the latter rest, is as integral a part of his science as is examination of the waters themselves, for these geologic features determine the extent, depths and circulatory systems of the oceans, with all that this applies. Conversely, we can not hope to understand the geology of continents or of islands until we understand the structure and history of continental shelves, of ocean floors or of the great corrugations of the latter. It is, therefore, eminently fitting that the academy should honor one who, commencing his career as a geologist, soon turned to the geological history of shore lines and of the sediments of the sea—especially when we remember that the donor of the medal, Sir John Murray, was himself the most eminent student of oceanic deposits. We see Vaughan's genius and the part he has played in the progressive unfolding of submarine geology in his studies of the corals and coral reefs of past ages, of the history of the islands of the West Indies and of the Floridian almost-island; of the organic skeletons that accumulated on the sea floor in past geologic ages, as exemplified especially by the fossil Foraminifera; leading, in order of evolution, to his examination of the composition of modern sediments, Atlantic and Pacific.

However, if I could, I would paint a word picture of Vaughan's great and unique service to oceanography in quite another field. For centuries past, the Pacific had carried the commerce and navies of the nations on their lawful occasions; and the nature of its surface waters had been examined, at many hands. Yet, the vast underlying bulk of Pacific waters hid their secrets. And a few years ago an area still remained, off to the westward of lower California, twice as large as the Republic of Mexico, still to be violated by its first sounding; a *terra incognita* extended from Hawaii toward the Aleutians and Japan, larger in area than the continental United States, cut by only one line of landings; and still to be marked by a single measurement (by modern standards) of the physical or chemical nature of the underlying waters. That the picture has now changed—that scientific observation, by different nations, has been focused on the wastes of the Pacific, the greatest unexplored areas on our planet—that the future of oceanography in the Pacific is now rosy, we have Wayland Vaughan chiefly to thank.

Of the many-sided ways he has brought this about, time lets me speak in particular only of his work at the Scripps Institution, for this illustrates the master's touch. Vaughan came in 1925 to direct this, one of the few institutions of its sort in the world. Thenceforth—reading between the lines—we see his intellectual leadership, see him projecting his thought ahead along all the avenues of research that have led there, to such wide advances in knowledge of Pacific circulation in general, of Californian up-welling waters and their effects on organic fertility, of ocean dynamics, of the interrelation between sea temperatures and meteorologic phenomena.

As a last evidence of the esteen in which Vaughan is held by his scientific colleagues I may quote the saying that "great men have great and little men have little men to succeed them." It is no secret that the day of Vaughan's retirement in the Scripps Institution draws near and that one of the most eminent of physical oceanographers is to be his successor.

HENRY B. BIGELOW

WOODS HOLE OCEANOGRAPHICAL INSTITUTION

RESPONSE OF THE MEDALLIST

President Lillie, Dr. Bigelow and other members of the National Academy of Sciences:

I THANK you for having selected me as the recipient of the Agassiz Medal for the year 1935. Besides my high appreciation of the honor that the National Academy has conferred on me, I feel deep personal satisfaction because of the association that I had for years with Mr. Alexander Agassiz and Sir John Murray.

It has been the custom for recipients of medals from the academy to give short accounts of their personal researches. After I graduated, with a major in physics, at Tulane University in New Orleans in 1889, I was for three years a teacher of physics and chemistry in a junior college in the village of Mt. Lebanon in northwestern Louisiana. Around that village there were many excellent exposures of marine fossiliferous deposits of middle Eocene age. They attracted my attention and I immediately began to collect fossils and to make studies of the local geology. I wished to ascertain the conditions in the sea under which the different organisms once lived and under which the enclosing sediments had been deposited. The series of questions that presented themselves determined the course of my life.

The purpose of most of my scientific work has been to add to knowledge of geological history by studies of marine geological formations—both the organisms contained in and the other materials composing such deposits. I had not advanced far in such studies before it became obvious that the only reliable basis for interpreting the past was knowledge of conditions under which organisms now live and under which the various kinds of marine sediments are now deposited in the sea. Occasionally some of my geological friends have accused me of having deserted geology. My reply to such accusations has been that I have not abandoned geological investigations, I have merely shifted emphasis from the product to the process aspect of the science.

The fact that the Agassiz Medal has been awarded to me is evidence that in the opinion of my scientific colleagues I have accomplished something of value. This greatly pleases me, but I must say that without the support of several powerful scientific organizations and the assistance of many scientific colleagues what I have done would not have been possible. I wish to express to the officials and other colleagues in the United States Geological Survey and to the officials and other colleagues in the Smithsonian Institution thanks for the support that they have given to my work through more than forty years. I am still a member of the staff of each of those organizations and their help has continued uninterruptedly to the present. I am also under obligations to the Carnegie Institution of Washington, particularly to my old friend, Alfred G. Mayor, for assistance from that source. The University of California and the members of the staff of the Scripps Institution of Oceanography have helped me in more ways than I can mention in these few words. I have also had assistance from many organizations and many individuals whom I can not here name. To all the organizations and to all my scientific colleagues who have helped me I wish to express my gratitude.

I mentioned that for years I was associated with Mr. Alexander Agassiz and Sir John Murray. While I was a graduate student at Harvard in 1892–94 Mr. Agassiz first asked me to help him with the identification of some of the corals that he had collected in his expeditions in Florida and the West Indies. This initiated between him and me a rather close relation which continued until his death in March, 1910.

In the recent discussions of coral reefs and the hypotheses for their formation sight has almost been lost of Alexander Agassiz's researches on coral reefs and of his valid contributions to knowledge of them. We now have reason to believe that a considerable part of his interpretations of the history of reefs was not well founded, for instance, he did not recognize the evidence of coastal submergence in many coral reef areas and he did not recognize that the surface waters in those areas will not dissolve limestone, but much of his work was sound and some of his important opinions have recently been corroborated. I wish particularly to call attention to the results obtained by J. Edward Hoffmeister and Harry S. Ladd in the Fiji and Tonga Islands. That many of the reefs in those regions are growing as veneers on limestones of Tertiary age, largely not of coral origin, has been demonstrated.

I first met Sir John Murray in Russia at the International Geological Congress there in 1897. At this congress he manifested one of his characteristic traits. Instead of devoting his attention to the older scientific men he asked a group of young American geologists if he might join it. We felt honored, and thereafter he drank, smoked and told stories with us so long as we could be together. The result was, at least for me, the formation of a friendship which lasted until he died. The last communication that I had from him, before his death in a motor accident in March, 1914, was a copy of his small volume, "The Ocean," the dedication note accompanying which is dated 5th November, 1913.

This medal, therefore, has for me significance in that the fund to establish it was contributed by one of my dear friends, and it is in memory of a man with whom I had close and friendly relations for many years.

A few remarks about some of the efforts made to promote oceanographic research in the United States between 1910 and the establishment of the Scripps Institution of Oceanography in 1925 may be of interest. In 1911 after Sir John Murray had delivered in Cambridge his memorial address on Alexander Agassiz, he and Lady Murray came to Washington and spent several months here, having an apartment in the Shoreham Hotel, across the street from the Cosmos Club, for which he had a visitor's card. While he was here I saw him almost every day. He did not only what he could to encourage oceanographic interest among those whom he met in Washington, but he also tried to bring about oceanographic research on the west side of the North Atlantic which would conform in method and be contemporaneous with the investigations that were being conducted on the east side of the North Atlantic under the auspices of the International Council for the Exploration of the Sea and with the work of such distinguished Norwegians as Helland-Hansen, Fridtjof Nansen and others. After leaving Washington he went to New York where Professor Henry Fairfield Osborn organized a dinner for him concerning which he said in a letter to Sir William Herdman, "Osborn is to have fourteen millionaires to hear me at the Museum as to what they should do for the study of the Ocean!! May it have some effect!" The attempt to establish an oceanographic institution at that time, 1911, was not successful, but the effect of Sir John Murray's efforts to promote oceanographic research in the United States was continuing.

A few years later when Nansen was in Washington, I think it was in January, 1918, a group of 25 or 30 scientific men interested in oceanography gave him a dinner at the Cosmos Club, and after dinner he delivered an informal address on oceanography. Nansen especially emphasized the necessity for the intensive study of oceanic circulation. His advocacy of oceanographic research in the United States did not bear immediate fruit, but his influence was similar to that of Sir John Murray in that it was one of the factors that later helped in the development of oceanography in this country. As has already been said, I was personally associated with Sir John Murray in his efforts to advance the study of the ocean in this country; and I was one of those who attended the dinner in Nansen's honor and subsequently took part in the discussion of his able address.

For some reason, which I do not know, it was decided before Dr. W. E. Ritter's retirement from the directorship of the "Scripps Institution of Biological Research" to convert the institution into one for oceanographic research. In 1923 I was offered the directorship of the institution, and its name was changed on October 25, 1925, from "Scripps Institution for Biological Research" to "Scripps Institution of Oceanography." Therefore the Scripps Institution of Oceanography was the first institution in the United States that had for its major purpose the prosecution of research on the ocean.

It was about 1924 that Dr. Wickliffe Rose, of the Rockefeller Foundation, became interested in the promotion of oceanography. Shortly after that the National Academy Committee on Oceanography was established, and as a result of its efforts the Woods Hole Oceanographical Institution was founded, assistance was given to the establishment of the Oceanographic Laboratories of the University of Washington, and some help was given to the Scripps Institution of Oceanography.

Since I think that the efforts of Sir John Murray and Nansen to promote oceanographic research in the United States are not generally known, the statement that I have made may be of some historic interest.

In closing I wish to reiterate my thanks to the members of the National Academy for conferring this medal upon me and again to pay homage to my two old friends, Mr. Alexander Agassiz and Sir John Murray.

T. WAYLAND VAUGHAN

PRESENTATION OF THE PUBLIC WELFARE MEDAL TO DR. FREDERICK FULLER RUSSELL

THE curiosities which stimulate the development of the sciences are sometimes derived from abstract contemplation of the known facts and their cataloging concepts. These curiosities arise with compelling insistence, however, when a scientifically conceived attack on an important practical problem reveals the inadequacies of existing knowledge. The achievements of Frederick Fuller Russell are important examples of the successful application of science to human welfare, and illustrate the advance of science through the interplay of theory and practice.

After receiving his medical degree at the College of Physicians and Surgeons of Columbia University, and continuing his studies in Germany, Russell joined the army at the outbreak of the Spanish-American war. He spent three years in Puerto Rico, then taught bacteriology and pathology at the Army Medical School and at George Washington University. In 1914 he went to Vera Cruz with the army of occupation and later served in Panama. In the world war, as assistant to the Surgeon General, he organized and administered the Division of Laboratories and Infectious Disease of the Surgeon General's office. He received the Distinguished Service Medal in 1919.

Russell's work throughout this period showed the qualities of practicality, drive to fundamentals and scientific curiosity which characterized his later years. His bacteriological studies yielded important results, an example being the Russell Double Sugar Medium by means of which recognition of typhoid became easy and positive. One contribution, however, was so vitally important as to overshadow the others. He simplified and systematized the procedures for vaccination against typhoid which had been studied experimentally in the laboratories, gave a mass demonstration of its safety and certainty of protection by introducing it in the army with such immediate and complete success that it became standard practice almost over night. It might be possible to estimate the number of lives saved under ordinary conditions by this procedure, but what the death rate from typhoid would have been without it during the world war can be only imagined.

Russell's active service in the army medical work ended in 1920. In that year Dr. Wickliffe Rose, who had organized the public health work of the Rockefeller Foundation, invited him to join in the work as director of laboratory service. Russell resigned from the army, and was commissioned a Brigadier-General in the Reserve Officers Medical Corps the following year. In 1923 he succeeded Rose as director of the International Health Division, a position he held until his retirement from the foundation in 1935, when he became a lecturer in public health at Harvard University.

Russell brought to the Foundation high abilities for administration as well as unusual aptitude and training in scientific medicine. Under his direction the International Health Division continued its sympathetic and understanding cooperation with governments in building up public health organizations and in training public health personnel, and intensified the efforts of its own staff in disease control. To Russell disease control meant the study of disease in its environment, by men of thorough scientific competence. This field work was backed by basic laboratory work at home, and constant interplay between field and laboratory ensured the rapid application in the field of new laboratory findings, while the studies and experiences in the field stimulated new research at home. Only by insistence upon this unity of effort could such remarkable progress have been gained in the etiology and control of malaria and yellow fever as was accomplished by the staff during Russell's leadership.

The story of these achievements has been told elsewhere. The complexities met with in malaria control have led to much greater understanding of the nature of the disease and of its carriers, and the previous pessimism regarding its eradication has disappeared. Through dangerous and unforgettable days of hope and disappointment the struggle for control of yellow fever went forward. Under Russell's generalship the staff in Africa, South America and New York worked as a unit, braving and suffering sickness and death from the insidious virus. For weeks and months Russell's deep concern for the safety of the staff brought him close to ordering a discontinuance of the work, and his days and nights were heavy. But step by step new knowledge came, and finally safety, with the securing of an inoculation technique which gave positive immunity. Now with increasing speed fundamental knowledge could be gained without the sacrifice of health or life, knowledge from which we know the endemic areas, more of the etiology of the disease, more of the nature of the virus.

Such is the nature of the work of Russell, the scientist and the administrator. Those of us who have counted him as a colleague and love him as a friend alone know the full measure of the man.

MAX MASON

RESPONSE OF THE MEDALLIST

Mr. President, Mr. Mason, Members of the National Academy of Sciences, Ladies and Gentlemen: I thank you most sincerely for the honor you have done me in presenting me with the Marcellus Hartley medal. I realize, as you all do, that the medal is given me because I was the director of a group of workers, and that the honor is for the group and that on this occasion I merely represent it.

Ever since I heard of the Marcellus Hartley plan I have been most interested in the idea and have wondered at the clever insight into affairs as they are, which is shown by the donors of the medal. You all know, especially those of you who have worked with governments, that they feel that each government has reputation and prestige to maintain, and that a government may be just as jealous of its reputation, in any field, as are some of the sensitive individuals that we all know. It is therefore quite true that work done in aid of governments may receive little recognition by the public and that only those, such as the members of the academy, are in a position to know the facts of each case. To the workers themselves, in such cooperative work, the desire for credit plays a very small part. They are as a rule, and especially if successful, quite content to see the march of progress from the side-lines, and to get their satisfaction from seeing the improvements in public health and the elevation of the general welfare of the people, and to be quite without feeling as to who receives the credit, since the government itself usually arranges for the publication of all reports on cooperative undertakings, and rightly so, since successful innovations become a regular part of the government program for the future.

The director of a voluntary organization, as contrasted with a government bureau, sits in the background; his work, in a general way, resembles that of the chess player; he can choose his knights and bishops and rooks and pawns, and move them into place for the opening of the game, but after that he cooperates, that is, he watches the game, makes moves at critical periods and then waits for a move from the other side. It is often slow, but always interesting, for there are many opportunities for suggestions, for the introduction of new elements of personnel, materials and ideas, and watchful waiting is essential.

With such conditions to deal with, one would not be very active with one game, at a time, so it has long been our custom to have several games proceeding simultaneously, and the director moves carefully from one to another, always looking for an opportunity to make a gain in some one of the projects. Obviously, one could overdo this sort of thing, and have so many games running that the scattering of effort would result in lack of concentration and wasted energy. We, therefore, always limited the number of projects, and since human life, especially its active part, is relatively short, we chose short diseases, to be used as demonstrations in the teaching of public health. Little can be done by decree, as you know, in influencing the habits of a people, so that the main point of effort has always been in education toward better things. Cancer, tuberculosis, leprosy are examples of long-drawn-out diseases, and in tuberculosis and leprosy the patient may live as long as the investigator. So we chose short diseases for demonstrations and studies. Yellow fever and malaria and hookworm are examples of such short and simple diseases that are, at least on their face, easily understood by the laity and therefore good for the purposes of education.

Very early in our work we learned that existing knowledge, no matter how extensive, was rarely adequate for practical control; there were too many loopholes in our knowledge, so we learned that we must carry out studies of each disease in its own environment as we endeavored to bring it under control, or to bring about its eradication. The basis of our programs became simultaneous study and control, in the field, and under natural conditions; only in this way could we acquire the necessary scientific basis for real progress at a cost within the means of the population involved, and that system has produced worth-while results, and there has been a constant tendency to lay more and more stress on field research as time went on, since obviously more accurate knowledge of the problems involved permitted us to carry out campaigns of control at a constantly diminishing cost in money and in personnel.

An example of such an effort is furnished by the yellow fever work. You have all heard of yellow fever as a disease from which we formerly suffered at irregular intervals, but to most of us in this part of the world the disease is no longer a threat, and some of us may even look upon it as an extinct disease. For us in the United States it was, until the introduction of travel by air. In former days, the disease was carried by sailing vessels and they bred the necessary mosquitoes in the open water butts; with the introduction of steam vessels, which carried their supply of water in closed tanks, the breeding of mosquitoes on board ship no longer went on, and steamships did not carry the disease from port to port. The incubation period of the disease is short, five or six days, and as the voyage from yellow fever ports to the United States was usually longer than that, the danger of its introduction of the disease rapidly diminished.

With the introduction of air travel, the whole situation changed, the duration of the voyage was so shortened that persons could arrive from the yellow fever regions within the incubation period of the disease, and we know that the person who is first taken sick after arrival in Miami might infect the local mosquitoes before any one was aware of the danger. Furthermore, a mosquito in nature probably has a life span of about three weeks, and during that time it can carry the disease up to the last day of its life. The carriage of mosquitoes by airships thus becomes a problem of first importance. I will return to this aspect of the problem later.

The number of cases of yellow fever reported from the regions where it is constantly present is always small, and yet we know that cases must be constantly present or the disease would die out. There must be many mild cases which give no characteristic symptoms, and as a result of field and laboratory studies a method was discovered by which one could reach a decision regarding the diagnosis of mild cases, and we found as a result of extensive studies that most cases of yellow fever are mild; they are diagnosed as headache, malaria, influenza and many other things, yet the protection test, with yellow fever virus, and the patient's blood serum indicated that the patient, no matter how mild the attack, was now immune as a result of a mild infection. This being true an extensive survey was planned of the yellow fever area in the Americas and in Africa. As a result of those studies, it is now possible to draw maps showing the extent of the disease in the two regions. These show that the infection has not occurred in recent years in the United States, Mexico, Central America or on the West Coast of South America. On the other hand, they show that it is still present in the Amazon Valley, particularly the upper valley, and that the region includes parts of Colombia, Equador, Peru and Bolivia as well as Brazil. On the African continent, it prevails along the West Coast from Dakar south almost to Portuguese East Africa, and extends inland almost to the borders of Ethiopia. It involves the southern part of Senegal and the Anglo-Egyptian Soudan, and the area extends south to include the upper half of the Belgian Congo.

Both the South American and the African regions, where the disease is endemic, are traversed by air travel routes, and the time of the journey is within the incubation period of the disease. We know, therefore, that the possibility exists of again introducing the disease into Southern Europe and the Southern States, but with this knowledge we can act intelligently and introduce safeguards in air traveling.

Strangely enough, Europe, which has always regarded Yellow Jack as an American disease in which it had no interest, has now become very much alive to the danger, and the Colonial powers and the League of Nations are awake to the need for proper safeguards for air travel from Africa to Europe. In the Americas, the Public Health Service has already taken measures in cooperation with the South American republics to insure safety.

I cite these things to serve as an example of the work which was done by various governments and voluntary organizations in the control of one of the world's most dreaded plagues. Work of this sort, as you see, can and must ignore political boundaries, and the results can only be obtained as a result of understanding between the workers of different nations who all have a common objective, of conquering a plague and providing better conditions for the nationals of many different countries. The work is done by many persons, and of course they all deserve credit, and in a gracious way you have recognized this, in the setting up of the Marcellus Hartley medal, which you have granted me this year, and which I am delighted to accept, with the feeling that in granting it you recognize the merit of the many persons who have shared in the work and that I am merely a symbol for cooperative, scientific effort to improve the condition of mankind through the application to human welfare, of whatever scientific truths and methods that are possible.

Again, Mr. President, I thank you for the honor and for this opportunity of speaking for my coworkers.

FREDERICK F. RUSSELL

ABSTRACTS OF PAPERS PRESENTED AT THE WASHINGTON MEETING OF THE NATIONAL ACADEMY OF SCIENCES

Torsion of rectangular tubes: WILLIAM HOVGAARD. The stresses in tubes subject to torsion are generally determined on the basis of a hydrodynamical analogy first pointed out by Lord Kelvin or by means of a membrane analogy developed by Prandtl. For thin-walled tubes an approximate solution was worked out by Bredt, applying Stokes's theorem. The shearing stresses are conceived to flow in the manner of an ideal fluid as a