A History of the First Half-Century of the National Academy of Sciences: 1863-1913

Committee on the Preparation of the Semi-Centennial Volume

ISBN

427 pages
7.5 x 10.5
1913

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WASHINGTON
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The Lord Baltimore Press
BALTIMORE, MD., U. S. A.

COMMITTEE ON THE PREPARATION OF THE SEMI-CENTENNIAL VOLUME

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PREFACE

MANY of the members of the National Academy of Sciences, especially those elected in recent years, have frequently expressed the wish to become acquainted with its early history, particularly that of the formative period of the organization, and also with the work it has done in behalf of the Government. As the information on these subjects which can be gathered from the early publications of the Academy is neither in connected form nor very extensive, it was decided in 1909 to have prepared for publication, in connection with the semi-centennial celebration of the Academy, a volume containing as complete an historical summary as could be brought together in the time available. A committee was appointed to take charge of the matter, and in the summer of 1910 the services of Dr. Frederick W. True were secured as editor.

Besides consulting the early records of the Academy, it was necessary to seek information from outside sources. The work of preparing this history, which has been arduous, is highly appreciated by the members of the committee in charge, who have realized the varied and baffling nature of the undertaking and desire to express their approval of its accomplishment. It is believed that the information assembled in this volume will afford a good insight into the nature of the activities of the Academy. The bibliographical references which it contains will enable those who desire more detailed knowledge to find it in the original documents.

As the Academy has established a series of publications known as the *Biographical Memoirs,* containing records of the lives and works of its members, it has not been thought necessary to attempt the preparation of new biographical sketches, but the volume contains brief notices of the lives of the incorporators, or original members, drawn chiefly from those included in the series mentioned.

It was hoped that a list of the scientific communications presented to the Academy during the half century, some two thousand in number, with references to the places of publications, might be added to the volume, but it was found impossible in the time available to compile the necessary data. The completion of this undertaking is therefore necessarily deferred until a later date.

ARNOLD HAGUE,
Chairman of Committee.

JANUARY 10, 1913.

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THE FOUNDING OF THE ACADEMY

THE National Academy of Sciences owes its origin as an organization, in an indirect manner, to the need of the Government for technical scientific advice in connection with the conduct of the Civil War. In February, 1863, the Secretary of the Navy, Gideon Welles, appointed a "Permanent Commission," consisting of Joseph Henry, Secretary of the Smithsonian Institution, Alexander Dallas Bache, Superintendent of the Coast Survey, and Charles H. Davis, Chief of the Bureau of Navigation, Navy Department, to report on various "matters of science and art," but chiefly of a practical import and relating to the physical sciences. These experts considered numerous subjects, and gave their opinion regarding them.

The letter of appointment, which is preserved in the archives of the Navy Department, is as follows:

"NAVY DEPARTMENT,
"February 11, 1863.

"SIR: The Department proposes to organize upon the following programme a permanent commission to which all subjects of a scientific character on which the Government may require information may be referred.

"Propositions relative to a permanent scientific commission:

"1st. There shall be constituted a permanent commission consisting of, for the present, Commodore Davis, Professor Henry, and Professor Bache, to which shall be referred questions of science and art upon which the Department may require information.

"2d. This commission shall have authority to call in associates to aid in their investigations and inquiries.

"3d. The members and associates of the Commission shall receive no compensation for their services.

"You are directed to act as a member of the Commission in conjunction with Professor Henry and Professor Bache.

"Such matters as are presented to the Department will be referred to you for examination and report by the Commission.

"I am respectfully, etc.,

"GIDEON WELLES,

"Sec'y of Navy.

"COMMODORE CHARLES H. DAVIS,

"Chief of Bureau of Navigation." [1]

Captain C. H. Davis, who published a life of his father, Rear-Admiral Charles H. Davis, in 1899, wrote as follows regarding the labors of this Commission:

"This commission was no sinecure, and was constantly in session, for it was at this time that mechanical and scientific ingenuity was beginning to be felt in application to naval construction and equipment, and to this commission were referred the innumerable plans and proposals for new inventions and devices with which the government at Washington was flooded. This commission is interesting because it led to the establishment of the National Academy of Sciences." [2]

From the designation "Permanent Commission," it might naturally be inferred that this body was preceded by an organization or board of a temporary character, but such appears not to have been the fact. There was, apparently, but one Commission, which owed its rather peculiar name to an endeavor on the part of Admiral Davis to find a designation corresponding to the term "Select Commission" sometimes employed by the British Government.[3]

Admiral Davis was appointed Chief of the Bureau of Navigation in the Navy Department in July, 1862, and resided in Washington from November of that year until April, 1865. During that time, according to Captain Davis, "he wrote home almost every day." Among the published letters of this period are four which throw a strong light on the steps which led to the organization of the Permanent Commission and the Academy. They

[1] Letters to Heads of Bureaus (manuscript), vol. 4, July 10, 1861, to December 17, 1868, p. 153.

[2] Davis, C. H. Life of Charles Henry Davis, Rear-Admiral, 1807-1877, by his son, Captain Charles H. Davis. New York, 1899, p. 286. Captain Davis later reached the rank of Rear-Admiral, but to distinguish him from his father, he is referred to below as Captain Davis. See also G. Brown Goode, "The Smithsonian Institution, 1846-1896," p. 152.

[3] See Admiral Davis' letter of February 24, 1863, quoted on p. 3.

reveal the fact that the two organizations were closely associated in the minds of their originators, and also that they came into existence almost at the same time. It seems best, on this account, to consider them in connection with each other rather than to attempt to trace the beginnings of each organization separately. The four letters referred to, as they appear in Captain Davis' book, are as follows:

"February 2, 1863. How much have I told you, if anything, about a Permanent Commission or Academy? Bache, Henry, and myself are very busy on this topic, and have made a move which will no doubt result in the Permanent Commission. The Academy is more doubtful" (p. 289).

"February 20. Inclosed is a copy of the order creating the Permanent Commission. But the Academy is to be introduced into Congress by Mr. Wilson [Senator from Massachusetts]. The whole plan of it was arranged last night between Mr. Wilson, Agassiz, Bache and Ben [Professor Peirce]. It was my plan amplified and improved" (p. 289).

"February 24. I told you a word about the Academy in one of my notes, but only a word, being in a hurry. The appointment of a Permanent Commission was suggested to me by one of my letters, which quoted a passage from the British War Office which spoke of a *Select Commission;* and when I mentioned it to Bache and Henry they acquiesced, and the latter presented the plan to the department. You saw, by the copy of the Secretary's letter to me, that our plan was accepted without any change whatever. We had hardly got through this thing before the idea flashed upon my mind that the whole plan, so long entertained, of the Academy could be successfully carried out if an act of incorporation were boldly asked for in the name of some of the leading men of science from different parts of the country. This I submitted to Bache and Henry with details, but the view was not immediately adopted. The next step was Agassiz coming to Washington as one of the regents of the Smithsonian Institution. Then followed a visit to Agassiz by Senator Wilson, who had nominated him to the regency. At this meeting, which took place at Bache's, Ben, Bache, and Dr. Gould were present; and it was there that the mode of proceeding was devised. Mr. Wilson introduced the bill last Saturday" . . . . (p. 289).

"February 27. . . . . I am looking for Agassiz to come here and be introduced to Admiral Foote, and then to go with me to the Capitol to see Mr. Grimes about the Academy bill. I go to the President's once more, and I hope for the last time, this morning.

"The dinner at Bache's was particularly pleasant, even for the chief's entertainments, which never fail to be agreeable. Judge Loring, Mr. Hosford, and Mr. Hilgard were there . . . ." (p. 291).

"March 7. . . . . If the plan we first pitched upon had been followed, that of creating the Academy with a dozen or twenty members, and allowing them to organize and fill up the whole number by usual system of ballot, then the odium of exclusion would have been divided and distributed. . . . . You will perceive at once that, on the plan I proposed, not only would the odium (if any) of exclusion be numerously shared, but a wider and broader opinion and control would have been brought to bear on selection, which would then have become election. And this was due to the interests of the government and to the claims of men of science" (p. 292).

In these letters the chronological order of the events narrated is largely inverted, and, on the first perusal of them, the actual sequence is not readily comprehended. They inform us that Admiral Davis, having come to Washington in November, 1862, heard and participated in various discussions among his scientific associates of the need of a national scientific organization. Having served as a member of various advisory boards, the idea occurred to him not long before February 2, 1863, that the organization might take the form of a Permanent Commission. He at once broached the subject to Bache and Henry who agreed that the plan was meritorious, while at the same time clinging to the idea of founding an academy. Henry was so favorably impressed with the commission plan that he immediately presented it to the Navy Department. This plan received the prompt attention of the Secretary of the Navy, who issued an order on February 11, creating the Permanent Commission.

While awaiting the result of the Navy Department's consideration of the plan to establish a scientific commission, the idea occurred to Admiral Davis that an academy might be organized by the simple process of asking Congress for its incorporation "in the name of some of the leading men of science from different parts of the country." This idea was also presented to Bache and Henry, who, however, were not immediately convinced of its merits. About this time Louis Agassiz, having been nominated by Senator Henry Wilson, of Massachusetts, a regent of the Smithsonian Institution, came to Washington and met him on February 19, at the house of Professor Bache, where were also assembled Professor Peirce, Dr. B. A. Gould and we may presume, Admiral Davis. The plan of incorporating an academy was discussed, and it was decided that Senator Wilson should introduce a bill of incorporation, which he did on Saturday, February 21. Admiral Davis asserts that the plan of action adopted on this occasion was his own, "amplified and improved."

While there is no reason to doubt the accuracy of the statements regarding the organization of the Academy contained in these letters, which were written while the events were taking place, it is interesting to find that many of them are corroborated by other documents.

That Louis Agassiz was nominated by Senator Wilson as a regent of the Smithsonian Institution at the time mentioned by Davis is verified by the record of the proceedings of the 37th Congress contained in the *Congressional Globe*. From this journal we learn that his name was proposed in the Senate by Senator Wilson, of Massachusetts, on February 6, 1863, and that the joint resolution providing for his appointment (Senate no. 126) was passed on that date; that this resolution passed the House on February 19, 1863; and that it was signed by President Lincoln on February 21.[4]

The date of the introduction by Senator Wilson of the bill incorporating the Academy is also found to be correctly given in Davis' letter. The *Globe* contains the following regarding it:

In the Senate.

Friday, February 20, 1863.—"Mr. Wilson, of Massachusetts, gave notice of his intention to ask leave to introduce a bill to incorporate a national academy of sciences."[5]

Saturday, February 21, 1863.—"Mr. Wilson, of Massachusetts, in pursuance of previous notice, asked and obtained leave to introduce a bill (S. No. 555) to incorporate the National Academy of Sciences; which was read twice by its title, and ordered to lie on the table, and be printed."[6]

The bill was passed by the Senate on March 3, 1863, without discussion.[7]

[4] *Congressional Globe,* 37th Congress, 3d Session, pp. 762, 1121, 1181.

[5] *Loc. cit.,* p. 1131.

[6] *Loc. cit.,* p. 1155.

[7] *Loc. cit.,* pp. 1500, 1501. There was no report on this bill.

IN THE HOUSE.

March 3, 1863.—"Mr. Thomas, of Massachusetts. I ask the unanimous consent of the House for leave to take up Senate bill No. 555, to incorporate a National Academy of Science.

"There was no objection, and the bill was taken up, read three times, and passed.

"Mr. Thomas, of Massachusetts, moved to reconsider the vote by which the bill was passed; and also moved that the motion to reconsider be laid on the table.

"The latter motion was agreed to."[8]

The bill, having been passed by both Houses, was signed by the President on the same day, Tuesday, March 3, 1863.

Upon examining the list of names of persons at the meeting held at the house of Professor Bache on February 19, to arrange the plan of incorporation, it will be noted that Joseph Henry is not mentioned. One might suppose that his name was accidentally omitted by Admiral Davis, but from remarks made later by Henry it appears certain that he did not attend the meeting. In his report as President of the Academy, for the year 1867, he speaks as follows:

"I feel myself more at liberty to urge the claims of the Academy, inasmuch as its members generally, including myself, took no step toward its establishment. Indeed, I must confess that I had no idea that the national legislature, amid the absorbing and responsible duties connected with an intestine war, which threatened the very existence of the Union, would pause in its deliberations to consider such a proposition."[9]

Whether other motives than the mere doubt of the feasibility of the plan for incorporating the Academy influenced Henry in refraining from attending the meeting of February 19, can, perhaps, not be discovered after the lapse of so many years. As soon as the Academy had been established, he took an active part in its proceedings, becoming chairman of the first committee appointed in 1863, and a member of two others appointed in 1863 and 1864. He also read a paper at the first scientific session of the Academy, in January, 1864, "On Materials of Combustion for Lamps in Light-houses." His name does not,

[8] *Loc. cit.*, p. 1540.

[9] Rep. Nat. Acad. Sci. for 1867. Sen. Misc. Doc. no. 106, 40th Congress, 2d Session, 1868. p. 5.

however, appear in the first list of officers of the Academy, nor of the members of the Council.

While, as has been seen, many of the statements in Admiral Davis' letters regarding the initial steps in the formation of the Academy are substantiated by other records, the most important one has yet to be considered. This is his claim that the practical plan for bringing the organization into existence was his own, though "amplified and improved," as he remarks, by the suggestions of others.

It is not to be supposed that Davis intended to claim having originated the idea of a national scientific association or academy. This thought, as Goode has shown,[10] was in the minds of Washington, Jefferson, Barlow, and other early American statesmen and publicists, and led to practical results of large importance through the activities of Franklin, John Adams and Poinsett.

Bache dwelt on the need of a national scientific organization in his address as retiring President of the American Association for the Advancement of Science, at Albany, in 1851, on which occasion he said:

"But first a few observations on the ordinary modes of promoting science; in connexion with which, I would throw out for your consideration some reasons which induce me to believe that *an institution of science, supplementary to existing ones, is much needed in our country, to guide public action in reference to scientific matters. . . . .*

"It is, I believe, a common mistake to associate the idea of academical institutions with monarchial institutions. We show in this, as in many other things, the prejudice of our descent. We have among us the two extremes of exaggerated nationality and of excessive imitation; let us modify each by the other, and be wise. A national institute is not necessary to Great Britain, with her rich and powerful universities. Republican France has cherished her Institute, seeking rather to extend than to curtail its proportions. . . . . Nor does the idea of a necessary connexion between centralization and an institution strike me as a valid one. Suppose an institute of which the members belong in turn to each of our widely scattered states, working at their places of residence and reporting their results; meeting only at particular times, and for special purposes; engaged in researches self-directed, or desired by the body, called for by Congress or by the

[10] Goode, G. Brown, The Origin of the National Scientific and Educational Institutions of the United States. Ann. Rep. Amer. Hist. Assoc. for 1889, pp. 53-161. 1890.

Executive, who furnish the means for the inquiries. The detail of such an organization could be marked out so as to secure efficiency without centralization, and constant labor with its appropriate results. The public treasury would be saved many times the support of such a council, by the sound advice which it would give in regard to the various projects which are constantly forced upon their notice, and in regard to which they are now compelled to decide without the knowledge which alone can ensure a wise conclusion. The men of science who are at the seat of government either constantly or temporarily, are too much occupied in the special work which belongs to their official occupations to answer such a purpose; besides, the additional responsibility which, if they were called together, they must necessarily bear, would prove too great a burthen, considering the fervid zeal, and I might almost say fierceness, with which questions of interest are pursued and the very extraordinary means resorted to to bring about a successful conclusion. . . . .

"Our country is making such rapid progress in material improvements, that it is impossible for either the legislative or executive departments of our Government to avoid incidentally, if not directly, being involved in the decision of such questions. Without specification, it is easy to see that there are few applications of science which do not bear on the interests of commerce and navigation, naval or military concerns, the customs, the light-houses, the public lands, post-offices and post-roads, either directly or remotely. If all examination is refused, the good is confounded with the bad, and the Government may lose a most important advantage. If a decision is left to influence, or to imperfect knowledge, the worst consequences follow.

"Such a body would supply a place not occupied by existing institutions, and which our own is, from its temporary and voluntary character, not able to supply." [11]

This declaration, which foreshadows so much of the program of the National Academy organized twelve years later, must have been well known to Admiral (then Lieutenant) Davis. Indeed, it is probable that he listened to Professor Bache's address when delivered in Albany, as he was present at the meeting and read a paper himself on the solar eclipse of July 28, 1851. The claim of Davis, therefore, was not that he was the first to detect the need of a national academy of science, or to outline its proper character and scope, but that he first hit on a practical plan for bringing it into existence and for securing the initial membership.

[11] Proc. Amer. Assoc. Advanc. Sci., 6th Meeting, 1851 (1852), pp. xlvii-li.

The more interesting question as to what scientific men were the chief promoters of the Academy movement is not easy of solution. Not only has the little coterie which is mentioned by Davis as having arranged the plan of incorporation passed away, but all the group of fifty incorporators. Of some of these men no published biographies exist, and for others we have only brief sketches and fragments of correspondence. Piecing together the scraps and shreds of information scattered through many volumes leads to no very satisfactory result. We may confidently believe that, as Davis informs us, Bache, Peirce, Henry, Davis and B. A. Gould were strongly imbued with the idea that some form of national scientific organization, created by and bearing at least a quasi-official relation to the Federal Government would be of importance both to American science and to the Government. It is more difficult to be assured as to others. The name of Louis Agassiz should probably be added to the list, although the idea seems tenable that his activities in behalf of the Academy were prompted chiefly by a desire to aid his scientific associates and friends. Marcou states that Agassiz " may be called one of the founders, but not the ' prime mover ' " and intimates that he took part in the plans for incorporation mainly to satisfy Bache.[12]

However this may be, he was sufficiently interested in the Academy to accept the position of foreign secretary, to which he was elected at the first meeting in 1863, and also to take an active part in shaping the constitution and by-laws.[13]

Among those who have been mentioned as early promoters of the Academy is J. Peter Lesley. In a biographical sketch of his life read before the American Institute of Mining Engineers in 1903, Benjamin S. Lyman remarks:

" About 1862 he [Lesley] and several of his scientific friends earnestly discussed the desirableness of forming a National Academy of Science, that should

[12] Marcou, Jules. Life, letters and works of Louis Agassiz, vol. 2, 1895, p. 157. Many of Marcou's statements are erroneous, as, for example, that Henry Wilson was Vice-President of the United States at the time of the incorporation of the Academy. They can hardly be accepted unless corroborated by other testimony.

[13] See Ames, Mary Lesley, Life and letters of Peter and Susan Lesley, vol. 1, 1909, p. 419, where there is an amusing account of the meeting for organization.

be limited in number and more select than the American Association for the Advancement of Science, and should have its meetings less encumbered with unsatisfactory communications. He was decidedly in favor of the enterprise, thinking that the exclusive character, and what might possibly be considered the aristocratic appearance or desires of such an organization, would not be distasteful to Americans, nor really inconsistent with their democratic principles. The Academy was incorporated by the United States Congress in 1863, and he was one of the original members, and continued to be a member throughout his life." [14]

The foregoing assertion of Lesley's early interest in the formation of an academy bears the impress of accuracy, but is somewhat at variance with a published letter of Mrs. Lesley, dated March 8, 1863, as follows:

" Yesterday came an official letter from the Honorable Henry Wilson, naming him [Lesley] as one of the corporators of the new National Academy of Sciences, and asking his attendance at the first meeting in New York. This was a very great surprise to Peter [Lesley], a thing entirely unsought and unsolicited, and gives him pleasure." [15]

It is quite in harmony with Lesley's unselfish and unassuming character that his interest in the Academy should be entirely impersonal.

There are some indications besides that contained in Lyman's address, just quoted, that the question of forming an academy was more or less widely discussed in 1862. In a biographical sketch of Professor Benjamin A. Gould, written by A. McF. Davis and published in 1897, the following remark is made:

" In 1862, he was appointed to reduce and compute the astronomical observations made at the Washington Observatory, and he was active both that year and the next in promoting the establishment of the National Academy of Sciences, of which he was an original member." [16]

Doctor George W. Hill, in a letter addressed to Doctor Arnold Hague, remarks of Admiral Davis and Professor Peirce:

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[14] Ames, Mary Lesley. Life and letters of Peter and Susan Lesley, vol. 2, 1909, p. 469. (Appendix D. Biographical sketch of J. Peter Lesley, by Benjamin Smith Lyman, Philadelphia, Pa. (New York Meeting, American Institute of Mining Engineers, October, 1903.).) (Published originally in Trans. Amer. Inst. Mining Engineers.)

[15] *Op. cit.*, vol. 1, p. 419.

[16] Davis, A. McF. Benjamin Apthorp Gould. Proc. Amer. Antiq. Soc., April, 1897, p. 7. (Also separate.)

"My impression is that these two men originated the idea of having a general scientific society for the whole country which, as far as our democratic institutions would allow, in imitation of those of Europe, should be under the patronage of the government. This idea was probably broached as early as 1862. Of course two men by themselves could not originate an academy and soon others were drawn into the project. Bache, Henry, B. A. Gould and Agassiz were invited to take part. It was decided that 50 should be the number of the members of the new scientific body."

Others besides those already mentioned should be perhaps included among the founders of the Academy, but it is certain that not all who were named as incorporators participated in the movement. We know that in several instances persons so named were unaware that they had been designated until they had received a letter from Senator Wilson advising them that they were included in the list. One of the incorporators declined membership in the Academy. It appears from the letters of Davis that the list was made up at the preliminary meeting held at the house of Professor Bache on February 19, 1863, or soon afterwards, and caused some dissatisfaction when published in the bill of incorporation.

It is perhaps an unnecessary task to endeavor to determine who should be considered the head and front of the Academy movement, but judging from contemporary evidence, this distinction probably belongs to Professor Bache. Arnold Guyot speaks of him as "the enlightened and far-seeing head of the Coast Survey" and "the founder of this Academy." [17]

E. S. Morse remarks: "Agassiz, Bache and Henry were the leading spirits in originating the National Academy of Sciences." [18] The address delivered by Professor Bache at Albany in 1851, a portion of which is quoted above (p. 7), contains the first definite plan for the particular kind of academy which was organized twelve years later. Doubtless many of its features had been suggested by Bache's associates and friends, and we know, indeed, that it was a frequent subject of discussion among the scientific men of America for many years. Bache himself remarked in 1863 that the need of such a body as the

[17] Biogr. Mem. Nat. Acad. Sci., vol. 2, 1886, p. 70.
[18] Pop. Sci. Monthly, vol. 71, 1907, p. 548.

National Academy of Sciences had "long been felt by the patriotic scientific men of the United States." Yet it was Bache who first gave the project a definite form and published it to the world. His plan cannot be said to have been copied from those which were formulated by Franklin before the Revolution, or by Barlow, Adams or others in the early years of the Republic, although, as a matter of course, they have some things in common. The earlier projects related especially to the founding of a national university, to initiating research in branches of sciences which had not been cultivated in America, or to aiding the Government in the exploitation and development of the national domain, and were also concerned with the study of political science, morals, literature and art.[19] At

[19] The nearest approach to the Academy plan to be found in connection with the earlier organizations is, perhaps, the proposition put forward by a committee of the National Institute for the Promotion of Science in 1842. At a meeting of the National Institute, held on August 8, 1842, the following report was made by a special committee, proposing to establish an annual scientific convention at Washington:

"They proposed that a meeting of the learned men of our country, distinguished for their attainments in the different sciences, particularly in those termed physical, should be held annually at the seat of the General Government, at some early period of the session of Congress, under the auspices of the [National] Institute, to communicate the results of their inquiries, to compare their observations, and to promote the general interests of science. It has seemed to the committee that this Institute affords an opportunity, which ought not to be neglected, of concentrating the genius and learning of our country at a common center, from which the beams of intelligence will radiate to gladden and bless the land." (Proc. Nat. Institute, 3d Bull., p. 335.)

"At the meeting of September 12, 1842, Mr. Poinsett, the president, proposed a series of resolutions intended to put the recommendation of the report into effect. All of these resolutions and reports . . . . were without avail." (Goode G. B. The Genesis of the U. S. National Museum, in Rep. U. S. Nat. Mus. for 1891, p. 294. 1893. See also Proc. Nat. Institute, 3d Bull., p. 336.)

The purposes of the American Academy of Arts and Sciences are set forth in its charter, from which the following is an extract:

"That the end and design of the institution of the said Academy is, to promote and encourage the knowledge of the antiquities of *America,* and of the national history of the country, and to determine the uses to which the various national productions of the country may be applied to promote and encourage medical discoveries, mathematical disquisitions, philosophical enquiries and experiments; astronomical, meteorological and geographical observations; and improvements in agriculture, arts, manufactures and commerce; and, in fine, to cultivate every art and science, which may tend to advance the interest, honor, dignity and happiness of a free, independent and victorious people." Charter granted May 4, 1780. (Memoirs of the American Academy of Arts and Sciences, vol. 1, 1785, p. vii.)

the time when the idea of a national academy first began to take root, these needs had been more or less adequately met. Colleges had been established in most of the States of the Union and were in a prosperous condition, research had been prosecuted in nearly every branch of science, and commerce and the development of the country had been encouraged by extensive surveys and other activities of the Government. The objects which the founders of the National Academy of Sciences had in view were of a somewhat different character. What they were can best be learned from those who were leaders in the movement. In the third section of the act of incorporation it is provided, that "The Academy shall, whenever called upon by any department of the Government, investigate, examine, experiment, and report upon any subject of science or art." In the first report of the Academy to Congress, dated March 28, 1864, Professor Bache, the first President, remarked:

"The want of an institution by which the scientific strength of the country may be brought, from time to time, to the aid of the government in guiding action by the knowledge of scientific principles and experiments, has long been felt by the patriotic scientific men of the United States. No government of Europe has been willing to dispense with a body, under some name, capable of rendering such aid to the government, and in turn of illustrating the country by scientific discovery and by literary culture." [20]

In the report for 1867, Joseph Henry, then President of the Academy, refers to the objects of the Academy in the following terms:

"The objects of this association are principally to advance abstract science, and to examine, investigate, and experiment upon subjects on which information is desired by the government.

"It was implied in the organization of such a body that it should be exclusively composed of men distinguished for original research, and that to be chosen one of its members would be considered a high honor, and consequently a stimulus to scientific labor, and that no one would be elected into it who had not earned the distinction by actual discoveries enlarging the field of human knowledge.

"The names of the fifty original members were included in the act of organization and were chosen from among those of the principal cultivators of science in this country. For the appointment of these members the academy itself is not

[20] Rep. Nat. Acad. Sci. for 1863 (1864), p. 1.

responsible. It is, however, responsible for those who have since been and are still to be elected; and I am happy to say that in filling the large number of vacancies which have been occasioned by death and resignation since the original organization, the principle before mentioned has been strictly observed, and no one has been admitted except after a full discussion of his claims and a satisfactory answer to the question, 'What has he done to advance science in the line of research which he has especially prosecuted?'

"The organization of this academy may be hailed as marking an epoch in the history of philosophical opinions in our country. It is the first recognition by our government of the importance of abstract science as an essential element of mental and material progress." [21]

It is obvious from the foregoing statements of Bache and Henry, that two principal objects were uppermost in the minds of the founders—to afford recognition to those men of science who had done original work of real importance and thereby to stimulate them and others to further endeavors; and to aid the Government in the solution of technical scientific problems having a practical bearing on the conduct of public business.

The idea that election to membership in a scientific association incorporated by the Congress of the United States might be regarded as a badge of distinction conferred by our Government, similar to the honors bestowed by the monarchical governments of Europe, seems to have provoked more or less discussion. By some, the bestowal of any such recognition was thought to be inconsistent with democratic principles. Professor Henry, however, was of the contrary opinion. In his report for 1867, already quoted, he remarks:

"It is not enough for our government to offer encouragement to the direct promotion of the useful arts through the more or less fortunate efforts of inventors; it is absolutely necessary, if we would advance or even preserve our reputation for true intelligence, that encouragement and facilities should be afforded for devotion to original research in the various branches of human knowledge. In the other countries scientific discovery is stimulated by pensions, by titles of honor, and by various social and official distinctions. The French academicians receive an annual salary and are decorated with the insignia of the legion of honor. Similar marks of distinction are conferred on the members of the

[21] Rep. Nat. Acad. Sci. for 1867 (1868), pp. 1, 2. Sen. Misc. Doc. no. 106, 40th Congress, 2d Session.

academy of Berlin and that of St. Petersburg. These modes of stimulation or encouragement may be considered inconsistent with our social ideas and perhaps with our forms of government. There are honors, nevertheless, which in an intelligent democracy have been and may be justly awarded to those who enlarge the field of human thought and human power. Heretofore, but two principal means of distinction have been recognized in this country, viz: the acquisition of wealth and the possession of political power. The war seems to have offered a third, in bestowing position and renown for successful military achievement. The establishment of this Academy may be perhaps regarded as having opened a fourth avenue for the aspirations of a laudable ambition, which interferes neither with our national prejudices nor our political principles, and which only requires the fostering care of government to become of essential benefit and importance not only to this, but all the civilized countries of the world." [22]

Whatever the merit of the views enunciated by Professor Henry, no tangible evidence of distinction has been attached to membership in the Academy, such as is connected with high military, political or judicial station. The members of the early American Geological Society were accustomed to append the letters "M. A. G. S." to their names, corresponding to the familiar "F. R. S." "F. L. S.," etc., of the Royal Society and the Linnean Society of London, and other English associations, but the practice has not obtained in connection with the National Academy of Sciences.[23]

To be the scientific adviser of the Government was second among the principal objects of the Academy, as laid down in the act of incorporation in 1863. The country was then in the throes of the Civil War, and the Government needed, as never before, sound advice on technical scientific subjects, especially such as had a bearing on naval and military affairs. Numerous commissions were appointed, including the Permanent Commission, already mentioned, and it was quite in harmony with the purpose of these organizations that one of the chief duties of the new academy should be to aid the Government wherever scientific truths could be serviceable. It has been intimated

[22] Rep. Nat. Acad. Sci. for 1867 (1868), pp. 3, 4. Sen. Misc. Doc. no. 106, 40th Congress, 2d Session.

[23] Goode, G. B. The origin of the National Scientific and Educational Institutions of the United States. Ann. Rep. Amer. Hist. Assoc. for 1889 (1890), p. 68.

by one writer that this provision was included in the bill of incorporation mainly to secure the passage of the bill, by convincing Congress of the practical utility of the Academy. This may be in part true, but it does not explain the fact that the executive branch of the Government immediately took counsel of the Academy on a variety of subjects and has continued to do so up to the present time.

In this connection, it is interesting to note the attitude of President Lincoln and his Secretary of State, Seward, toward the Academy, as shown by the following letter which was addressed to Professor Bache a few months after its organization:

"DEPARTMENT OF STATE,
"WASHINGTON, January 8, 1864.

"SIR: I have the honor to acknowledge the receipt of your note of the 7th instant, tendering to this department the aid of the Academy of Sciences in any investigations that it may be thought proper to institute with a view to the great reform of producing an uniformity of weights and measures among commercial nations. Be pleased to express to the academy my sincere thanks for this enlightened and patriotic proceeding, and assure them that, with the authority of the President, I shall be happy to avail myself of the assistance thus tendered to me, and to that end I shall at all times be happy to receive the suggestions of the academy, or of any committee that may be named by it, in conformity with the spirit of the note you have addressed to me.

"I am, Sir, your obedient servant,
"WILLIAM H. SEWARD.

"PROFESSOR A. D. BACHE,
"President of the National Academy of Sciences." [24]

That the founders of the Academy felt that it owed a duty to the Government is shown by the rather singular provision which was incorporated in the constitution, that each member should upon his admission "take the oath of allegiance prescribed by the Senate of the United States for its own members." This matter of an oath of allegiance was by no means regarded as one of slight importance, as is indicated by the animated discussion to which it gave rise when the report of the committee on the constitution was brought before the Academy at the first meeting.[25]

[24] Rep. Nat. Acad. Sci. for 1863, p. 11.

[25] See Ames, Mary L. Life of Peter and Susan Lesley, vol. 1, p. 419.

In a letter dated April 23, 1863, Lesley writes:

"Some one argued that we would lose government patronage, unless we bid for it with the oath; I suspect it was only an unfortunate way of stating a higher truth, that we are the children of the government, and the Academy is the creation of the government, and owes it the oath of allegiance as its first duty." [26]

In view of this evidence and the fact that several of the original members of the Academy were conspicuous for their services to the Government in connection with the War, it can hardly be maintained that the offer of aid was merely a form of words inserted in the bill of incorporation for the purpose of inducing Congress to pass the measure.

This governmental relationship is one of the chief peculiarities of the National Academy. Other scientific organizations were founded whose membership was drawn from all parts of the country, whose scope covered all branches of scientific research, and whose transactions reflected credit on their membership and on American science, but none could claim recognition as the scientific adviser to the Government.

While to-day many scientific bureaus under the national Government are in existence, the conditions were quite different in 1863, when the Academy was organized. At that time the only governmental organizations of this class were the Coast Survey, the agricultural divisions of the Patent Office, and the Naval Observatory. To-day technical information on a wide range of subjects is available within the limits of the civil service. Nevertheless, the legislative and executive branches of the Government still continue to refer scientific matters of importance to the Academy year by year for information and advice.

On March 5, 1863, two days after the passage of the bill incorporating the Academy, Senator Wilson addressed letters to the fifty men of science whose names were mentioned therein, advising them of their designation as incorporators, and requesting them to fix on a day when it would be most convenient to meet in New York City for the purpose of organization. This letter is printed in the first *Annual* of the Academy.[27]

[26] *Loc. cit.*, p. 420.

[27] Ann. Nat. Acad. Sci. for 1863-4 (1865), p. 10.

More than three-fifths of the incorporators replied to this request, and on March 18, 1863, Senator Wilson, having given consideration to the various dates suggested, selected April 22 as the day, and the chapel of the University of the City of New York (now New York University) as the place for the meeting.[28] This meeting was called to order at 11 o'clock by Senator Wilson who delivered the following address:[29]

Address of the Hon. Henry Wilson

Delivered at the opening of the first session of the Academy, April 22, 1863.

"Gentlemen: I hold in my hand the Act, passed in the closing hours of the Thirty-seventh Congress, 'To incorporate the National Academy of Sciences,' In compliance with many kind requests I am here to call the corporators to order. In rising to perform this agreeable task, I crave for a moment your indulgence.

"This Act, under which you have met to organize, incorporates in America, and for America, a National Institution, whose objects, ranging over the illimitable fields of science, are limited only by the wondrous capacities of the human intellect. Such an institution has been for years in the thought and on the tongue of the devotees of science, but its attainment seemed far in the future. Now it is an achieved fact. Our country has spoken it into being, in this 'dark and troubled night' of its history, and commissioned you, gentlemen, to mould and fashion its organization, to infuse into it that vital and animating spirit that shall win in the boundless domains of science the glittering prizes of achievement that will gleam forever on the brow of the nation.

"When, a few months ago, a gentleman whose name is known and honored in both hemispheres, expressed to me the desire that an Academy of Physical Sciences should be founded in America, and that I would at least make the effort to obtain such an act of incorporation for the scientific men of the United States, I replied, that it seemed more fitting that some statesman of ripe scholarship should take the lead in securing such a measure, but that I felt confident I could prepare, introduce, and carry through Congress a measure so eminently calculated to advance the cause of science, and to reflect honor upon our country. I promptly assumed the responsibility, and with such aid and suggestions as I could obtain, I prepared, introduced, and by personal effort with members of both Houses of Congress, carried through this act of incorporation without even a division in either House.

[28] *Op. cit.*, p. 11. New York University at that time occupied a large building of light-colored stone on the east side of Washington Square. The chapel was in this building.

[29] *Op. cit.*, pp. 12-15.

"The suggestion was sometimes made that the nation is engaged in a fearful struggle for existence, and the moment was not well chosen to press such a measure. But I thought otherwise. I thought it just the fitting time to act. I wanted the *savans* of the old world, as they turn their eyes hitherward, to see that amid the fire and blood of the most gigantic civil war in the annals of nations, the statesmen and people of the United States, in the calm confidence of assured power, are fostering the elevating, purifying, and consolidating institutions of religion and benevolence, literature, art and science. I wanted the men of Europe, who profess to see in America the failure of republican institutions, to realize that the people of the United States, while eliminating from their system that ever-disturbing element of discord, bequeathed to them by the colonial and commercial policy of England, are cherishing the institutions that elevate man and ennoble nations. The land resounds with the tread of armies, its bright waters are crimsoned, and its fields reddened with fraternal blood. Patriotism surely demands that we strive to make this now discordant, torn, and bleeding nation one and indivisible. The National Academy of Sciences will, I feel sure, be now and hereafter another element of power to keep in their orbits, around the great central sun of the Union, this constellation of sovereign commonwealths.

"This act of incorporation may not be, is not, perfect. The task has been one of difficulty and delicacy. The number of members must be limited, while the most eminent men of science must be recognized, and sectional claims harmonized. If unintentional injustice has been done to any one, if msitakes have been made, time will, I trust, correct the injustice and the mistakes. Changes will surely come. 'Death is in the world,' and this original list of honored names will not remain long unbroken. If men of merit have been forgotten in this act of incorporation, the Academy should seize the first and every occasion to right the seeming wrong.

"This Academy is destined, I trust, to live as long as the republic shall endure, and to bear upon its rolls the names of the *savans* of coming generations. Let it then advance high its standard. Let it be as inflexible as justice, and as uncompromising as truth. Let it speak with the authority of knowledge, that pretension may shrink abashed before it, and merit everywhere turn to it confident of recognition.

"In the Providence of God, the Thirty-seventh Congress was summoned to the consideration of measures of transcendent magnitude. It enacted measures, empowering the government to raise hundreds of millions of dollars and millions of men, to protect the menaced life of the nation and preserve the vital spirit of freedom. It dealt with great questions of revenue and of finance. It obliterated an abhorrent system from the national capital, and engraved freedom upon every rood of the national territory. It consecrated the public domain to homesteads for the homeless and landless, and authorized the construction of a railway to unite the Atlantic and the Pacific seas. The enactment of this act to incorporate the

Academy of Sciences, was not the least in the long list of acts the Thirty-seventh Congress gave to the country, which will leave their impress upon the nation for ages yet to come. It was my fortune to take a humble part in these great measures of legislation. It is a source of profound gratification to me, that, amid the pressure of public affairs, I have been enabled to contribute something to found this Academy for the advancement of the physical sciences in America. It will ever be among my most cherished recollections, that I have been permitted through your courtesy to unite with you in organizing this National Academy, which, we fondly hope, will gather around it, in the centuries yet to come, the illustrious sons of genius and of learning, whose researches will enrich the sciences, and reflect unfading lustre upon the republic."

The official records of the Academy do not contain an account of this first meeting or a list of the members who attended it. The New York *Commercial Advertiser* of April 23, 1863, however, contains a list of the names and states that Professor Henry was elected President *pro tem.,* and Professor Caswell, temporary secretary. The notice is as follows:

"THE NATIONAL ACADEMY OF SCIENCE.

"The last Congress incorporated a National Academy of Science, in pursuance of which the following thirty-one corporators of the institution assembled in the chapel of the New York University for the purpose of organizing:—Prof. Agassiz, Stephen Alexander, A. D. Bache, F. [A.] P. Barnard, J. T. [*G.*] Barnard, U. S. A.; W. H. C. Bartlett, U. S. M. C.; Profs. Caswell, Coffin, Dana, C. H. Davis, U. S. N.; Profs. Wazer [*Frazer*], Wolcott Gibbs, J. W. [*M.*] Gilless [*Gilliss*], U. S. A. [*U. S. N.*]; B. A. Gould, Prof. Guyot, James Hall, Joseph Henry, Hilyard [*J. E. Hilgard*], Hubbard, U. S. N. O.; Profs. Leidy, Lesley, Newberry, Newton, Peirce, Vauman Rogers [*Fairman Rogers*], R. E. Rogers, W. B. Rogers, L. M. Rutherford [*Rutherfurd*], Joseph Saxton, B. Silliman, Jr., Joseph Winlock, U. S. Nautical Almanac Office. The number of corporators is restricted to fifty. The meeting was called to order by Senator Wilson. Professor Henry of the Smithsonian Institute [*sic*] was chosen president *pro tem.,* and Professor Caswell, temporary secretary. The proceedings were conducted with closed doors."

This account is probably correct, except for slight errors in the spelling of names, etc. We know that the number of incorporators was 50. Senator Wilson stated that more than three-fifths responded to his letter regarding the meeting, and the number 31 in the newspaper article is therefore, quite probably correct. Lesley informs us that Professor Henry was in the chair, and mentions as being present also, Agassiz, Alexander, Bache, Barnard, Caswell "the secretary," Frazer, Gould, Leidy, Lesley, R. E. Rogers and W. B. Rogers, all of whom are included in the *Advertiser* list.

The New York *Daily Tribune* of April 23, 1863, informs us that Senator Wilson's address was followed by a brief statement by Professor Agassiz of "the fundamental principles upon which a permanent edifice of science should be based," also, that a committee of nine was appointed to draft a form of organization. The members of this committee, according to the New York *World* of the same date were as follows: Caswell, Bache, Rodgers, Gibbs, Frazer, Silliman, Jr., Gould, Peirce and Agassiz. The *Herald* of that date states that the committee met at the Brevoort House in secret session, and substitutes the names of Henry and Winlock for Caswell and Gibbs. It also includes Rogers, instead of Rodgers, which, as will be shown presently, was correct.

Corroborating these newspaper items regarding the committee on the constitution is a remark in Lesley's letter of April 23, 1863. "Yesterday I went down to the eight o'clock evening session [of the Academy], at which we heard and began to vote upon the constitution and by-laws, as reported by the committee of nine appointed in the morning." [30] Further corroboration, together with other interesting details, is found in a letter of William B. Rogers, dated April 28, 1863, from which the following is an extract:

"Of the fifty corporators named in the bill, thirty-two were present the first day, and twenty-seven during the rest of the session. A committee of organization was first appointed, consisting of nine, Bache being chairman, supported by Benjamin Gould, Agassiz, Peirce, Benjamin Silliman, Frazer, etc., and to which I also was admitted. The Constitution and Rules, most elaborately prepared, were read from the MS. by Bache. There was no dissent on any important point, unless when I made objection. One of the provisions made the tenure of the offices of president, vice-president and secretary, for life. To this no one objected, and I let it pass without voting until, the morning's task being closed, Bache was

[30] Life of Lesley, vol. 1, p. 419.

about shutting up his book. Then I rose, and calmly called their attention to this clause, told them that to exact that would be to blast every hope of success, and so impressed them with the responsibility of such a course that they voted the term of six years instead of for life." [31]

The article of the constitution which seems to have provoked the most animated discussion was, as already mentioned, that which provided that the members of the Academy should take an oath of allegiance to the Government. This is not surprising, when one recalls the condition of the country at the time. The article was adopted, however, and the whole business of the meeting was completed, including the adoption of the constitution and by-laws, and the election of officers in a session of three days, ending on the afternoon of April 24.[32] Lesley, in his cautious spirit, remarks on "the splendid success of the organization *as it appears,*" and continues "Time will show how much reality underlies this show. We have laid down the base of a pyramid *for the ages.*" Hubbard was more enthusiastic. "A better three days for science were never spent," he writes to his brother, "The inauguration of this Academy marks the most important epoch ever witnessed by science in America." [33]

The account of this first meeting, as given by Professor Bache in his report as President of the Academy, is as follows:

"In pursuance of the provisions of that Act [of incorporation], the members of the National Academy met in New York on the 22d of April, 1863, and completed their organization, renewing by their loyal oath their obligations to serve their country and its constituted authorities to the best of their abilities and knowledge, on such subjects as were embraced in their charter, and upon which they might be consulted, and adopting a Constitution and Laws which they supposed would enable them to carry on successfully the plans of Congress as sketched in the charter.

"Providing for the full and deliberate consideration and arrangement of their laws by a Committee selected for their capability in such a task, the Academy

[31] Life and Letters of William Barton Rogers, edited by his wife, vol. 2, p. 161, 1896.

[32] Although President Bache in his first report states that the constitution and by-laws were adopted at this meeting, it seems probable that the action was informal, as they are mentioned later in the same report, as having been "finally passed" on January 6, 1864. (See p. 8.)

[33] B. A. Gould, Eulogy on Joseph S. Hubbard. Ann. Nat. Acad. Sci. for 1863-4 (1865), p. 72.

adopted the laws presented to their discussion, divided into Classes and Sections for the consideration of matters of science, elected officers, and adjourned to a stated day, the 4th of January, and to Washington, the National Capital, with which they were henceforth to be connected in their membership of the National Academy of Sciences." [34]

The organization for the year 1863 was as follows:

President, ALEXANDER DALLAS BACHE.
Vice-President, JAMES DWIGHT DANA.
Foreign Secretary, LOUIS AGASSIZ.
Home Secretary, WOLCOTT GIBBS.
Treasurer, FAIRMAN ROGERS.

CLASS OF MATHEMATICS AND PHYSICS

Chairman, BENJAMIN PEIRCE.
Secretary, BENJAMIN A. GOULD.

CLASS OF NATURAL HISTORY

Chairman, BENJAMIN SILLIMAN, SR.
Secretary, J. S. NEWBERRY.

Council: CHARLES HENRY DAVIS, JOHN TORREY, LEWIS M. RUTHERFURD, J. PETER LESLEY, and the officers and chairmen of classes *ex officio.*

In addition to considering the constitution and by-laws and electing officers, the Academy at this first meeting appointed a committee on the form of a diploma, on a corporate seal, and on a stamp for books and other property, and also a committee on the mode of electing foreign associates. The latter committee did not report until January, 1864, and the former appears not to have presented any formal report.

[34] Ann. Nat. Acad. Sci. for 1863-4 (1865), pp. 48, 49.

CHAPTER II

THE ANNALS OF THE ACADEMY

IN chronicling the history of the Academy it has seemed desirable to divide the half century into periods of ten years each, although in some instances, for the sake of clearness, the whole story of a transaction is given in one place without regard to years.

1863–1867

The first meeting of the Academy held in New York on April 22, 1863, was a meeting for organization. It was devoted, as already shown, to the consideration of a constitution and by-laws, the election of officers and a council, and the appointment of certain committees. In accordance with the provisions of the constitution, the members arranged themselves in two classes, (a) mathematics and physics, and (b) natural history; and a chairman and secretary were elected for each class. Five sections were included under each class. The assignment of members to these sections seems not to have been thoroughly carried out until the meeting of August, 1864, and even at that date the names of several members do not appear under any section. The names of the sections and the number of members enrolled under each, which are matters of considerable interest, are shown in the following table:

Class of Mathematics and Physics	Number of Members	
Sect. 1. Mathematics	6	
Sect. 2. Physics	6	
Sect. 3. Astronomy, Geography and Geodesy	9	
Sect. 4. Mechanics	6	
Sect. 5. Chemistry	3	
	—	30

Class of Natural History	Number of Members	
Sect. 1. Mineralogy and Geology	6	
Sect. 2. Zoölogy	5	
Sect. 3. Botany	1	
Sect. 4. Anatomy and Physiology	2	
Sect. 5. Ethnology	0	
	—	14
Total		44

It will be seen from the foregoing figures that the number of members who joined the sections concerned with the physical sciences was twice as large as the number which joined those concerned with the natural sciences. This was due to the fact that the Academy movement was promoted by the physicists rather than the naturalists. As indicated by certain remarks of Professor Bache and Senator Wilson, the original plan seems to have contemplated the formation of an academy of physical sciences.

It is interesting to notice that the paleontologists aligned themselves with geology rather than zoölogy. The section of botany had but one member, and that of ethnology, none. Half the membership, in so far as it was assigned to sections, assembled in the first three physical sections,—mathematics, physics, and astronomy (with geography and geology).

The first scientific session of the Academy, following the meeting for organization, was held in Washington on January 4 to 9, 1864, in the Capitol, in the rooms of the Pacific Railroad Committee of the Senate which were placed at the disposal of the Academy. In the interval between these two meetings, however, six committees on technical subjects had been appointed. These reported at the January meeting, and in three cases the reports were adopted and the committees discharged, while in the other three the committees were continued. Four additional committees were appointed before the close of 1864. The work of these committees and of others appointed subsequently forms the subject of a later chapter. The importance of the scientific committees was felt by President Bache, who considered that it was largely through their activities that the Academy was to fulfil its functions. In his report for 1863 he remarks:

"The first trial of the working of the Academy was to be made, and the first effort was to be through the action of a Committee on Weights and Measures, for the appointment of which, to consider the subject of the 'Uniformity of Weights, Measures and Coins, considered in relation to domestic and international commerce,' the Academy had been addressed before its adjournment by the Hon. Secretary of the Treasury, S. P. Chase.

"It was obvious that the only effective and prompt mode of action by members scattered over the United States, as were the fifty named in the charter, must be through committees. Action must originate with committees, and be perfected by discussion in the general meetings of the Academy, or in the classes or sections. Decisions to be finally pronounced by the entire body." [1]

For the first time, the Academy listened to the reading of scientific papers by its members. In the program were included the names of Agassiz, Alexander, Bache, F. A. P. Barnard, J. G. Barnard, B. A. Gould, Henry, Peirce, Rutherfurd and Strong. The subjects of the 16 papers that were presented were all connected with the physical sciences, except three by Professor Agassiz (two of which related to fishes and one to individuality among animals), and one by Stephen Alexander on the forms of icebergs. The preponderance of physical subjects is not surprising, when it is recalled that two-thirds of the membership at this time were enrolled in the class of mathematics and physics.

The papers were referred to the Committee on Publication, which was instructed to "take order" for their publication, while the Council was directed to provide the means. The Academy was at this time without funds, except the amounts received from members as dues, and the orders could not, therefore, be carried out immediately. It was not until 1866 that the first volume of the *Memoirs* of the Academy was issued, and this contained but two of the 16 papers read at the first scientific meeting in 1864. It was proposed in 1866 to collect and pub-

[1] Annual Report of the President for 1863. Ann. Nat. Acad. Sci. for 1863-4 (1865), p. 49.

lish the minor papers in the *Proceedings* of the Academy, but this action was never taken, the first issue of the *Proceedings* having been devoted to the reports and minutes.

Besides formally adopting a constitution and by-laws, acting on reports of scientific committees, and listening to scientific communication, the Academy transacted other important business at the meeting of January, 1864. It elected the first foreign members, or "Foreign Associates," as they were styled in the constitution. The by-laws provided that not more than ten Foreign Associates might be elected at any one meeting, and the Academy proceeded at once to elect this number. This first list comprised Sir Wm. Rowan Hamilton, Karl Ernst Von Baer, Michael Faraday, J. B. Élie de Beaumont, Sir David Brewster, G. A. A. Plana, Robert Bunsen, F. W. A. Argelander, Michel Chasles and Henri Milne-Edwards.

The Academy had not been in existence six months when it lost one of its original members, Professor Hubbard, one of the youngest of the incorporators, who died on August 16, 1863, at the age of 46 years. The event was reported at the meeting of January, 1864, and in accordance with the by-laws, Dr. B. A. Gould was appointed to prepare a biographical notice. This notice, the first of the series of biographical sketches published by the Academy, was read at the New Haven meeting, August 5, 1864, and printed in the first *Annual*.[2]

In accordance with the by-laws, the death of three eminent scientific men of the country not members of the Academy was announced at the meeting of January, 1864, and three members were appointed to prepare biographical sketches. Only two of the sketches appear to have been presented, however, and the practice was not continued in subsequent years, doubtless on account of the burden which it imposed on the membership, and the lack of funds for printing.

Of the second session of the Academy for the year 1864, which was held in New Haven on the 5th and 6th of August, little has been recorded, beyond the fact that ten papers were

[2] Pp. 71-112.

read, including the two biographical sketches of non-members already mentioned. Of the remaining eight papers, all but one related to the physical sciences.

The Academy lost three more of its original members during the year 1864, Edward Hitchcock, who died on February 27, Joseph Gilbert Totten, who died on April 22, and Benjamin Silliman, Sr., who died on November 24. Biographical notices of them were published in the *Annual.*

The year 1865 was signalized by the publication of the first *Annual,* a pamphlet of 112 pages in duodecimo form, which appeared between January 1, and February 13. It contained the Act of Incorporation, the constitution and by-laws, a list of officers, members, foreign associates and committees, the first report of the President, and a eulogy of J. S. Hubbard, one of the incorporators. As the Academy was without funds, the expense of printing was met by contributions of individual members, and in accordance with a vote of the Academy it was distributed to members of both houses of Congress, and to the heads of departments of the Government.[3]

Although the eighteenth by-law of the Academy provided that the *Annual* should be published on the first day of each year, this first number did not appear until the Academy had been in existence nearly two years, and only two additional numbers were issued, dated, respectively, 1866 and 1867. The by-law, or rule, as it was afterwards called, remained in force, however, until 1896, when it was finally stricken out.[4]

The year 1865 was further characterized by the fact that no requests for the investigation of scientific matters were received from the Government and no new scientific committees appointed.

Thirty-four papers were read at the scientific sessions of this year, or somewhat more than were presented in 1864. The program covered a much wider scope than that of the preceding year. While astronomy, physics and mathematics were well repre-

[3] Proc. Nat. Acad. Sci., vol. 1, 1877, p. 43.
[4] Rep. Nat. Acad. Sci. for 1896, p. 10.

sented, ten papers on geological subjects were presented, four papers on zoölogy, two papers relating to anthropology, etc.

The Academy lost one of its original members this year, James Melville Gilliss, who died on February 9, 1865. It was also unfortunate as regards the presiding officers, President Bache having been in ill health, and the Vice-President, James Dwight Dana, having been forced to resign on August 23, from the same cause.[5] The report to Congress on the operations of the Academy during 1865 was submitted by Professor Henry.

As in the preceding year, the Washington meeting of the Academy was held in the Capitol. The August meeting was held at Northampton, Massachusetts. Few details have been recorded regarding either of these meetings. From Lesley's letters we learn that the Northampton session opened with 13 members present, which number increased to 20 on the following day. This session opened on August 23, and closed on the afternoon of the 26th.

The division of the membership between the two classes "Mathematics and Physics" and "Natural History" underwent few changes in 1865, but the section of "Ethnology" came into actual existence through the assignment of one member thereto. Advantage was also taken in several sections of a provision of the constitution whereby members assigned to the

[5] Professor Dana's reasons for resigning are mentioned in letters written by him to Professor Baird and Professor Guyot. On December 10, 1864, he wrote to Professor Baird: "As the time for our January (1865) meeting of the National Academy approaches, I become more and more convinced that I ought not to encounter the labor and fatigue of the occasion. Had I no duties but those of a private in the Academy I should have less fear. But with the cares of President, which involve meetings of council, as well as all business meetings, at least, of the Academy, and much more of an outside nature, I am sure I should be unwise to risk attendance. . . . . I should much prefer now to throw up the position; for besides my incapabilities from imperfect health, I should enjoy myself far more if I could have my time and strength to mingle socially with the members present." (The Life of James Dwight Dana, by D. C. Gilman, 1899, pp. 362, 363.)

To Professor Guyot he wrote on February 14, 1865: "I wish most heartily I were out of the office of Vice-President, and I think I shall take an early opportunity to abdicate. It makes the meetings, now that Bache is unwell, times of great fatigue for me, and of no satisfactory intercourse with friends on the ground. I dislike the duty, and care nothing for the honor of it. You will not be surprised, therefore, if my resignation is handed in not long hence." (*Op. cit.*, p. 329.)

various sections could be elected honorary members of others. Thus, a member of the section of chemistry was elected to the section of botany, a member of the section of mathematics to the section of astronomy, etc.

The year 1866 found the Academy without presiding officers. The first President, Professor Bache, continued in ill-health and was unable to attend the meetings, and the Vice-President, J. D. Dana, as already mentioned, resigned in August, 1865, from the same cause. The Academy being thus without presiding officers, proceeded on January 25, 1866, to elect Joseph Henry as Vice-President. "On taking the chair, Mr. Henry stated that while he was highly honored by the election, he felt much hesitation in accepting the office, since his duties in connection with the Smithsonian Institution were more than sufficient to occupy his attention, and that he could only accept the responsible position with the understanding that he would be permitted to retire as soon as the president should be able to resume his duties, or his place could be filled by another."[6] As the event proved, however, Henry did not retire, but remained at the head of the Academy for twelve years.

The Academy lost another of its original members, Augustus A. Gould, who died on September 15, 1866.

This year again the Government sought the advice of the Academy on technical scientific matters and two committees were appointed, one on the improvement of the harbor of San Juan del Norte, or Greytown, in Nicaragua, and the other on proving and gauging spirits subjected to duty. Both committees presented reports, which were published in the annual report of the Academy, that relating to the gauging of spirits being voluminous and detailed.

Thirty-eight papers were presented for discussion at the two scientific sessions held in 1866, or a few more than were included in the programs of the preceding year.[7] The subjects covered a wider range than those of the preceding year. The greatest

[6] Rep. Nat. Acad. Sci. for 1866, p. 1. Sen. Misc. Doc. no. 44, 40th Congress, 1st Session.
[7] Including three biographical sketches.

number of papers were on astronomy, followed by zoölogy, physics and geography.

The Academy this year for the first time voiced its interest in scientific activities outside its own sphere by passing resolutions expressing satisfaction at the action of the Government in authorizing the employment of metric weights and measures, and recommending that the metric system be taught in the public schools, and be made a subject of examination for admission to colleges and universities; and also "that the Academy considered it highly desirable that the discretionary power granted by Congress to the Postmaster-General to use the metrical weights in the post-offices be exercised at the earliest convenient day." Another resolution was adopted, commending the generosity of Nathaniel Thayer, of Boston, in fitting out an expedition to South America under the conduct of Professor Agassiz.

The summer meeting was again held at Northampton, Massachusetts. Few details regarding it have been recorded, but it was referred to by one who was present as "a brilliant meeting."

An important event of the year 1866 was the publication of the first volume of the *Memoirs* of the Academy. It was in quarto form and comprised 342 pages. The volume contained five articles, three on astronomical subjects, one on the distribution of certain diseases in the United States and another on rifled guns. It was distributed through the Smithsonian Institution to 34 libraries in the United States and 24 in other countries. A second number of the *Annual* was also published.

The events of 1867 were numerous and important. At the opening of the year, in February, the Academy lost its first President, Professor Bache. In his report as Vice-President, Professor Henry remarked: "During the past year the Academy has been called upon to mourn the loss of its distinguished president, Alexander Dallas Bache. This eminent savant devoted his life industriously to the advance of science, and may be said to have fallen a martyr to the cause of his country in the hour of its peril." Bache was one of the principal leaders, if not the prime mover, in the formation of the Academy, and his deep interest in its work is indicated by the fact that he bequeathed his estate to the Academy as a fund for the promotion of researches in the natural and physical sciences. His original intention was to place the fund under the control of a board, or, in case the board failed to act, that the trustees of the estate should apply the funds to the purposes specified, under the direction of the American Philosophical Society. Soon after the organization of the National Academy, however, on July 15, 1863, he added a codicil to his will which reads as follows:

"ITEM: My will is that, upon the death of my wife, all the rest and residue of my estate[8] shall be paid over to and vest in the corporation of the National Academy of Sciences, incorporated by act of Congress, passed the 3d day of March, A. D. 1863, whom I hereby appoint trustees in the place of my said executors under the fourth clause of my said will, to apply the income, according to the directions in the said clause contained, to the prosecution of researches in physical and natural science by assisting experimentalists and observers in such manner and in such sums as shall be agreed upon by the board of direction in the said clause named."[9]

Mrs. Bache died in February, 1870, and in 1871 the treasurer, Fairman Rogers, reported that the amount handed over to him by the executors of the estate of Professor Bache was $40,515.07, "together with an annual ground rent of $102, and some lands in Missouri not now [then] available."[10] In 1879, this amount was increased by $4650, on the death of Henry Wood Bache, a nephew of Professor Bache, who was a beneficiary under the will of Mrs. Bache.[11] The income of the original fund amounted in 1872 to about $2500. The first allotment for scientific research was made in 1871 by the board having the fund in charge, the chairman of which was Joseph Henry. The amount of the grant was $500, and was the first of a series made to Professor J. E. Hilgard in connection with the magnetic survey of the United States.

[8] The property excepted was a house in Washington, which he gave to his sister, but with the provision that after her death and that of his wife it should also pass to the Academy.

[9] Rep. Nat. Acad. Sci. for 1867, p. 11. Sen. Misc. Doc. no. 106, 40th Congress, 2d Session.

[10] Proc. Nat. Acad. Sci., vol. 1, p. 81.

[11] *Loc. cit.*, p. 156.

Through this bequest, the Academy was put in possession of an important instrumentality for the promotion of scientific research, and nearly every year, for forty years, the Academy has granted one or more allotments for investigations in various branches of science, but chiefly in physics and astronomy. By 1889 the number of allotments had risen to 79, amounting in all to more than $38,000.[12] Professor Bache's generous action has not only been of direct benefit to American science, but has suggested other bequests and donations to the Academy, through which research has been stimulated and aided.

Besides the death of Professor Bache, other important changes had taken place in the membership of the Academy between 1863 and 1867. Of the fifty incorporators eight had died, namely, Hubbard, Totten, Hitchcock, Benj. Silliman (senior), Gilliss, A. A. Gould, Bache and Alexander. Eleven members had resigned, and in accordance with the provisions of the constitution, two were constituted honorary members on account of age or remoteness from the places of meeting.

The January meeting for 1867 was held as usual in Washington and 17 members were present. Only seven papers were read at this meeting, the smallest number presented at any meeting since the organization of the Academy. Resolutions were again passed recommending that the metric system of weights and measures be taught in the public schools and higher institutions of learning; and, in addition, registering the opinion that it was highly desirable to employ metric weights in the post-offices "at the earliest convenient day."

At the August meeting of 1867 a resolution signed by eight members was offered, requesting that Congress should be asked to amend the act incorporating the Academy so that the membership could be increased beyond fifty. The resolution was discussed at this meeting and referred to the Council. At the next session, on recommendation of the Council, it was rejected. The matter did not rest here, however, for at the meeting of April, 1870, it was brought forward again, and this time unanimously adopted by the Academy.

[12] Proc. Nat. Acad. Sci., vol. 1, p. 317.

At the summer session the Committee on Weights and Measures was authorized and directed "to communicate with individuals and corporations representing the various trades throughout the country tendering advice and assistance in any efforts they may be disposed to make in regard to the introduction of the metric weights and measures."

The summer session this year was held in New Haven, 17 members being in attendance. A singular feature of the scientific program was that of the 29 papers read, 10 were by Professor Agassiz and related chiefly to fishes. The remaining papers, with two exceptions related to the physical sciences.

A third number of the *Annual* of the Academy was published in 1867, after which it was discontinued.

1868–1872

Professor Henry continued during 1867 to preside over the meetings of the Academy in the capacity of Vice-President, but in January, 1868, he was elected President, and held that position for 11 years. At the same time, Wm. Chauvenet was elected Vice-President. The resolution to increase the membership was brought up again at this time, but was rejected. The feeling appears to have prevailed, however, that a larger attendance was desirable, and action was taken authorizing the President to invite as many persons not belonging to the Academy as he might think proper, while each member was privileged to invite a number not to exceed five. The time of the first session was by resolution changed from January to the second week in April, while that of the second session was changed from summer to fall, usually October or November. This new arrangement of meetings was put into effect in 1869 and has continued in force to the present.

Not content with passing resolutions regarding the use of the metric system of weights and measures, the Academy in 1868 appointed a committee to wait upon the Postmaster-General and urge their adoption in the post-offices. It appears from the records that the communication of the committee was listened to with attention, but no action was taken by the Government at that time.

The Committee on Weights and Measures was also requested to consider certain changes in the coinage that had been proposed, and was authorized to communicate its views to Congress.

A committee was appointed by the Academy in 1868 in connection with the total eclipse of the sun which was to occur the following year and would be visible in the United States. The observations on this important eclipse, during which the presence of the new element, coronium, was discovered in the sun's corona, led to the presentation of four papers relating thereto at the following session of the Academy, held at Northampton from August 31 to September 3, 1869.

In the year 1868 the number of asteroids discovered by astronomers had reached 101, and the Academy appointed a committee to give names to those bearing the numbers 100 and 101. The name *Hecate* was chosen for the former, and *Helena* for the latter.

The Academy lost another of its original members in 1869, Theodore Strong, and two others, Frazer and Caswell, resigned and were placed on the list of honorary members. As showing its continued interest in astronomical investigation, the Academy this year appointed a committee to consider the completion and publication of Gilliss' observations of zones of stars around the South Pole. A committee was also appointed to determine whether the magnetic observations made by Harkness while on board the monitor *Monadnock* were suitable for publication.

The latter observations were made by Professor William Harkness under an order of Rear-Admiral John Rodgers, U. S. N., during a cruise of the *Monadnock* from Philadelphia to San Francisco, by way of the Straits of Magellan, beginning in October, 1865. This detail was made by the Navy Department upon the recommendation of so-called "Compass Committee" of the Academy, which was concerned with questions of magnetic deviations in iron vessels. "The investigation was undertaken because the vessel was heavily armored and the voyage extended far into both hemispheres, thus affording a favorable opportunity of submitting Poisson's theory of the deviations of compasses on iron ships to the test of rigorous observations, which had never been done before." The observations were published in the Smithsonian *Contributions to Knowledge*,[13] with the following prefatory note by Joseph Henry:

> "This paper was originally an official report presented to the Navy Department by Professor Harkness; but, as that department made no use of it, the National Academy of Sciences, in August, 1867, passed a resolution asking for the manuscript. This request was complied with; and, an abstract of the paper having been read to the Academy in April, 1869, it was referred to a commission consisting of the President of the Academy, Professors J. H. C. Coffin, and F. Rogers, in accordance with whose recommendation it is now published by the Smithsonian Institution." [14]

About 40 papers were read at the two sessions of 1869 and an equal number the preceding year. They covered a very wide range of topics, but the majority related to the physical sciences.

Although in 1868 the Academy rejected the proposition to have the restriction on the number of members removed, the subject was revived in 1870 and met with favorable consideration. A resolution was unanimously passed providing that "a memorial be addressed by the President of the Academy to the Congress of the United States, asking for the amendment of its charter in such manner as to remove the restrictions to the number of its members." The matter was presented to Congress on May 4, 1870, by Senator Henry Wilson, and the amendment asked for was granted in an act approved on July 15,

[13] Vol. 18, 1873. The paper was accepted for publication on September 18, 1871. The signatures are dated from December, 1871, to January, 1873.

[14] The resolution asking for the manuscript will be found in the Report of the National Academy of Sciences for 1867, page 9 (40th Congress, 2d Session. Sen. Misc. Doc. no. 106). The preface above quoted is not in accord with the *Proceedings*, which, on page 73, state that the committee was appointed in April, 1869, also (page 75) that Professor Harkness read a paper on magnetic deviations in iron ships, in April, 1870, and not in April, 1869. In both the *Proceedings* and the *Report*, the vessel is incorrectly referred to as the *Miantonomah*.

1870.[15] The amendment was accepted by the Academy on the following year and in 1872, upon the adoption of an amended constitution, 25 new members were elected, having been selected from a list of 29 names submitted by the Class of Mathematics and Physics, and 18 names submitted by the Class of Natural History. A resolution was adopted, however, that after 1872 only five members should be elected at any one session of the Academy.

The year 1870 was further marked by the important circumstance, already mentioned above, that the Bache Fund became available. The first allotment from the income which it afforded was made in the following year, in connection with the magnetic survey of the United States.

A committee was appointed this year to consider measures to secure the successful observation of the short transit of Venus of 1874. The Academy also expressed, in a resolution, its gratification at the appointment by the Government of the Argentine Republic of Dr. B. A. Gould, one of the original members of the Academy, as the director of the new national astronomical observatory at Cordoba.

The second Vice-President of the Academy, William Chauvenet, died in December, 1870, and the office remained vacant until 1872, when Wolcott Gibbs was elected to succeed him.

A committee to revise the constitution and the by-laws of the Academy in accordance with the act of Congress, approved July 14, 1870, amending the original act of incorporation, reported in 1871. This report was referred to the Council which in 1872 brought it again before the Academy. The constitution and rules, as amended, were unanimously adopted on April

[15] July 11, 1870. "On motion of Mr. Wilson, the Senate, as in Committee of the Whole, proceeded to consider the bill (S. No. 881) to amend the act to incorporate the National Academy of Sciences. It directs that the act to incorporate the National Academy of Sciences, approved March 3, 1863, be, and the same is hereby, so amended as to remove the limitation of the number of ordinary members of the Academy as provided in the act.

"The bill was reported to the Senate without amendment, ordered to be engrossed for a third reading, read the third time, and passed." (*Congressional Globe,* 41st Congress, 2d Session, part 6, p. 5437.)

The bill passed the House without objection on July 14, 1870, and was approved July 15, 1870.

17 of that year. While many of the changes introduced modified the organization of the Academy, they did not affect its character or scope. The whole system of classes and sections was abolished, members were no longer required to take an oath of allegiance to the Government, and the provisions for impeaching and expelling members were omitted. The limitation in the number of members was removed, in accordance with the amended act of incorporation, and various changes were made in the manner of electing members. The time of meeting in Washington was changed from the third day of January to the third Tuesday in April. Persons not members were permitted to read papers upon invitation of the Academy. A clause was added to the constitution providing that "bequests and trusts having for their object the advancement of science may be accepted and administered by the Academy."

As already mentioned, immediately upon the adoption of the revised constitution in April, 1872, twenty-five new members were elected. In a letter to the President of the Senate, dated February 23, 1873, Joseph Henry, President of the Academy, remarked on this action as follows:

> "The enlargement of the Academy has already had a most beneficial effect in stimulating the zeal of the younger men in the country who are devoted to scientific pursuits. A large number of the most valuable papers were contributed by the younger members at the recent session in Cambridge [November, 1872], and it is evident that the usefulness of the Academy is largely increased by being brought into closer sympathy with all the cultivators of science in the country." [16]

For lack of communications, or for some other reason, no scientific session was held in the fall of 1870 or 1871, and at that of April, 1872, only six papers were presented, one of them being a biographical memoir. It appears probable that the enlargement of the membership of the Academy was intended, in part, at least, to offset the waning interest in the meetings, and Professor Henry's gratification at the strengthened programs which followed this action can be well understood.

Through the solicitation of Captain Chas. F. Hall, who had undertaken two voyages into the Arctic regions, and a number of

[16] Proc. Nat. Acad. Sci., vol. 1, pp. 100, 101.

his friends, Congress in the winter of 1869-70 passed an act authorizing the organization of an expedition toward the North Pole, which was later known as Hall's Third Arctic Expedition, or the voyage of the *Polaris,* from the name of the vessel commissioned for the undertaking. The Act of Congress was as follows:

"SEC. 9. *And be it further enacted,* That the President of the United States be authorized to organize and send out one or more expeditions toward the North Pole, and to appoint such person or persons as he may deem most fitted to the command thereof; to detail any officer of the public service to take part in the same, and to use any public vessel that may be suitable for the purpose; the scientific operations of the expedition to be prescribed in accordance with the advice of the National Academy of Sciences; and that the sum of fifty thousand dollars, or such part thereof as may be necessary, be hereby appropriated, out of any moneys in the treasury not otherwise appropriated, to be expended under the direction of the President."

Approved, July 12, 1870.[17]

Captain Hall was appointed leader of the expedition, and in accordance with the Act of Congress the Secretary issued instructions to him, in which were included those of a committee of the National Academy of Sciences. The instructions were embodied in a pamphlet, which was published under the title: "Instructions for the Expedition toward the North Pole from Hon. Geo. M. Robeson, Secretary of the Navy. With an appendix from the National Academy of Sciences. 1871."

On page 4 the following reference is made to the Academy:

"You [Chas. F. Hall] will render Dr. Bessels and his assistants all such facilities and aids as may be in your power to carry into effect the said further advice, as given in the instructions herewith furnished in a communication from the president of the National Academy of Sciences. It is, however, important that objects of natural history, ethnology, etc., etc., which may be collected by any person attached to the expedition, shall be delivered to the chief of the scientific department, to be cared for by him, under your direction, and considered the property of the government; and every person be strictly prohibited from keeping any such object."

The instructions and appendix are also contained in the Report of the Secretary of the Navy for 1871, pp. 238-260.

[17] Stat. at Large, vol. 16, 1871, p. 251, 41st Congress, 2d Session, chap. 251, sec. 9.

The scientific instructions on astronomy were prepared by Simon Newcomb, and J. E. Hilgard; on magnetism, force of gravity, ocean physics and meteorology, by J. E. Hilgard; on natural history, by S. F. Baird; on geology by F. B. Meek; on glaciers, by Louis Agassiz. In a letter addressed to the Secretary of the Navy, June 9, 1871, and printed in the pamphlet mentioned above, Professor Henry remarked:

" . . . . The expedition, except in its relation to geographical discovery, is not of a scientific character, and to connect with it a full corps of scientific observers, whose duty it should be to make minute investigations relative to the physics of the globe, and to afford them such facilities with regard to time and position as would be necessary to the full success of the object of their organization, would materially interfere with the views entertained by Captain Hall, and the purpose for which the appropriation was evidently intended by Congress.

"Although the special objects and peculiar organization of this expedition are not primarily of a scientific character, yet many phenomena may be observed and specimens of natural history be incidentally collected, particularly during the long winter periods in which the vessel must necessarily remain stationary; and therefore, in order that the opportunity of obtaining such results might not be lost, a committee of the National Academy of Sciences was appointed to prepare a series of instructions on the different branches of physics and natural history, and to render assistance in procuring the scientific outfit." [18]

This expedition, as is well known, ended in disaster. Having reached the latitude 82° 11′ N. on August 29, 1871, the highest attained by any explorer up to that time, Hall was soon afterward taken suddenly ill at Thank God Harbor, Greenland, and died there on November 8, 1871.[19]

[18] Instructions for Expedition toward North Pole from Hon. Geo. M. Robeson. Appendix, pp. 7, 8.

[19] In 1871 six members of the Academy, Messrs. Meigs, Peirce, Hilgard, Baird, Henry and Barnard (F. A. P.), addressed a letter to the Hon. William M. Stewart, chairman of the Senate Committee on Mines and Mining, recommending that means be provided for testing the economic value of Western coals. The letter was printed as Senate Miscellaneous Document no. 74, 41st Congress, 3d Session. In 1875 the Academy adopted the following resolution on the subject: "*Resolved,* That the National Academy recommends that an appropriation be made by Congress for completing and extending to all known American coals the series of experiments now to be made by the Navy Department under an appropriation of Congress, and published in the report of W. R. Johnson on American Coals." (See Proc. Nat. Acad. Sci., vol. 1, p. 111.) The following year the Academy again adopted the

1873–1877

In 1872 the Academy lost another of its original members, John F. Frazer, and in 1873 three more,—Louis Agassiz (who was one of the most prominent leaders in the establishment of the Academy, and who held the office of Foreign Secretary for eleven years), Joseph Saxton and John Torrey. The latter year seems to have been otherwise uneventful.

Following its policy of promoting astronomical science, a committee was appointed in 1873 "to take into consideration the need of more Accurate Investigation, and Tables of the Celestial Movements, and to devise such measures as may seem best adapted to improve the Accuracy of Astronomical Tables."

Joseph Henry this year expressed his intention of resigning the presidency, which he had held for six years, the term fixed by the constitution. A letter "numerously signed by members of the Academy" was, however, presented at the first session of 1874, and Henry thereupon decided to withhold his resignation, and continue to serve as President, which he did until his death in 1878.

The interest felt by the members of the Academy in the metric system of weights and measures was newly manifested in 1875. As is well-known, an international conference on new metric standards was held in Paris in 1870, but its deliberations were interrupted by the opening of the Franco-Prussian War. It convened again in 1872 and soon afterward the proposition was advanced that an international bureau of weights and measures be established. At the April meeting of 1875 the Academy passed resolutions soliciting the President of the

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same resolution, on motion of General Meigs, in slightly different form, thus: "*Resolved*, That the President and Council of the National Academy be requested to prepare and present to Congress in the name of the Academy a memorial advising that the course of Experiments upon American Coals, made under direction of Congress by the Navy Department and reported in Johnson's Report on American Coals, be resumed and continued so as to include all the coals now used in the United States in sufficient quantities to be of value in the arts, and in manufactures, and in commerce." (Proc. Nat. Acad. Sci., vol. 1, pp. 115, 116.)

The records of the Academy do not contain any information as to the reasons which prompted this action, or the results which followed from it.

United States " to ratify the assent which is understood to have been provisionally given by his diplomatic representative in Paris, to the creation of such a bureau, and to recommend to Congress to make the necessary provision to defray such portion of the expense attending its maintenance as may probably fall to our share." [20] The International Bureau was established on May 20, 1875, the United States being the first country to sign the convention.

At this time plans were well advanced for holding a great international exposition in Philadelphia, the Centennial Exhibition of 1876, to mark the one hundredth anniversary of the signing of the Declaration of Independence. It had been proposed in the Academy that invitations should be issued to prominent men of science abroad to attend the exposition and a committee was appointed to report upon the plan. After consideration, however, the committee reported unfavorably and the scheme was abandoned.

The Government exhibits at this exposition were extensive and diversified, and were, for the time, extremely well installed. The autumn meeting of the Academy was held in Philadelphia in the year of the exposition and the members were so favorably impressed by the display made by the several departments and bureaus of the Government, the Smithsonian Institution and other organizations, that they were induced to pass resolutions urging the transfer of these exhibits in their entirety for permanent exhibition in Washington. The resolutions were as follows:

October, 1876.

" *Whereas,* The members of the National Academy of Sciences have been greatly impressed by the extent, variety, and richness of the truly national collection contained in the Government Building at the Centennial Exhibition, and considering the great importance and the lasting interest with which the people of the United States regard this collection, therefore:—

" *Resolved,* That in the opinion of the Academy, the Government Collection as a whole should be transferred to Washington and there preserved in an appropriate building for perpetual exhibition.

[20] Proc. Nat. Acad. Sci., vol. 1, p. 110.

"*Resolved,* That the Academy entertain the hope that the President of the United States will favor the foregoing proposition, that he will delay the dispersion of the exhibit from the several Executive Departments until Congress has assembled, and that he will recommend to that body to provide for the transfer of the Government Exhibit to the City of Washington, and for its subsequent permanent support." [21]

The autumn meeting of 1872 was held in Cambridge, Massachusetts, that of 1873 in New York City, and those of 1874, 1875 and 1876 in Philadelphia. In the latter year the Academy having been asked by the British Minister to suggest names of persons considered eligible to receive the Albert Medal of the Society of Arts for "distinguished merit in promoting arts, manufacture, or commerce," suggested the name of Joseph Henry "as most worthy of all living Americans to receive that recognition." [22]

The original constitution of the Academy provided for four series of publications, reports, memoirs, annals and proceedings. While the reports and annals began to be issued soon after the organization of the Academy, the memoirs were delayed three years from lack of funds, and the first part of the first volume of *Proceedings* did not appear until 1877. This part comprised 120 pages and contained the constitution and by-laws, a summary of the important business operations of the Academy, resolutions relating to scientific matters, the programs of the scientific sessions, reports of committees and other miscellaneous information. Though more or less fragmentary and incomplete, it is valuable as a continuous record of the proceedings of the Academy during the first 14 years of its existence. A second part carried the record to 1884, and a third to 1895. No further parts have been issued.

Another publication which first appeared in 1877 was the *Biographical Memoirs.* The first volume, in octavo form, contained memoirs of fifteen deceased members. Some of these sketches had already appeared in the *Annual,* and the series, for

[21] Proc. Nat. Acad. Sci., vol. 1, p. 118.
[22] *Loc. cit.,* p. 114.

which there was no definite provision in the constitution, may perhaps be considered as a continuation of that publication.

Although in 1875 the diplomatic representative of the Government had signed the convention for the establishment of an international bureau of weights and measures, that action required ratification by the Senate to be binding on the United States. On recommendation of the Committee on Weights, Measures and Coinage, the Academy in 1877 addressed a memorial to Congress in which the members "respectfully urge that the Senate ratify said convention, and that Congress make the requisite appropriation to carry the same into effect."

The treasurer reported in October, 1876, that the principal of the Bache Fund amounted to $43,300, of which $42,300 was invested in United States certificates, and $1000 in certificates of the city of Davenport, Iowa. In addition, the Academy had received from the Bache estate 160 acres of land situated in the State of Missouri, and a house and lot in the city of Washington, No. 723 Twentieth Street, S. W. In connection with the various allotments made from the fund for scientific researches, some pieces of apparatus had been purchased, and in 1877 the Academy directed that all such apparatus when no longer needed for the purposes of the investigations undertaken should be turned over to the Home Secretary, and be at all times subject to the disposal of the Academy.

Jeffries Wyman, one of the original members of the Academy, died in 1874, and another, Joseph Winlock, in 1875. In 1877 two others died, Alexis Caswell and Rear-Admiral Charles H. Davis, the latter, as shown by this history, probably the first to conceive a practical plan for the formation of the Academy.

In 1877 the practice was established of having important inventions based on scientific principles exhibited before the Academy. In that year an exhibition was made in the chemical laboratory of Columbia College, of the Jablokoff electric candle, a form of arc light which caused a revival of interest in the problems of electric lighting.

1878–1882

At the April session of the following year, Mr. Thomas A. Edison exhibited to the Academy the phonograph, which was invented by him in 1877, and also his "carbon telephone." The record contains the following statement regarding this exhibition:

April, 1878.

"During the session Mr. Thomas A. Edison exhibited to the Academy his Phonograph and Carbon Telephone, communicating with the latter through one of the Western Union Telegraph wires with the Central Office of that Company in Philadelphia, and members of the Academy holding conversation with Mr. Henry Bentley of that city." [23]

Toward the close of the year 1877 the health of the second President of the Academy, Joseph Henry, suffered a severe decline, and at the April session of 1878 an address was read in his behalf, in which he called attention to his long term of service, and renewed the request which he had made some six years previously, that he be allowed to resign his office. In closing his address he remarked, "I retain the office six months longer in the hope that I may be restored to such a condition of health as to be able to prepare some suggestions, which may be of importance for the future of the Academy." [24]

The appreciation of Henry's services was such that the following resolution was adopted unanimously:

"*Resolved,* That with every sentiment of sympathy and regard for Professor Henry, the Academy most respectfully declines to entertain any proposition looking to his retirement from the office of President." [25]

His infirmities, however, increased with such rapidity that he was obliged to hasten his valedictory address, and at the end of the same session his farewell was delivered in the following words:

"GENTLEMEN: I have been much interested in the proceedings of the present meeting of the National Academy. Although I have been unable to be present,

[23] Proc. Nat. Acad. Sci., vol. 1, p. 130.
[24] *Loc. cit.,* p. 132.
[25] *Loc. cit.,* p. 132.

except during a small part of the session, yet I have been made acquainted with everything that has occurred.

"Whatever might have been thought as to the success of the Academy, when first proposed by the late Prof. Louis Agassiz, the present meeting conclusively proves that it has become a power of great efficiency in the promotion of science in this country. To sustain this effect, however, much caution is required to maintain the purity of its character and the propriety of its decisions.

"For this purpose great care must be exercised in the selection of its members. It must not be forgotten for a moment that the basis of selection is actual scientific labor in the way of original research; that is, in making positive additions to the sum of human knowledge, connected with unimpeachable moral character.

"It is not social position, popularity, extended authorship, or success as an instructor in science, which entitles to membership, but actual new discoveries; nor are these sufficient if the reputation of the candidate is in the slightest degree tainted with injustice or want of truth. Indeed, I think that immorality and great mental power actually exercised in the discovery of scientific truths are incompatible with each other, and that more error is introduced from defect in moral sense than from want of intellectual capacity.

"Please accept my warmest thanks for the kind expressions of sympathy you have extended to me during this period of my illness, and in refusing to accept my resignation as President of the Academy. I shall be thankful if a beneficent Providence extends my life during another year, and grants me the privilege of greeting you again in a twelve-month from this time as successful laborers in the fields of science.

"I can truly say that I entertain for each member of the Academy a fraternal sympathy, and rejoice at every step he makes in the development of new truths.

"With my best wishes for your safe return to your homes, and for a rich harvest of scientific results in the ensuing year, I now bid you an affectionate farewell." [26]

He died on May 13, 1878. In the address of the Acting President, Professor O. C. Marsh, at the April session of 1879 we find the following words relative to Henry's services to the Academy:

"It is fitting to this occasion, that I should allude, at least, to Professor Henry's great services to the Academy as its presiding officer during the last ten years.

"After the death of the first President of the Academy, Professor Alexander Dallas Bache, in 1867, Professor Henry was elected his successor at the next meeting, in January, 1868. From that time until he left the chair at the last Annual Meeting, in April, 1878, it had been his constant thought to advance the

[26] Proc. Nat. Acad. Sci., vol. 1, pp. 132-133.

best interests of the Academy. How zealously he guarded its good name; how impartially and wisely he guided its deliberations; and how earnestly he strove to maintain for it a high standard in Science, we can all bear ample testimony." [27]

Shortly before his death, in 1878, a number of personal friends established a fund "as an expression of the donors' respect and esteem for Professor Joseph Henry's personal virtues, their sense of his life's great devotion to science with its results of important discoveries, and of his constant labors to increase and diffuse knowledge and promote the welfare of mankind." This fund, which amounted to $40,000, was deposited with a trust company, with the provision that the income derived from it should be paid over to Professor Henry during his lifetime, and afterward to his wife and daughters; and that after the death of the last survivor it should be delivered to the Academy "to be thenceforward forever held in trust under the name and title of the 'Joseph Henry Fund,' the principal to be forever held intact, and the income to be from time to time applied by the said National Academy of Sciences in its sole discretion to assist meritorious investigators, especially in the direction of original research."

On June 30, 1878, Congress passed an act requiring the Academy to consider the methods and expenditures of the several surveys carried on under Government auspices, and to report a plan for conducting them to the best advantage as regards cost and results, and for the publication and distribution of reports, maps, etc. The views of the Academy on this subject, which was one of much importance, will be considered in the chapter devoted to the work of the Academy as the scientific adviser of the Government.

After the death of Professor Henry, the Vice-President, Professor Marsh, was Acting President until April, 1879, when Professor Wm. B. Rogers was elected President. The term of office under the constitution was six years, but Professor Rogers died in May, 1882, and Professor Marsh again became Acting President until April, 1883, when Professor Wolcott Gibbs

[27] Proc. Nat. Acad. Sci., vol. 1, p. 149.

was elected to the presidency. Professor Gibbs was, however, unable to serve and Professor Marsh was thereupon elected President.

In a work entitled "Investigation of the Distance of the Sun,"[28] published in 1867, Professor Simon Newcomb called attention to the desirability of further experiments in relation to the velocity of light.

At the spring session of 1878, he presented a communication explaining the methods employed by the French physicists, Foucault and Fizeau, for measuring the velocity of light, and pointing out the discrepancies in the results obtained by them. He outlined a modification of Foucault's method which he had worked out and another which had been devised by Ensign Albert A. Michelson, U. S. N., and asked the Academy's consideration of the question whether the Government should not be asked to provide the means for carrying on experiments in accordance with the improved methods. A resolution was passed at the same session, providing for the appointment of a committee to consider the matter and report to the President and Council who should have power to act. The committee reported favorably on the project, and its report was sent to the Secretary of the Navy, Hon. R. W. Thompson, through whose interest an appropriation of $5000 was made by Congress, to be expended under the direction of the Secretary. Professor Newcomb was appointed by the Secretary of the Navy to conduct the experiments, and immediately took steps to procure the necessary apparatus. The experiments proved more laborious than had been expected and it was not until November 15, 1881, that Professor Newcomb was able to report definite results. These were not as satisfactory as had been hoped, on account of certain defects in the apparatus used, which were not detected until a late date. At the time of reporting in 1881, the sum of $2,000 was still needed to complete the experiments.

The defects in the instruments having been remedied the experiments were taken up again July 24, 1882, and continued until September 5, 1882.

[28] Washington Observations, 1865. Appendix 2.

On account of the discrepancy between the results obtained by Professor Michelson in 1879 and those by Professor Newcomb in his first series of observations, the former undertook the repetition of his experiments in 1882 by means of a grant from the Bache Fund of the National Academy, and in 1883 some cognate experiments on the velocity of differently colored rays of light through various refracting media. The results of Professor Newcomb's experiments and the subsequent ones of Professor Michelson were published under the Navy Department in 1885.[29]

By an act, approved March 3, 1879, Congress established a National Board of Health to consist of one surgeon of the Army, one surgeon of the Navy, a medical officer of the Marine Hospital Service, an officer of the Department of Justice, and seven physicians from civil life. By the provisions of this act, the Academy was requested and directed to coöperate with the board and to report to Congress. A committee of nine members was appointed the same year and assisted the board in the preparation of its first annual report.

Regarding the work of this committee, the President of the Academy reported in 1880, as follows:

"A communication was received from the president of the National Board of Health, dated April 14, 1880, expressing the high appreciation of the Board, of the aid and co-operation rendered by the Committee of the Academy in the preparation of its annual report in accordance with the constituting act approved March 3, 1879, and requesting, in view of the importance of the subjects under its charge, that the Committee be continued or a new one appointed.

"The committee of the Academy to co-operate with the National Board of Health was accordingly continued." [30]

In view of this appreciation and request the committee was reappointed annually until 1883. In 1886 the chairman reported that four years had elapsed since the Board of Health had requested assistance and the committee was, therefore, discharged.

[29] Astronomical Papers prepared for the use of the American Ephemeris and Nautical Almanac, vol. 2, parts 3-4. Velocity of Light in Air and Refracting Media. 4°. Washington: Bureau of Navigation, Navy Department, 1885.

[30] Proc. Nat. Acad. Sci., vol. 1, p. 174.

In 1881, when the Academy had been in existence for eighteen years, the number of papers which had been read at the scientific sessions was no less than 649. Of these papers only five had been published by the Academy, and the President, Professor Rogers, felt that it had not received the recognition by the scientific world which it would have received if the papers of each year had been issued promptly in a journal or some other publication of the Academy. He, therefore, proposed that they should be brought together annually and transmitted with the report to Congress. Though the appeal for the support of the membership in this plan was urgent and was repeated several times, it seems not to have been generally responded to, and the reports continued as before to be made up of only an outline of the proceedings. It can be readily understood that in an organization like the Academy, whose members are for the most part connected with educational or governmental institutions, and are engaged in extended investigations along more or less definite lines, it would be difficult to obtain a series of papers each year for publication. Many communications are necessarily of a preliminary or extemporaneous character, while, on the other hand, such completed papers as are available for publication by the Academy are often so comprehensive, and require so large an amount of illustration that they are unsuitable for an annual report.

At the spring session of 1880 the Academy took notice in its *Proceedings* of two astronomical happenings of importance. Dr. B. A. Gould, a member of the Academy, who since 1870 had been director of the Argentine National Observatory at Cordoba, completed his "Uranometria Argentina" and atlas of the southern heavens, and upon receipt of a copy of that work the Academy passed this resolution:

"*Resolved,* That the Academy . . . . desires to express its high appreciation of the great and permanent value of that magnificent work, the fruit of the labors of our colleague during many years of absence from his country and home, and which reflects the highest credit on the wise liberality of the statesmen who have promoted the establishment of their national observatory and have sustained its progress." [31]

The second resolution related to the determination of longitudes telegraphically, in accordance with a method perfected by Dr. Gould while connected with the United States Coast Survey. Having listened to a paper by Lieutenant-Commander F. M. Green on the results obtained in the Hydrographic Office of the Navy Department on foreign coasts of the Atlantic Ocean, the Academy, in a resolution, expressed its hope that the work might be extended to the Pacific and Indian Oceans, which resolution was communicated to the Secretary of the Navy.

Fairman Rogers, who had served as treasurer of the Academy for a period of 18 years, beginning with its organization, resigned in April, 1881, and Mr. J. H. C. Coffin was elected to succeed him.[32] In this year and the two years following, the Academy was much occupied with matters relating to trust funds. The director of the Washburn Observatory at the University of Wisconsin, James C. Watson, who was a member of the Academy, died on November 23, 1880, and bequeathed the residue of his estate, after certain bequests to relatives and friends had been satisfied, to the Academy for establishing a medal, " to be awarded, with a further gratuity of one hundred dollars, from time to time to the person in any country who shall make any astronomical discovery or produce any astronomical work worthy of special reward and contributing to our science "; and also " for preparing and publishing tables of the motion of all the planets which have been discovered by me [J. C. Watson] as soon as it may be practicable to do so." The estate was found to be in an involved condition, and it was not until July 5, 1882, that the claims against it were settled. On that date the following decree of court was handed down:

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[31] Proc. Nat. Acad. Sci., vol. 1, pp. 175, 176.

[32] This year a committee, of which Professor J. E. Hilgard was the chairman, was appointed to consider and report on means for obtaining a legal value for the degrees of the Baumé hydrometer. The committee reported progress in 1882, but appears to have reached no practical conclusion. (See Proc. Nat. Acad. Sci., vol. 1, pp. 199, 208.)

"That all the rest, residue and remainder of said personal estate, consisting of the sum of five thousand and fifty-seven dollars and twenty-five cents in cash, one hundred and seventy-four shares of said stock of the Michigan Mutual Life Insurance Company, and the undivided two-thirds of said miscellaneous books, and all and singular the said books and scientific papers as delivered by said executor to it, be, and the same are hereby, assigned and set over to the said National Academy of Sciences, its successors and assignees." [33]

Nine years later, in 1891, the stock of the insurance company was sold for the sum of $10,720 and the whole amount of the fund was then $18,666.88. The first grant from the income of the fund was made in 1883 for search for an intra-mercurial planet. In 1886 the Watson Gold Medal was awarded for the first time to Dr. Benjamin Apthorp Gould "for his valuable labors for nearly forty years in promoting the progress in astronomical science, and especially for his successful establishment of the National Observatory of the Argentine Republic, as manifested in the six volumes of observations recently prepared and published by him."

This medal was presented at the spring session of 1887, a special evening meeting being held on April 20 in the lecture-room of the National Museum for that purpose. The President of the Academy, Professor Marsh, in a presentation address remarked as follows:

"Dr. Gould's great works are:

"1. The Uranometria Argentina, one volume, with large atlas. This work comprises a catalogue and map of all the stars down to the seventh magnitude, from the south pole to 10 degrees north declination, the position and magnitude of each being given. It is not a mere catalogue, but embodies an exhaustive study of the distribution of stars of different magnitudes and their relations to the Milky Way.

"2. The Argentine General Catalogue, one volume, 4to, contains the places of nearly 33,000 (32,448) stars, determined with the highest accuracy with the meridian circle. Three determinations of each star were generally made. The catalogue is followed by a list of the stars contained in some of the most noted clusters.

"3. The Cordoba Zone Catalogues, seven volumes, give the places of 73,160 stars down to the tenth magnitude.

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[33] Proc. Nat. Acad. Sci., vol. 1, p. 227.

"Many variable stars were discovered during these investigations, and two whose proper motion is about 6″ annually are equaled by only one other, so far as is known.

"Eleven hundred photographs of southern star clusters, taken during the years 1872-1883, have been preserved and are now undergoing measurement.

"Five volumes of meteorological observations have been published from stations established in all parts of the Argentine territory, giving the climate relations of the southern half of the continent and establishing the isothermal lines.

"The observatory and a national meteorological office were left in full organization and activity.

"This vast and comprehensive work is embraced in thirteen quarto volumes already published, and six are now prepared for publication, making nineteen in all."[34]

At the Congress of Electricians held in Paris in 1881 a resolution was adopted requesting the French Government to invite other governments to an international congress for the determination of electrical units. Various governments, including that of the United States, accepted the invitation and appointed delegates. The American delegates were Professor John Trowbridge and Professor H. A. Rowland, both of whom were members of the National Academy of Sciences. At the meeting of November, 1881, the following resolution was adopted by the Academy:

"*Resolved,* That the National Academy of Sciences cordially approves of the formation of an international commission on electrical units, as suggested by the Paris Electrical Congress, and earnestly hopes that the necessary appropriation may be made by the Congress of the United States to enable the members of this Academy already appointed on this commission, through the Department of State, to carry out the needed experimental determinations with credit to the country."[35]

This resolution was favorably considered by Congress and we find in the Sundry Civil Act for the fiscal year ending June 30, 1883, an item under the State Department providing the sum of $3,000 for "the payment of the actual and necessary expenses of the two civilian experts as delegates of the United States to an

[34] Proc. Nat. Acad. Sci., vol. 1, p. 290.
[35] *Loc. cit.,* p. 199.

International Commission for the Establishment of Electrical Units." [36]

The international conference opened in Paris on October 16, 1882, but the delegates of the United States were not able to attend until the second meeting which was held on October 26, 1882.[37]

The work of this session was chiefly preliminary. The delegates were not present at the second session, which was held in 1884, the United States being represented by Mr. Vignaud, secretary of the American Legation, who presented several communications on their behalf.[38] At this conference the "legal," or "congress" ohm, ampere, and volt were established.

1883–1887

Dr. Henry Draper, an astronomer of note, and a member of the National Academy, died on November 20, 1882. At the spring session of the following year the President announced that Mrs. Mary Anna Palmer Draper, his widow, had presented to the Academy the sum of $6000 for the purpose of establishing a gold medal to be called the "Henry Draper Medal," and to be awarded to "any person in the United States of America or elsewhere who shall make an original investigation in Astronomical Physics, the results of which shall be made known to the public, such results being, in the opinion of the said National Academy of Sciences, of sufficient importance and benefit to science to merit such recognition."

The first Henry Draper Medal was awarded in 1885 to Professor S. P. Langley. In making this award the committee remarked, "The committee bases this recommendation upon the numerous investigations of a high order of merit which have been made by Professor Langley within the past few years in solar physics, and especially in the domain of radiant energy."

[36] Stat. at Large, vol. 22, 1883, p. 302, 47th Congress, 1st Session, chap. 433.

[37] Ministère des Affaires Étrangères. Conférence Internationale pour la Détermination des Unité Électriques. 16 Octobre, 26 Octobre, 1882. Procès-verbaux. Paris, 1882, pp. 8, 154.

[38] *Idem,* 2d Session, 1884, pp. 6, 13, 37, 67, 80.

The committee cited 21 papers published between 1874 and 1884, and gave a brief summary of each, remarking in conclusion: "Professor Langley has published numerous other papers upon subjects connected with solar or astral physics, but it is believed that those which have now been mentioned will fully justify the recommendation of the committee."

About 1883 the Academy began the practice of sending delegates to other learned societies and to universities, both in America and in Europe, and in the minutes of the meeting of April of that year we read that on recommendation of the Council it was voted "that the Secretary be directed to acknowledge, with thanks, the invitation extended to the Academy by the Royal Society of Canada to send delegates to the meeting to be held at Ottawa, May 22, 1883, and the President be authorized to appoint delegates to attend the said meeting." Dr. T. Sterry Hunt was appointed delegate on this occasion.

In 1887, Professor C. H. F. Peters, of Hamilton College, was appointed, at the request of the Académie des Sciences, Paris, to represent the Academy at an international conference held in Paris on April 16 of that year to consider a plan for making a chart of the heavens by photography. At this important congress, which extended from April 16 to 25, 1887, fifty-six astronomers, representing sixteen different nationalities, were present. The objects to be attained and the methods to be employed were set forth in the following resolutions, passed at the first session of the congress:

"1. The progress made in astronomical photography demands that the astronomers of our time undertake in common the description of the heavens by astrophotographical means.

"2. This work is to be done at stations to be selected, with instruments that, in their essential points, ought to be identical.

"3. The aim is (a) to make a general photographical chart of the heavens for the present epoch, and to obtain the data which shall permit fixing the positions and the magnitudes of all the stars down to a certain class with the greatest possible precision; (b) to provide the best means for utilizing, for the present epoch as well as for the future, the data furnished by the photographical process." [39]

[39] Rep. Nat. Acad. Sci. for 1887, p. 49.

Upon the recommendation of a "technical committee," the congress agreed that refracting telescopes should be used in photographing the stars, that stars from the first to the fourteenth magnitude, inclusive, (probably some 2,000,000 in all), should be photographed, and that the telescopes used should have objectives with an aperture of 0.33 meters and a focal distance of 3.43 meters. The congress then divided into two sections each of which submitted a series of resolutions relative to the conduct of the proposed undertaking. It was found that the directors of six observatories were prepared to agree at once to participate in the work, and in the end 18 observatories assumed a share in it. None of the observatories of the United States, however, joined in the enterprise, which was completed in 1912. It was originally estimated that it would be necessary to make 60,000 negatives, but the number was afterwards reduced to about 20,000. The expense involved was estimated to exceed $2,000,000.[40]

The next invitation accepted was from the University of Bologna, which celebrated its 800th anniversary in June, 1888. Dr. S. Weir Mitchell was appointed to represent the Academy on this occasion. In May, 1891, the Academy again sent a delegate to the Royal Society of Canada, which held its tenth meeting in Montreal on the twenty-seventh of that month. The delegate appointed was the Vice-President, Mr. Francis A. Walker. The President, Professor Marsh, was selected by the Academy as its representative at the tercentenary of the University of Dublin, held in July, 1892. Two years later, in 1894, Dr. J. S. Billings was appointed the delegate of the Academy to the eighth International Congress of Hygiene and Demography, held at Budapest in September of that year.

The subject of trust funds again became prominent in 1884. Professor J. Lawrence Smith, a member of the Academy, and well known as a chemist, and student and collector of meteorites, died in October of the preceding year. His very large collection of meteoric stones was acquired by Harvard University for

[40] See Rep. Nat. Acad. Sci. for 1887, pp. 48-53.

the sum of $8000, and this amount his widow placed at the disposal of the National Academy as a fund "to promote the study of meteoric bodies." As indicated by the discussion of the subject in an earlier year, the Academy was in doubt as to its power under the Act of Incorporation to accept and administer trust funds. Although a clause had been added to the constitution in 1872 to the effect that "bequests and trusts having for their object the advancement of science may be accepted and administered by the Academy," the organic act still contained no distinct provision of this character. A committee of six was appointed in 1878 "to procure from Congress an addition to the Act of Incorporation of the Academy, which will enable it to accept and administer trust funds." [41]

No progress appears to have been made in this matter, however, until 1884, when, as the result of a special effort, the necessary amendment was secured in the following form:

"An act to authorize the National Academy of Sciences to receive and hold trust funds for the promotion of science, and for other purposes.

"*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the National Academy of Sciences, incorporated by the act of Congress approved March third, eighteen hundred and sixty-three, and its several supplements, be, and the same is hereby, authorized and empowered to receive bequests and donations, and hold the same in trust, to be applied by the said Academy in aid of scientific investigations and according to the will of the donors.

"Approved, June 20, 1884." [42]

The deed of trust transferring Mrs. Smith's donation to the Academy for the establishment of the J. Lawrence Smith Fund was signed on May 6, 1884. In his report for that year the President remarked: "The object of this memorial gift was to

[41] Proc. Nat. Acad. Sci., vol. 1, p. 136.

[42] Stat. at Large, vol. 23, 1885, chap. 107, p. 50, 48th Congress, 1st Session.

The bill was introduced in the House by Mr. Cox of New York, on May 9, 1884, referred to the Committee on the Library, and ordered printed. The committee reported favorably on May 20, and the report was ordered printed. The bill was brought up in the House by Mr. Singleton on June 7, and passed without discussion. In the Senate the same bill was referred to the Committee on the Library on June 9. It was brought up by Senator Sherman on June 11 and passed without discussion.

promote the study of meteoric bodies, a branch of science which Dr. Smith had pursued with much success, and, in accordance with the wishes of the donor, it was decided that a gold medal, to be given as a reward for original investigations, would be most appropriate." The expense for preparing the die for this medal which was to be called the "Lawrence Smith Medal," was met by Mrs. Smith. It was designed by Chaplain of Paris, and the first award was made to Professor Hubert A. Newton in 1888, as will be noted on a later page.

In the summer of 1881 Prof. S. P. Langley spent some weeks on the summit of Mt. Whitney in the Sierra Nevada of California, under the official direction of the Chief Signal Officer of the Army, in making astrophysical observations.[43] He was so much impressed with the suitability of that place as a permanent station for scientific observations, that on his return, with the assent of the Chief Signal Officer of the Army, he laid before the National Academy of Sciences a proposition to have the mountain peak set apart as a reservation for scientific uses. The mountain was described by Prof. Langley in a letter addressed to the Acting Chief Signal Officer of the Army, and dated June 14, 1882, in the following manner:

> "Mt. Whitney is a barren peak in the Sierras of southern California, reputed to be the highest in the State. It is a mass of granite, extremely abrupt on the Eastern slope, which overlooks the Inyo desert, and is, except for scientific purposes, believed to be valueless, as with the exception of the unmarketable pine trees on the lower slopes, there is no vegetation, and no gold has ever been found in its vicinity.
>
> "This very barrenness, as the indication of exceptional dryness, fits it as a station for special meteorological investigations, as do also its extremely precipitous character, and consequent abrupt rise from the plain." . . . .

In a previous letter to the Chief Signal Officer, dated February 13, 1882, Prof. Langley remarked: "In case a Signal Service Station be erected on Mt. Whitney, I would respectfully suggest to the Chief Signal Officer that it should contain not only provision for the regular meteorological observations, but also for the temporary accommodation of other scientific observers who

[43] See Prof. Papers of Signal Service, No. 15, 1884, p. 9.

may be desirous of obtaining his permission to enjoy the advantages of a site unsurpassed, in my opinion, in the world, among those equally accessible. There is the greatest abundance of stone on the peak, but construction will be slow, owing to the difficulty of labor at that altitude, and the difficulty of supplies until the mule trail is completed.

" With the contemplated trail, mules could go in one day from the projected railroad in Owen's River Valley to the very summit of what is believed to be the highest mountain in the United States. Though the mere fact that it is probably the highest point, may attach one kind of interest to this site, it is not merely on that account that I have already spoken so strongly in its favor. The dryness of the air, the altogether exceptional purity of the sky, the altitude, the remarkable differences of level of adjacent points (Mt. Whitney is 11,000 feet above a station in sight, and but 15 miles away) together with its accessibility, make this in my opinion a site especially deserving of occupation."

The matter was laid before the Academy in April, 1882, when the following resolution was adopted:

"*Resolved,* That the Academy suggest to the Honorable the Secretary of the Interior that a reservation be set apart for scientific purposes in the Sierra Nevada, California, of not less than ten miles square, and to include the summit called, by the State Geological Survey, Mount Whitney, and another peak lying southward, which has sometimes been confounded with Mount Whitney, and which is locally known as " Sheep Mountain." [44]

The President of the Academy appointed S. P. Langley, W. H. Brewer and J. W. Powell as a committee to have charge of the matter.

As the reservation was to be a military one, a letter was addressed to the Secretary of the Interior, on July 28, 1883, by Secretary of War, Robert T. Lincoln, in which he remarked: " I beg that you will please advise this Department whether there exists any objection to the setting apart for military purposes of the land in question, and that if no objection thereto exists the land be temporarily withheld from sale or entry until the orders of the President declaring and setting it apart as a military reser-

[44] Proc. Nat. Acad. Sci., vol. 1, p. 207.

vation can be obtained." No objection appears to have been made, and on October 4, 1883, the Acting Chief Signal Officer of the Army announced to the committee of the Academy that President Garfield had, on September 20, 1883, proclaimed Mt. Whitney to be a military reservation. The fact was announced to the Academy in April, 1884, as appears from the report for that year, in which the following statement is made:

"It was reported that the reservation of public lands on and near Mount Whitney, California, for scientific purposes, had been established, and the committee was continued, with the view to securing and utilizing the reservation for the said scientific purposes." [45]

It was not until fourteen years later that definite steps were taken for the utilization of the mountain summit. In the Smithsonian Report for 1909 we find the following account of the circumstances under which it was brought about:

"Mount Whitney Expeditions.

"In August, 1908, with Director Campbell, of the Lick Observatory, Mr. Abbot spent about twenty-four hours on the summit of Mount Whitney (14,502 feet). This mountain, which was the objective point of the famous expedition of Mr. Langley in 1881, was recommended by him to be reserved by the Government and used as the site for an observatory. The reservation was in fact, made, but no observatory has been established there. Mr. Abbot carried with him to Mount Whitney a pyrheliometer and wet and dry thermometers, and made observations on the summit both in the afternoon and morning hours. Both he and Mr. Campbell were favorably impressed with the advantages of the place for observing, and with the relative convenience of ascending the mountain, considering its great altitude. Fine building stone, sand, and water were found at the summit. Messrs. Campbell and Abbot, therefore, recommended to the Secretary of the Smithsonian Institution that a grant from the Hodgkins fund should be made for the purpose of erecting on the summit of Mount Whitney a stone and steel house to shelter observers who might apply to the Institution for the use of the house to promote investigations in any branch of science. This recommendation was approved, and the house is now in course of construction (July, 1909)." [46]

In the years 1882 and 1883 the Academy lost four of its original members, besides the President, Professor Wm. B.

[45] Rep. Nat. Acad. Sci. for 1884, p. 11.
[46] Smithsonian Report for 1909, pp. 65, 66.

Rogers. These were Professor Stephen Alexander (died June 25, 1883), Major-General J. G. Barnard, U. S. A. (died May 14, 1882), Dr. John L. LeConte, entomologist (died November 15, 1883), and Admiral John Rodgers, Superintendent of the U. S. Naval Observatory (died May 5, 1882). Of the incorporators twenty others had died prior to 1883, and thus twenty years after its organization the Academy had lost one-half of its original membership.[47]

The second volume of the *Memoirs* of the Academy, containing four papers, was transmitted to Congress with the report for 1883, and was published in 1884. With the report for 1884 was transmitted the first part of the third volume of the *Memoirs,* containing eight papers. The second part of this volume was printed in 1886, but many of the plates belonging to it were burned, and the distribution was delayed. It was not issued until July, 1887. The completed volume contains seventeen papers. Commenting on the fact that the first part of the third volume of *Memoirs* had been ordered printed by Congress, the President of the Academy remarked in his report for 1884:

"I congratulate the Academy that the precedent for the publication by the Government of both the annual report and an accompanying volume of memoirs is now fairly established, and it alone remains for the members of the Academy to do their part in presenting their memoirs ready for publication each year in time to accompany the report to Congress." [48]

A total eclipse of the sun occurred on May 6, 1883, and was visible in the South Pacific Ocean. It was of special interest to

[47] Two of the fifty incorporators withdrew from membership soon after the Academy was organized. One of these was Rear-Admiral John A. Dahlgren. The following extracts from his published diaries relate to the incident:

"March 10 [1863].—I omitted to mention that Congress had incorporated 'a National Academy of Science,' with fifty Corporators, of which I was one. This measure, from which should proceed a great institution, is due solely to Mr. Wilson, Senator from Massachusetts. . . . .

"May 14 [1863].—I sent my resignation as a member of the National Academy of Sciences to Professor Bache, who had been elected President of the Academy. Next day he replied, requesting me not to insist, that I would be excused from the service, &c.

"But on the 18th May I wrote to him adhering to my determination." (Memoir of John A. Dahlgren, by Madeleine V. Dahlgren, 1882, pp. 389, 394.)

[48] Proc. Nat. Acad. Sci., vol. 1, p. 255.

astronomers on account of the relatively long period of totality, which afforded an unusual opportunity for a search for intra-mercurial planets. A paper on this eclipse was read by Professor C. A. Young at the meeting of November, 1882, at the suggestion of Mr. Charles H. Rockwell, of Tarrytown, New York,[49] and the matter having thus been brought to the attention of the Academy, was referred to the Council which reported the following resolution:

"The Council of the National Academy of Sciences, appreciating the importance of astronomical and physical observations of the total eclipse of the sun, May 6, 1883, the long duration of which is especially favorable for observations for the search of intra-mercurial planets and the study of solar physics, approves the project of an expedition to some suitably situated island in the Pacific Ocean, and recommends the appointment of a committee to commend it to persons interested in the advancement of science, and to the Navy Department of the United States, for such aid and facilities for the purpose as can be best afforded." [50]

This resolution was adopted by the Academy, and a committee consisting of Professor C. A. Young (chairman), Professor J. H. C. Coffin, Dr. Henry Draper, Professor Asaph Hall, Professor J. E. Hilgard, Professor Simon Newcomb, and Professor H. A. Newton, was appointed to take charge of the matter. Subsequently, on the death of Dr. Draper, Professor S. P. Langley was appointed in his place, and Professor C. S. Peirce was added to the committee. Mr. C. H. Rockwell was also invited to join the committee "as having been the real originator of the project." An endeavor to obtain funds for the expedition by private subscription having proved unsuccessful, the committee determined to appeal to the Government.

Its representations to the Secretary of the Navy were very favorably received, the naval vessel *Hartford,* Captain Carpenter commanding, was placed at the disposal of the observing party, and all necessary arrangements made to secure the success of the expedition.

[49] Mr. Rockwell had presented a communication on the subject before the American Association for the Advancement of Science in August of the same year.

[50] Proc. Nat. Acad. Sci., vol. 1, p. 211.

A memorial asking for an appropriation of $5,000 to defray the expenses of the observing party was presented to Congress and having the support of the Secretary of the Navy was favorably considered. The Sundry Civil Act for the fiscal year ending June 30, 1884, contained the following item:

" . . . . To enable the National Academy of Sciences to make observations of the eclipse of the sun on the sixth of May next, at an island in the Pacific Ocean, five thousand dollars, the expenditures to be accounted for by the Superintendent of the Coast and Geodetic Survey under the rules that govern that work; to be immediately available." [51]

As the act was not approved until March 3, 1883, however, the money was not available in time to serve the purposes of the expedition and the sum of $3,500 was, therefore, advanced by the trustees of the Bache Fund. At the same time a grant of $500 was made by the Academy from the Watson Fund in aid of the search for intra-mercurial planets. The observing party consisted of Professor E. S. Holden (chief), Professor Charles S. Hastings, Mr. C. H. Rockwell, Mr. E. D. Preston, Mr. Winslow Upton and Ensign S. J. Brown, U. S. N. Four officers of the *Hartford* also joined the party as voluntary observers, and two English observers, sent out by the Royal Society, were likewise included.

The objective point of the expedition was Caroline Island, a small island in the South Pacific, which had been suggested by Mr. Rockwell as most suitable for an observing station. The party remained on the island from April 21 to May 9, and returning reached San Francisco on June 11. The expedition was successful as a whole, though the search for an intra-mercurial planet, which was undertaken personally by Professor E. S. Holden, the leader of the American party, gave a negative result.

The committee and observers made a report to the Academy at the meeting of November, 1883, which report was by resolu-

[51] Stat. at Large, vol. 22, 1883, p. 611, 47th Congress, 2d Session, chap. 143. Act approved March 3, 1883.

tion ordered to be included with the report of the President for that year. It was not published there, however, but in the *Memoirs* of the Academy.[52] A resolution was also adopted by the Academy thanking the Secretary of the Navy for the aid rendered by the Navy Department, and also Captain Carpenter and the other officers of the *Hartford* for "the energy and personal interest with which they co-operated in the work."

We read in the annual report of the Secretary of the Navy for 1883 that "the *Hartford,* before she became the flagship [of the Pacific Station], made a cruise to Caroline Island, carrying a party of observers of the solar eclipse, sent by the National Academy of Sciences"; [53] also the following:

> "*Hartford:* Arrived at Callao from the United States January 11, 1883. Proceeded to Caroline Island with a party of observers of solar eclipse in May last. Returned to Callao via Honolulu; arrived at Callao August 18." [54]

Through the death of Joseph Henry in 1878, the National Academy of Sciences became concerned with the Tyndall trust fund. This fund, which amounted to about $13,000, was established by John Tyndall from the proceeds of his lectures in America in 1872 and 1873. Having been invited by friends to lecture in this country, he decided to do so, with the idea of bringing pecuniary aid to the city of Chicago which, as is well known, was devastated by fire in the fall of 1871. On arriving in America, however, he found that the city had already received such great contributions of money that the amount he could command would be insignificant in that connection. He turned his donation, therefore, in the direction of establishing a trust fund to enable American students of physics to study at the German universities. He designated Professor Joseph Henry, Dr. E. L. Youmans, and General Hector Tyndale, a kinsman, as trustees of the fund, with the proviso that vacancies on the board occurring through death or otherwise should be filled by the

[52] Vol. 2, 1883, pp. 1-146.
[53] Rep. Secr. Navy for 1883, vol. 1 (1883), p. 20.
[54] *Op. cit.,* p. 170.

President of the National Academy of Sciences. After the death of Joseph Henry, the President in 1880 appointed President Barnard of Columbia College as his successor. In spite of the conscientious efforts of the trustees to apply the income of the fund to the purposes intended by Professor Tyndall, certain practical difficulties defeated their efforts,[55] and in the course of a number of years the principal and accumulated interest together amounted to about $32,000. The circumstances were communicated to Professor Tyndall who thereupon modified his donation and established three graduate fellowships, each with a fund of about $11,000, in the department of physics in Harvard College, Columbia College and the University of Pennsylvania for the stimulation of original research, and the advancement of physical science in the United States.

1888–1892

The first Lawrence Smith Medal was awarded in 1888 to Professor Hubert A. Newton, Professor of Mathematics at Yale University, " in recognition of his eminent services in the investigations of the orbits of meteors." The presentation was made on the evening of April 18, 1888, in the lecture-room of the National Museum, the President of the Academy, Professor O. C. Marsh, presiding. The first and last paragraphs of the report of the committee on the award, which is printed in full in volume one of the *Proceedings* of the Academy.[56] are as follows:

" Professor Newton's study of the subject extends over a long series of years, and has led to results of very great popular interest as well as scientific importance. Meteors in the sense in which the word is now used have from the remotest ages attracted the attention of mankind. Observations of greater or less value have long been accumulating. Chemistry had shown that meteoric bodies which fall upon the earth contain no element not already known as a constituent of the crust of the earth, but astronomy had not yet brought the wanderers of the heavens into a system and shown that they are moving in definite orbits and

[55] See Smithsonian Report for 1885, part 1, pp. 25, 26.
[56] Proc. Nat. Acad. Sci., vol. 1, p. 308.

are not distributed by chance in the celestial spaces. Professor Newton's first paper was published in 1860, and was succeeded by a number of others, the last having been read to the National Academy in April of the present year [1888].

"In the judgment of the committee these researches are of a very high order of merit and of interest."

The meeting of the evening of April 18, 1888, was made further memorable by the presentation of the second Henry Draper Medal to Professor Edward C. Pickering, Director of the Harvard Observatory "for his work in astronomical photometry and photography." The report of the committee on this award is also printed in full in the *Proceedings*,[57] but it will be of interest to quote a few paragraphs from it, as follows:

"The Committee on the Henry Draper Medal begs leave herewith to report that it has carefully considered the investigations which have been made in astronomical physics since the award of this medal in 1885, and that, as a result of such consideration, the said committee desires to recommend that the Academy award this medal for the year 1887 to our fellow-member, Prof. Edward C. Pickering, the Director of the Harvard College Observatory, for his recent work in astronomical photometry and photography.

"Professor Pickering was appointed to the position which he now holds in February, 1877. An examination of the annual reports which he has presented to the visiting committee of the observatory will show the great amount and the great variety of the work which has been done there under his direction. . . . . Most of it is in the department of astronomical physics, and this it is to which the committee desires to direct attention.

"The work in astronomical physics, which has been done in the observatory of Harvard College under Professor Pickering's immediate supervision, seems readily divisible into three classes: First, stellar photometry; second, stellar photography; and third, stellar spectrum photography. . . . .

"In the opinion of the committee, Professor Pickering has displayed in these researches a skill, ingenuity, and vigor which entitle him to an honorable place among the scientific men of our own or of any previous age."

The committees charged with the consideration of awards of the Lawrence Smith and Henry Draper medals found their action hampered by a clause in the deeds of gift of the funds on which the medals were based, requiring that awards in each case should be for investigations made, or publications completed "since the time of the last preceding award and presentation of

[57] *Op. cit.*, p. 300.

the said medal." A recommendation was therefore adopted that the donors of these medals should be asked to cancel the clause.

The second award of the Watson Medal was also made in 1888 to Professor Edward Schönfeld, director of the observatory at the University of Bonn, Germany, "for his services in cataloguing and mapping the stars visible in our latitudes, and especially for his recently published Southern *Durchmusterung*." "As Professor Schönfeld was not present at this meeting, the Foreign Secretary was instructed to forward the medal and one hundred dollars in gold to him through the German Embassy at Washington."[58]

A committee appointed by the Academy reported in 1890[59] in favor of the re-adoption of the plan of classifying the membership. The constitution of the Academy, in the form in which it was originally adopted in January, 1864, provided that the membership should be divided into two classes, namely, (a) Mathematics and Physics, and (b) Natural History, and that the members should arrange themselves in sections, according to the subjects which they represented. The organization was then, as follows:

Class A Mathematics and Physics *Sections*	Class B Natural History *Sections*
1. Mathematics.	1. Mineralogy and Geology.
2. Physics.	2. Zoölogy.
3. Astronomy, Geography, and Geodesy.	3. Botany.
4. Mechanics.	4. Anatomy and Physiology.
5. Chemistry.	5. Ethnology.

This arrangement continued in force until 1872, when the whole system of classes was abolished. The matter came up

[58] Proc. Nat. Acad. Sci., vol. 1, p. 323.

[59] This year a committee, consisting of Professor S. P. Langley (chairman), Professor T. C. Mendenhall, and Professor E. C. Pickering, was appointed, at the suggestion of the chairman, "to secure such uniformity of measures in physical apparatus as will promote interchangeability of their parts." The committee appears not to have reported. (*See* Rep. Nat. Acad. Sci. for 1890, p. 13.)

again for consideration in 1885, when it was proposed to divide the membership into four sections, but this proposition was rejected.[60] Notwithstanding this decision, the subject was brought forward anew and, as already mentioned, was referred to a committee which, in 1890, reported in favor of the re-adoption of a classification of the membership, on the ground that it would bring into closer relationships members pursuing the same branches of science, would afford better facilities for the discussion of special technical subjects, and would provide a number of groups of experts to whom subjects of inquiry could be referred by the Academy. As to the method of classification, the committee remarked as follows:

> " As regards the method of classification, the task of fixing upon this is far more difficult now than it was when the National Academy was founded, nearly thirty years ago. In fact, it appears well nigh impossible to establish one so that it shall be both strictly scientific, according to present ideas, and at the same time practical. Your committee therefore propose a classification closely similar to that originally established, and believe that, however liable to technical criticism, it is essentially such as is least likely to meet with difficulties in its practical working." [61]

This report was referred to the Council, and the subject continued under discussion for nine years longer before a new decision was reached.

In April, 1892, the Academy adopted a resolution declaring that a reorganization into sections was desirable,[62] and in November of the same year a committee on amendments to the constitution reported in favor of the following classification of the membership:

1. Mathematics, including Astronomy and Geodesy.
2. Physics.
3. Engineering, including Civil, Mechanical, Electrical, Hydraulic, etc.
4. Chemistry, including Applied Chemistry.
5. Geology, including Mineralogy, Paleontology, etc.
6. Biology.
7. Anthropology, including Sociology, Economic Science, etc.

[60] Proc. Nat. Acad. Sci., vol. 1, p. 264.
[61] *Loc. cit.*, p. 338.
[62] *Loc. cit.*, p. 368.

The committee remarks: "The plan of dividing the membership into classes according to the various branches of science represented, essentially that of the French Academy, is apparently looked upon with favor by many members as offering a means of securing a more judicious selection and a fairer distribution of the honors of membership among the different classes of scientific workers."[63]

This report was referred to the Council and was printed and distributed to the members of the Academy.

In 1894 the Council reported in favor of still another classification, as follows:

CLASS A. Mathematics and Astronomy.
CLASS B. Physics and Engineering.
CLASS C. Chemistry and Mineralogy.
CLASS D. Geology and Paleontology.
CLASS E. Biology.
CLASS F. Miscellaneous.

This report was considered in a committee of the whole and held under advisement until 1899, when an amendment to the constitution was adopted providing for the division of the Academy into six standing committees, instead of classes. The committees, which are quite similar to the classes proposed in 1894, are as follows:

1. Mathematics and Astronomy.
2. Physics and Engineering.
3. Chemistry.
4. Geology and Paleontology.
5. Biology.
6. Anthropology.

This classification was amended in 1911, the committees on Biology and Anthropology being replaced by four separate committees, as follows: (a) Botany, (b) Zoölogy and Animal Morphology, (c) Physiology and Pathology, and (d) Anthropology and Psychology.[64]

The third Henry Draper Medal was awarded in 1890 to Professor H. A. Rowland for his researches on the solar spec-

[63] *Loc. cit.*, pp. 373, 374.
[64] Rep. Nat. Acad. Sci. for 1911, p. 14.

trum, and was presented at a public session held in the National Museum on the evening of April 16. The President, in a presentation address, mentioned the following memoirs as being those for which, in particular, the award was made: A mathematical paper on the Theory of Concave Diffraction Gratings; a memoir upon the Practical Construction of a Screw of a Linear Dividing-Engine; a Research upon the Solar Spectrum, "including the magnificent charts which accompanied it, produced by photography"; investigation upon the Absolute Wave-Lengths of the Lines in the Solar Spectrum; investigations upon the Spectra of the Elements, and particularly of the Spectra of Iron and Carbon.

In November of the same year the third Watson Medal was awarded to Dr. Arthur Auwers, of Berlin, "for his contributions to stellar astronomy, including his superintendency of the zone observations of the *Astronomische Gesellschaft,* his researches on variable proper motions, and his re-discussion of Bradley's observations." The award was made effective in April, 1891, when the medal and one hundred dollars in gold were transmitted to Dr. Auwers through the German Embassy in Washington. In reporting on the award, the committee made special reference to Dr. Auwer's investigations of the proper motion of Sirius and Procyon, his determination of a fundamental system of declinations to which all catalogues of stars should be reduced, his work on the parallaxes of the fixed stars, and also to his new reduction of Bradley's epoch—making observations, which was characterized as his greatest work.

President F. A. P. Barnard, of Columbia College, one of the incorporators of the Academy, who died on April 27, 1889, provided in his will for a gold medal which should be awarded every five years to the person making "such discovery in physical or astronomical science, or such novel application of science to purposes beneficial to the human race, as, in the judgment of the National Academy of Sciences of the United States shall be esteemed most worthy of such honor." This medal, which was to be styled "The Barnard Medal for Meritorious Services to

Science," was to be awarded by the trustees of Columbia College upon the nomination of the Academy. At the meeting of November, 1891, the Academy voted to accept the obligation to make nominations and appointed a committee to take charge of the matter. The first nomination was made at the annual meeting of the Academy in April, 1895, at which time the committee reported, in part, as follows:

"Acting upon all the suggestions received from members of the Academy and such other information as the members of the committee could secure, and acting in strict conformity to the specific conditions of the bequest, the committee herewith unanimously presents the name of Lord Rayleigh for the first award of the Barnard medal for his brilliant discovery of argon, which illustrates so completely the value of exact scientific methods in the investigation of the physical properties of matter." [65]

The Academy was again, in 1892, made the trustee of a fund for the encouragement of chemical research. This fund was one presented to Wolcott Gibbs, an incorporator of the Academy, by his friends, upon the occasion of his attaining the age of seventy years. Professor Gibbs expressed his appreciation of this token of regard and his desire to place it in the hands of the Academy for the promotion of science, in an affecting letter from which the following sentences are extracted: [66]

"My dear Professors Jackson and Loeb: May I beg you to present to those from whom I received, a few days since, so signal a mark of friendship and good-will my heartiest, most earnest, and most grateful acknowledgment? The address which I received on my seventieth birthday, signed by more than one hundred friends, pupils, and assistants, brings back my youth in recalling the names of those who now join to offer me more than mere good wishes to cheer my advancing age. Their active friendship has taken the form which was most acceptable to me—that of an endowment to assist research in my own branch of science; so that I can feel that in a certain sense my power to work will not terminate with my life. As the generosity of my friends permits me also to dispose of the manner in which the endowment shall be administered, I submit to them, through you, the plan which seems to me best adapted to carry out their wishes—a plan which has been fully tested in somewhat similar cases and found to work well in practice.

[65] Rep. Nat. Acad. Sci. for 1895, pp. 29, 30.

[66] The letter is given in full in Proc. Nat. Acad. Sci., vol. 1, pp. 365, 366. The amount of the fund was $2,600. Professor Gibbs was subsequently President of the Academy.

"I therefore propose that the fund raised for endowment shall be given to the National Academy of Sciences, to hold the same in trust and to invest and reinvest as may be necessary or advisable. The income or interest of the fund shall be administered by a board of directors consisting of three persons, of whom at least two shall be members of the Academy. . . .

"Sincerely yours,

"WOLCOTT GIBBS.

"NEWPORT, *March* 1, 1892."

It will be recalled that the number of members of the Academy was originally restricted to 50, and that in 1870, by an unanimous vote, Congress was petitioned to amend the charter and remove this restriction. Favorable action was taken by Congress, and the limitation was removed by an Act approved July 14, 1870.

In 1892 Professor B. A. Gould wrote a letter to the President of the Academy informing him that a fund which would yield an annual income of $1,500 could be procured for the Academy, provided the membership should be reduced to 50, or at most to 70, the idea of the person offering to present the fund being that the income should be used to defray a part of the expenses of members attending the meetings of the Academy. The matter was referred to the Council, apparently without discussion, and seems never to have been further acted upon, but at the November meeting of the same year the committee on amendments to the constitution reported: "There is divided opinion upon the desirability of decrease in membership, with a preponderance of belief on the whole that the present limit, which is practically one hundred, is about right."[67] While no reduction was regularly recommended, the committee proposed a plan of election which in its opinion, would "satisfy the demands of those who are desirous of placing greater restrictions around admission to membership in the Academy, as well as those who believe that the limiting number of members cannot be placed below one hundred without doing injustice to many scientific men who by reason of their accomplishments are fairly

[67] Proc. Nat. Acad. Sci., vol. 1, p. 373.

entitled to the honor of an election."[68] This plan was not adopted, but though various changes in the method of electing members were introduced subsequently, the number of members has remained about one hundred.

The Home Secretary reported in 1890 that the fourth volume of the *Memoirs* of the Academy had been completed "after long delays." The first part of this volume was printed in 1889, but only 177 copies were distributed that year owing to a difficulty in obtaining the plates for the whole edition. The 5th and 6th volumes were printed and distributed in 1892 and 1893.[69]

The delays in publication during these years caused much dissatisfaction. The committee on amendments to the constitution which reported in November, 1892, took occasion to comment in quite emphatic language on the subject. They remarked with much truth:

"A scientific society usually is esteemed, both at home and abroad, in proportion to the number and value of its publications.

"Under existing conditions few members of the Academy use it as a medium for reaching the public. Life is too short. Yet it is evident that it cannot rank with similar societies in other countries until its publications represent the best work of its members."[70]

The suggestion was made that a semi-annual publication issued soon after each meeting of the Academy, and containing at least abstracts of the various papers presented, might serve to make the work of the Academy known to the scientific world, but this idea has never been followed out.

1893–1897

Awards of the Draper and Watson medals were again made in 1893 and 1894, the fourth Draper Medal being awarded to

[68] *Loc. cit.*, p. 375.

[69] In his report for 1894, the Home Secretary remarked, "The bill providing for the printing of all reports and memoirs of the Academy passed the House last year, and is now (April 17, 1894) in the hands of the Senate." (Rep. Nat. Acad. Sci. for 1894, p. 7.)

The Act of Congress, approved January 12, 1895, providing for the public printing and binding and the distribution of public documents contains the following item: "Of the Memoirs of the National Academy of Sciences, two thousand five hundred copies: five hundred for the Senate, one thousand for the House, and one thousand for distribution by the Academy of Sciences." (Stat. at Large, vol. 28, p. 616, 53d Congress, 3d Session, chap. 23.)

[70] See Proc. Nat. Acad. Sci., vol. 1, pp. 375, 377, where the report is given in full.

Professor H. K. Vogel of Potsdam, Germany, and the fourth Watson Medal to Dr. Seth C. Chandler for his researches on the variation of latitude. The report of the trustees of the Watson Fund, which is printed in full in the Annual Report for 1895, contains the following paragraphs relative to the award to Dr. Chandler:

"On the recommendation of the board of trustees of the Watson fund the Academy last year unanimously awarded the Watson medal to Seth C. Chandler, of Cambridge, Mass., for his investigations relative to variable stars, for his discovery of the period of variation of terrestrial latitudes, and for his researches on the laws of that variation. . . . .

"Although not mentioned as forming any part of the grounds for the award of this medal, Dr. Chandler's important labors for many years upon cometary orbits are well known to astronomers. . . . .

"The trustees of the Watson fund feel that this brilliant series of investigations is preeminently deserving of the highest recognition which can be given by the National Academy, and have therefore not hesitated in recommending the award of the medal to Dr. Chandler." [71]

It will be recalled that "the Barnard Medal for Meritorious Services to Science" was established by President F. A. P. Barnard of Columbia College (now Columbia University) July 17, 1889, with the provision that it should be awarded every five years after that date, by the trustees of Columbia College, upon the recommendation of the National Academy of Sciences. The first award was made in 1895 to Lord Rayleigh "for his brilliant discovery of argon, which illustrates so completely the value of exact scientific methods in the investigation of the physical properties of matter." [72]

In the decade between 1884 and 1894 the Academy lost twelve of the incorporators, or original members, President F. A. P. Barnard of Columbia College (died in 1889), the astronomer and educator who was the second Foreign Secretary of the Academy and served in that capacity from 1874 to 1880; Bartlett, the physicist (1893); the botanists, Engelmann (1884)

[71] Rep. Nat. Acad. Sci. for 1895, pp. 24-29.
[72] *Loc. cit.*, pp. 29, 30.

and Gray (1888); Guyot, the geographer (1884); Hilgard, the mathematician and physicist (1891); Leidy, the anatomist and paleontologist (1891); Longstreth, the astronomer (1891); Robert E. Rogers, the chemist (1884); the paleontologist, Newberry (1892); Rutherfurd, the astronomer (1892); and Benjamin Silliman, junior, the chemist (1885), who was also a member of the committee which drafted the first constitution.

On the first of January, 1894, only eight of the 48 original members remained,[73] J. D. Dana, Wolcott Gibbs, B. A. Gould, James Hall, J. P. Lesley, H. A. Newton, Fairman Rogers, J. D. Whitney.

The year 1895 was notable in the history of the Academy from the fact that four sessions were held,—a special session at New York, on February 9, to carry out the Act of Congress relative to the application of the definitions of the units of electrical measure; the regular annual meeting, held at Washington from April 16 to 19; a second special session, held in Philadelphia, October 30; and a scientific session held in Philadelphia, October 31. The proceedings of the important meeting for the application of electrical units are given in full in the report for the year, and will be mentioned again in the chapter on the work of the Academy as the adviser of the Government.

The annual report for the year 1895 contains an interesting detailed statement by the Treasurer regarding the trust funds of the Academy, all of which showed substantial increases. The Bache Fund, which was originally $40,515, had increased to $50,998; the Watson Fund, originally about $13,757, had increased to $18,667, together with invested income amounting to $4,427; the Draper Fund, originally $6,000, was raised to $6,604, together with invested income amounting to $1,300; the Lawrence Smith Fund of $8,000, increased to $8,235 with invested income of $597. The Wolcott Gibbs Fund remained at $2,673. In all, the trust funds at the disposal of the Academy amounted at this time to $94,000.

[73] It will be recalled that two of the incorporators, Dahlgren and Boyden, declined membership in the Academy, or resigned within a few months.

The fourth President of the Academy, Professor O. C. Marsh, who had held that office since 1883, declined re-election in 1895, and the Academy passed the following resolution unanimously: "That the thanks of the Academy be tendered to the retiring president for the zeal and ability with which he has administered in succession the offices of vice-president and president of the Academy during a period of seventeen years." [74] Professor Marsh was succeeded by Professor Wolcott Gibbs who held the office of President until April, 1900, when he resigned. He was succeeded in 1901 by Dr. Alexander Agassiz.

In this same year, 1895, which we have been considering, the Academy expressed its gratification at the completion, under the direction of two of its members, of extensive publications calculated to be of great benefit to science and to the people. These were the reports on the geology of Pennsylvania and the catalogue of the library of the Surgeon-General's Office. The resolution was as follows:

"*Whereas,* since 1874, Prof. J. P. Lesley, as the director of the second geological survey of Pennsylvania, has, with the cooperation of a band of assistants, published 127 octavo volumes of reports, which will remain a monument of his scientific and literary activity:

"*Resolved,* That the National Academy of Sciences, at a session held in Philadelphia on the 30th of October, 1895, while expressing their regret at the absence of their fellow-member, J. P. Lesley, wish at the same time to congratulate him on the successful completion of his reports on the geological survey of Pennsylvania, and further to express their appreciation of the services he has rendered to science in devoting his life to the interest of the survey, a task to which he has brought an unsurpassed knowledge of the geology of the State.

"2. The Academy congratulate their fellow-member, Dr. John S. Billings, on the completion of his Catalogue of the Army Medical Library, and on the issue of the final sixteenth volume of this unequaled gift to the medical scholars of the world." [75]

In 1896, when a bill was pending in the Senate calling for the restriction of experiments on the lower animals in the District of Columbia (Senate no. 1552), a letter was addressed to Senator Jacob H. Gallinger by the Chief of the Bureau of Animal

[74] Rep. Nat. Acad. Sci. for 1895, p. 23.
[75] *Loc. cit.,* p. 31.

Industry, U. S. Department of Agriculture, the Surgeon-General of the Navy, the Surgeon-General of the Army and the Surgeon-General of the Marine-Hospital Service, in which it was requested that the Academy be asked to express an opinion on the probable effect of such restriction on the progress of biological science.

The letter was forwarded by Senator Gallinger to the Academy, with a request for suggestions or a report on the subject. The Academy took the rather unusual course of reporting directly and not by means of a committee. The report consisted of a letter signed by Wolcott Gibbs, the President of the Academy, in which it was asserted that experiments in animals have resulted in "incalculable benefits to the human race." It was admitted that abuses might occasionally arise, but the fact was pointed out that no claims were made by those interested in obtaining restrictive legislation that abuses existed in the District of Columbia to which the pending bill had reference.[76] Senator Gallinger remarked on the floor of the Senate on May 26, 1896, regarding this bill:

> "I desire to state that this is the bill known as the vivisection bill, concerning which there is a great deal of controversy and a very marked difference of opinion, both on the part of physicians and the general public. . . . . It is proper I should state in this connection so as to correct a misapprehension that is being very industriously circulated, that it does not propose to prohibit vivisection, but that it proposes to restrict and regulate it according to law, and that is all." [77]

The third International Zoölogical Congress was held in Leiden in 1895 and on that occasion a commission was appointed to examine the codes of nomenclature adopted in various connections, with a view to determining whether the international code should be amended to agree with the provisions of any of them. The commission was to report at the next succeeding congress to be held in London in 1898.[78] The American member

[76] This letter, which was dated April 24, 1896, is published in full in the Report of the Academy for that year, pages 18 to 20.

[77] Congressional Record, vol. 28, part 6, p. 5709, 54th Congress, 1st Session, 1896. The caption of the bill was: "For the further prevention of cruelty to animals in the District of Columbia." (See Senate Report 1049, 54th Congress, 1st Session, on Senate Bill 1552.)

[78] Rep. Nat. Acad. Sci. for 1896, p. 12.

of the Commission, Dr. Charles Wardell Stiles, upon his return to this country, addressed a letter, dated April 21, 1896, to the President of the Academy, requesting that one of its members be appointed to serve on an advisory board to which he could submit propositions which he intended to present to the Congress of 1898. The President appointed Dr. Theodore N. Gill as the representative of the Academy.

To the five trust funds for the promotion of science, already administered by the Academy, a sixth was added in 1897, when Alice Bache Gould presented the sum of $20,000, to create a fund in honor of her father, Benjamin Apthorp Gould, " for the prosecution of researches in astronomy." In a letter addressed to the Academy and dated November 17, 1897, Miss Gould explained the objects which she had chiefly in mind in establishing this fund. In this letter she writes:

" My object in creating the fund is two fold—on the one hand to advance the science of astronomy, and on the other to honor my father's memory and to insure that his power to accomplish scientific work shall not end with his life.

" Throughout my father's lifetime his patriotic feeling and scientific ambition were closely associated, and I wish, therefore, that a fund bearing his name should be used, primarily, for the benefit of investigators in his own country or of his own nationality. I recognize, however, that sometimes the best possible service to American science is the maintenance of close communion between the scientific men of Europe and of America, and that, therefore, even while acting in the spirit of the above restriction, it may occasionally be best to apply the money to the aid of a foreign investigator working abroad.

" In this connection I must also refer to the strong interest felt by my father in the National Academy of Sciences,[79] and to his belief in the importance of creating and maintaining a single national scientific body, whose preeminence should be unquestionable and of concentrating power in its hands. . . . .

" I wish that in all cases work in the astronomy of precision should be distinctly preferred to any work in astrophysics, both because of my father's personal preference and because of the present existence of generous endowments for astrophysics." [80]

This fund was accepted by the Academy by a unanimous vote, and three trustees were appointed to take charge of it.

[79] Dr. Gould was one of the incorporators of the Academy.

[80] The letter is given in full, together with the deed of trust, in the Annual Report for 1897, pp. 14-16.

1898–1902

The Academy became connected in 1899 with a movement having for its purpose the association of the scientific academies of Europe and America for the furtherance of enterprises of international scope and importance. It first came to the notice of the National Academy through a letter addressed to its President by Lord Lister, President of the Royal Society of London. This letter, which was dated April 14, 1899, is as follows:[81]

"THE ROYAL SOCIETY, BURLINGTON HOUSE,
"*London, W., April 14, 1899.*

"SIR: The Royal Society has frequently had occasion to take action in respect to scientific undertakings calling for the cooperation of several countries, and undertakings of this nature show a tendency to increase. The experience of the society has led to the belief that it would be very advantageous to the interests of science generally if some machinery could be devised by means of which suggestions made for international cooperation in scientific inquiries could be thoroughly discussed by the leading men of science, from a purely scientific point of view, before definite proposals are made with a view to official action by the Governments of the countries concerned.

"With this view the Royal Society has communicated with the leading scientific academies of Europe, whose replies give much encouragement to the idea that it may be possible to establish an organization under which formal and regular meetings of representatives of all leading scientific academies may be held for the purpose of discussing scientific matters calling for international cooperation, and by this means preparing the way for international action. The Council of the Royal Society regards this question as one of great importance, and I am to request you to bring it before your Academy, and to ask whether that body would be prepared to join such an organization if established, and to cooperate in arranging the details for inaugurating it upon a practical working basis.

"I have the honor to be, very faithfully, yours,

"LISTER,
"*President Royal Society.*"

The letter was followed in June of the same year by an invitation from the German academies, transmitted by the Royal Prussian Academy of Sciences in Berlin, to send delegates to a conference at Wiesbaden on the 9th and 10th of October for the purpose of organizing an international association of learned

[81] Rep. Nat. Acad. Sci. for 1899, pp. 14-15.

societies. The object of the organization, as expressed in this letter, was to be "to support scientific undertakings which have been begun or recommended either by the assemblage of the united scientific bodies, or by a group of them, or by a single one of them, and to render mutually intelligible arrangements to facilitate scientific intercourse."

Such an invitation could scarcely be declined, and the President of the Academy, after consultation with the members of the Council, appointed as delegates to the Wiesbaden conference Messrs. Billings, Bowditch, Newcomb, Remsen and Bell. Only Messrs. Bowditch, Newcomb and Remsen were, however, able to attend the meeting.

At the November meeting of the Academy (1899) resolutions were adopted ratifying the action of the President in appointing delegates to the Wiesbaden conference, and authorizing him to appoint delegates to the International Association from time to time as might be desirable; also, approving the plan of organization adopted at Wiesbaden, accepting membership in the International Association, and recommending the appointment by the Association of special international committees.[82] The general committee of the Association met in Paris on July 31, 1900, the delegates from the National Academy on that occasion being Messrs. H. L. Abbot, J. M. Crafts and A. Graham Bell.[83] The first meeting of the Association was held in Paris in 1901, the Academy being represented by Professor George L. Goodale.[84]

Two medals within the gift of the Academy were awarded again in 1899, the Henry Draper Medal to Professor James E. Keeler, Director of the Lick Observatory, for his researches in

[82] The letters from the Royal Society of London and the Royal Prussian Academy of Sciences, together with plans of organization and a list of academies and delegates are given in the Annual Report of the National Academy of Sciences for 1899, pp. 14-18.

[83] A report of this meeting and a brief notice of the earlier proceedings, by J. M. Crafts, are printed in the Annual Report of the Academy for 1900, pp. 14-16.

[84] On account of illness, Professor Goodale was unable to attend this meeting. All the other academies forming the Association, seventeen in number, were represented. Some of the more important matters discussed are mentioned in the Annual Report of the Academy for 1901, p. 17.

spectroscopic astronomy, and the Watson Medal to Sir David Gill, Her Majesty's Astronomer at the Cape of Good Hope, "for his work in perfecting the application of the heliometer to astronomical measurements, which has resulted in an important advance in astronomy of precision, especially in the determination of parallaxes of the sun and stars and of the position of the planets." [85]

The fourth President of the Academy, Professor O. C. Marsh died on March 18, 1899. He had been Acting President in 1878 and 1882, and President from 1883 to 1895. He bequeathed to the Academy the sum of $10,000 "for promoting original research in the natural sciences." [86]

The time having arrived once more in 1900 for an award of the Barnard Medal, the committee appointed by the Academy unanimously recommended Professor Röntgen for that honor, in the following letter:

"The committee appointed to select one or more names of persons who are best entitled to receive the Barnard medal from Columbia University respectfully report that, after careful consideration of the subject, the name of Prof. Wilhelm Conrad Röntgen is presented as being that of the person who has within the five years beginning July 17, 1894, made the discovery which is most worthy of this honor, under the terms of the will of President Barnard.

"Professor Röntgen announced his discovery of what he called the X-rays, now commonly known as Röntgen rays, in December, 1895. These rays exhibit many peculiar properties, and have been applied to various practical uses, the most important of which thus far have been in surgery. They are at the present time one of the most interesting and important subjects of research in physical science, and the discovery may be properly termed an epoch-making one." [87]

In the ensuing year the Henry Draper Medal was awarded to Sir William Huggins for his investigations in astronomical physics. The report of the committee, though somewhat long for quotation in this connection, is so very interesting that it seems desirable that it should be given in full. It is as follows:

"It is not an easy matter to concentrate into a few pages the results attained by an active worker during a period of nearly half a century. Fortunately, in the

[85] Rep. Nat. Acad. Sci. for 1899, p. 10.
[86] See Rep. Nat. Acad. Sci. for 1910, p. 15.
[87] Rep. Nat. Acad. Sci. for 1900, p. 11.

present case, this labor has been greatly simplified by the recent publication by Sir William and Lady Huggins, of an Atlas of Representative Spectra from wave length 4,870 to 3,300, together with a discussion of the evolutional order of the stars, and the interpretation of their spectra, preceded by a short history of the Observatory and its work. This monumental volume not only furnishes a statement of the various publications of the authors, but exhibits the relation of the various investigations undertaken much better than could readily be done by another. From this it appears that the work began in 1856 with a 5-inch Dolland equatorial, which was replaced two years later by an excellent 8-inch Clark telescope. In 1870 this was again replaced by a 15-inch achromatic and an 18-inch reflector. In 1858 Sir William, then Mr. Huggins, undertook with Dr. Miller the visual study of stellar spectra. This work was continued until 1864, and the results were communicated to the Royal Society. Soon after this, on August 29, 1864, Sir William made one of the great discoveries in astrophysics. He found that the spectrum of the planetary nebula in Draco, N. G. C. 6543, had a monochromatic spectrum.

" It has heretofore been supposed that all nebulæ might consist of distant stars and could be resolved into their components by a telescope of sufficient power. This theory was at once disposed of, and it appeared that of 60 of the brighter nebulæ and clusters about one-third were of this gaseous character. In 1866 the observations of the new star in Corona gave the first clew to the cause of these remarkable objects. In 1868 Sir William was able to announce the first step in an investigation which in recent years has become one of the most important in astrophysics. The hydrogen lines in the brightest stars showed a slight displacement, from which the motion of these bodies in the line of sight may be determined. The accurate measurement of this quantity is now occupying a large part of the time of the greatest telescopes in the world. It is leading to unexpected results, which throw important light on the formation of the universe. The fact that these displacements are wholly independent of the distance of the source of light gives an opportunity to study problems for which ordinary visual methods fail entirely. About this time, also, a study of comets showed that their spectra closely resembled that of olefiant gas. A proposal of great scientific importance was a method of observing the solar protuberances in the uneclipsed sun. This method was devised independently by Mr. Lockyer. It is now claimed that these remarkable phenomena can be better seen any clear day at a fixed observatory than with portable instruments during a total solar eclipse. In 1876 the study of the spectra of the stars by means of photography, which had been attempted without attaining satisfactory results in 1863, was undertaken. Among the results published four years later, one of the most important was the discovery of the wonderful series of lines due to hydrogen. Similar series of lines are now found to exist in the spectra of many other terrestrial elements, and form the basis of the spectroscopic relation of these substances with one another.

"During the last quarter of a century Sir William and Lady Huggins have worked together in developing this most powerful method of research. Applying it to one object after another, a theory of the universe has been evolved, which is described in full in the work mentioned above. It is probable that this method must, in general, be followed in all attempts to study the chemical relation of stars to one another.

"We thus see that Sir William Huggins's activity has extended over nearly half a century. During this time discoveries of the greatest importance have been made, on which advances in astrophysics largely depend. Besides this, laborious investigations have been undertaken, extending over many years, by which the methods discovered have been developed and applied. For this remarkable record of scientific activity and perseverance the undersigned recommend the award by the Academy of the Henry Draper medal to Sir William Huggins."[88]

The President of the Academy, Wolcott Gibbs, resigned in the spring of 1900 and the office remained vacant until April, 1901, when Alexander Agassiz was elected to succeed him. Dr. Agassiz remained at the head of the Academy throughout the term of six years prescribed by the constitution. He was succeeded in 1907 by Dr. Ira Remsen.

The years 1901 to 1903 were notable in the history of the Academy on account of the number of celebrations of important events in the learned world in which it participated through delegates appointed by the President. At the celebration of the 450th anniversary of the founding of the University of Glasgow, June 12 to 14, 1901, the Academy was represented by Professor William G. Farlow and Dr. Theodore N. Gill. Professor Farlow also represented the Academy at the meeting of the International Association of Botanists held at Geneva, in August, 1901, and of the International Association of Academies at Paris, April 16, 1901. At the bicentennial celebration of Yale University in October, 1901, the Academy was represented by Dr. Ira Remsen. Professor Edward S. Morse was appointed a member of the general committee of the International Congress of Americanists held in New York in 1902. At the installation of Dr. Edmund J. James as president of the Northwestern University, on October 19 to 21, 1902, the Academy had as its delegates

[88] Rep. Nat. Acad. Sci., for 1901, pp. 10, 11.

Professors C. R. Van Hise and E. H. Moore; and at the installation of Dr. Joseph Swain as president of Swarthmore College, on November 15, 1902, the Academy's delegate was Professor Edgar F. Smith. The centenary celebration of the birth of the Norwegian mathematician Abel was held at Christiania on September 5, 1902, on which occasion Professor Simon Newcomb was the delegate of the Academy. He was also delegated to attend the meeting of the Council of the International Association of Academies in London, June 4, 1903.

The eighth volume of the *Memoirs,* containing seven articles, was completed and published in 1902.

1903–1907

At the end of the third decade in its history, the number of original members of the Academy who still remained was, as already noted, but eight. At the end of the fourth decade, January 1, 1904, all of these had died, save one. They comprised the naturalist, James D. Dana, who was the first Vice-President of the Academy (died in 1895); Benjamin A. Gould, the astronomer (1896); James Hall, the paleontologist (1898); J. Peter Lesley, the geologist (1903); H. A. Newton, the astronomer (1896); J. D. Whitney, the geologist (1896); and Fairman Rogers, who was the first Treasurer of the Academy, and served in that capacity for sixteen years (1900).

The Henry Draper Medal was presented on April 20, 1904, to Professor George E. Hale, Director of the Yerkes Observatory, for his important services to astronomy. The report of the committee, which made the award contains the following statements regarding his labors:

"The work of Professor Hale may be divided into four classes: Investigations of solar phenomena, studies of stellar spectra, editing the Astrophysical Journal, and the executive work involved in the direction of the Yerkes Observatory. In 1868, it was shown by Janssen and Lockyer, independently, that solar protuberances might be observed when the sun was not eclipsed. The method employed was to allow an image of the edge of the sun's disk to fall upon the slit of a spectroscope, and thus obtain the spectrum of this region only. If the image of a protuberance fell upon the slit, so large a portion of its light was monochromatic that the hydrogen line C appeared as a bright line in the corresponding portion of the spectrum. If now the slit was widened, the form of the protuberance became visible. By placing a second slit so as to cut off all portions of the spectrum except that of the line to be studied, replacing the eyepiece by a photographic plate, and giving similar motions to the latter and to the image of the sun on the slit we have the spectroheliograph. The principal credit must be given to Professor Hale for the independent invention of this instrument, for excellence in the plans of its mechanical construction, for skill in its use, and for the final results obtained with it, although as almost always happens, a portion of the credit must be given to other astronomers who were pursuing the same line of work. . . . .

"Professor Hale has shown the same skill in invention, construction, and application in the other portions of his work. The problem of photographing the spectra of the stars of the third and fourth types is one of unusual difficulty. . . . . By the great light-collecting power of the 40-inch refractor, and the use of isochromatic plates, Professor Hale succeeded in photographing the spectra of these stars with a large dispersion. . . . .

"During the years 1893, 1894, and 1895, Professor Hale edited the astrophysical portion of Astronomy and Metaphysics. In January, 1896, he established the Astrophysical Journal, associating with him the leading astrophysicists of the world as assistant editors. . . . .

"The manifold duties of the director of a great observatory may not be appreciated by one who sees only the results. To attain success good judgment, patience, skill, and knowledge of a great variety of subjects are required. For the establishment, erection of buildings, construction of instruments, selection of officers, general plan of work, and assignment of duties, a vast amount of time and energy is required before the actual scientific work begins. . . . .

"The reasons enumerated above show why the Henry Draper medal has been awarded to Prof. George Ellery Hale."[89]

As would naturally be anticipated, the adhesion of the National Academy to the project for an International Association of Academies in 1899 soon involved it in the consideration of scientific enterprises of world-wide scope. The first of these was a movement for the organization of an international seismological association, which was brought to its attention by Sir Michael Foster in 1902, in his capacity as chairman of the international council of the Association of Academies and as repre-

[89] For the full report, see Rep. Nat. Acad. Sci. for 1904, pp. 14-15.

sentative of the Royal Society of London. To aid the Royal Society in advising the British Government, he desired to be informed of the views of the National Academy, and the other constituent academies of the Association, as to whether it was deemed desirable to promote the project of the international seismological conference held in Strassburg in April, 1901, for the formation of an international seismological association. The object of this association was to be the solution of the various problems of seismology through the establishment of seismological stations in various parts of the world.[90]

The matter was referred to the Council of the National Academy, which appointed a committee to consider it. The committee reported in November, 1905. In the meantime, meetings of the International Association of Academies were held in 1903 and 1904, and at the latter seismology was a prominent subject of discussion. The report which the committee of the National Academy brought in in 1905 was, however, unfavorable as regards the establishment of seismological stations, on the ground that the theoretical basis of the science was very imperfect. "Seismometry" the committee remarked, "is open to improvement in two directions. On the one hand, some able mathematical physicist should be commissioned to elaborate the theory of vibrations in a sphere in which elastic properties and density vary with the radius; and on the other hand, experimental physicists should make strenuous efforts to devise a seismometer capable of recording the vertical components of small shocks."[91] The report ended with a recommendation that the matter be brought to the attention of the Carnegie Institution of Washington, and the Home Secretary was instructed by the Academy to send a copy of the report to that institution.

At the April meeting, 1904, a committee was appointed to consider the preparation of general plans for international work in solar research and to enter into communication with other

[90] See Rep. Nat. Acad. Sci. for 1902, pp. 17-19, where the letter and the plan of the seismological conference are given in full.

[91] Rep. Nat. Acad. Sci., for 1905, p. 16.

organizations for the purpose of securing their coöperation in the undertaking. The Louisiana Purchase Exposition, an exposition of universal scope, was held in St. Louis that year, and in connection therewith was assembled an International Congress of Arts and Sciences. As a large number of prominent men of science from all parts of the world were likely to attend the Congress, it was deemed an auspicious occasion on which to hold a conference on solar research. Accordingly, invitations to such a conference were sent to scientific organizations in Europe and America that were likely to be interested in the proposed undertaking. The conference was attended by delegates from 12 academies and astronomical, astrophysical, and physical societies. The International Meteorological Committee was also represented. The conference was opened by Professor George E. Hale, chairman of the committee of the National Academy of Sciences, who explained the purpose of the proposed organization, "emphasized the importance of encouraging individual initiative, and urged that no less attention be paid to such encouragement than to the accomplishment of large pieces of routine work through cooperative effort."

In the form of resolutions, the conference expressed its views regarding the form of coöperative research which was desirable, the desirability of obtaining the approval and patronage of the International Association of Academies, and the coöperation of the International Meteorological Committee and the Hungarian Academy of Sciences, and the formation of an international committee and a committee on program. After discussing various aspects of the work of the solar research, the conference adjourned to meet at Oxford in 1905. The Oxford meeting, at which the organization was denominated the International Union for Coöperation in Solar Research, was largely attended and was followed by a meeting at Meudon, near Paris in May, 1907. The Union commenced the publication of a series of *Transactions,* a copy of the first volume of which was presented to the Academy at the April meeting, 1907, by the chairman of the committee of the Academy. The fourth meeting of the Solar Union, as it is informally designated, was held on Mount Wilson, California, in 1910. At this time it comprised committees representing eight academies, three astrophysical societies, five physical societies, and four other organizations, including the International Meteorological Committee. The chairman of the committee of the National Academy remarked as follows, regarding the work:

"The chief work of the union is undoubtedly the stimulation of interest in solar research and the encouragement of workers in the field. It has brought together astronomers and physicists on common ground, thus contributing toward the solution of problems lying on the borderland between these subjects. The influence of the union seems to be apparent in the marked activity which has resulted in many recent additions to our knowledge of the sun. But it has also accomplished much in other ways. The establishment of a new system of wave lengths, based on Michelson's determinations of the absolute wave length of the green cadmium line, and the measurements of standard lines already made by Fabry and Buisson, Eversheim, and Pfund, will be of lasting benefit to exact science. The daily photography of the sun, with spectroheliographs in Sicily, France, Spain, Germany, England, Mexico, the United States, and India, will soon be supplemented, it is hoped, by stations in Australia and China, and possibly in Japan. In this way the changing phenomena of the solar atmosphere are recorded from hour to hour. A program for the co-operative study of sun-spot spectra, adopted at Paris, will now be revised to adapt it to the new conditions presented by recent discoveries. The chief progress in the study of the intensity of the solar radiation has come through the work of the Smithsonian Astrophysical Observatory, but the use in Italy, France, and India of standard pyrheliometers sent out by Abbot should soon result in the initiation of a general scheme of cooperation. Adams's discovery that the law of the solar rotation varies at different altitudes in the sun's atmosphere has been confirmed by Pérot, and others are entering this important field. Cooperation in eclipse observations and in other departments of solar research has also been initiated by the union." [92]

The ninth volume of the *Memoirs* was published in 1905.

The time for the award of the Barnard Medal having arrived once more in 1905, the committee of the Academy recommended that Professor Henri Becquerel be the recipient of this honor. The report made at the April meeting of that year was as follows:

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[92] Rep. Nat. Acad. Sci. for 1910, p. 18.

"The committee on the Barnard medal respectfully recommend that Prof. Henri Becquerel, of Paris, member of the Institute, be recommended by the National Academy of Sciences to the trustees of Columbia University as the proper recipient of the Barnard medal to be awarded next June. In making this recommendation the committee has borne in mind not only the important discoveries in the field of radio-activity made by Professor Becquerel during the last five years, but also the fact that he was the original discoverer of the so-called dark rays from uranium, which discovery has been the basis of subsequent research into and of our present knowledge of the laws of radio-activity." [93]

Since the formation of the International Association of Academies, of which the National Academy became a member, the interest in the national and international coöperation in research work has greatly increased, and the Academy has participated in many undertakings of broad scope which have been beneficial in the promotion of science. Mention has already been made of the work of the International Seismological Association and the International Union for Coöperation in Solar Research. In 1906, a proposal was made to the Academy that it should lend its aid and patronage to a scheme for national coöperation in chemical research. The primary object of the plan was to arouse interest in and to provide means for a systematic attack on the problem of the free-energy changes which accompany chemical reactions. "The principle of the second law of energetics," remarked the promoter of this enterprise in 1906, "that any change in the state of a system, whether physical or chemical, is capable of producing under the most favorable conditions a definite quantity of work is one whose importance has been extensively recognized within the last few years. This importance arises not only from the direct significance from a scientific and technical standpoint of this maximum quantity of work obtainable from any physical change or chemical reaction, but also from the fact that from its value alone can be directly computed the equilibrium conditions of the chemical reaction in question, the direction in which under specified conditions it will take place, and the electromotive force of any voltaic cell in which the reaction goes on reversibly." [94]

[93] Rep. Nat. Acad. Sci. for 1905, p. 13.
[94] Rep. Nat. Acad. Sci. for 1906, p. 19.

Not only was the importance of the investigation *per se* insisted upon, but it was considered that it would stimulate an interest in chemical research among the rising generation of students of that branch of science, particularly, because it offered a wide field for individual ingenuity and initiative, while at the same time it did not demand the most costly and extensive facilities, or the most finished training. The scheme was referred by the Academy to a committee which reported favorably upon it, and the report was adopted by the Academy.

The committee was continued, and in accordance with the approval of the Academy, associated with itself Dr. G. N. Lewis of Boston, who had given much attention personally to the problems of chemical reactions. At the November meeting, 1907, this committee reported that it had prepared a circular letter to heads of departments and to research workers in educational establishments, outlining the plan of research, and asked the Academy to approve its distribution. This was granted and the letter was accordingly circulated. Besides stating the problem and asking coöperation in its solution, the letter mentioned three pamphlets bearing on the subject which had been prepared, by the committee containing a summary of the problem, the best means of attacking it and a résumé of the condition of knowledge regarding it. These were entitled respectively, "The Maximum Work Producible by Chemical Reactions," "The Principles of Energetics and their Application to Chemical and Physico-chemical Changes," and "The Free Energy of Chemical Compounds."

The list of trust funds of the Academy, already a long one, received an important addition in November, 1907, when General Cyrus B. Comstock, Director of the Geodetic Survey of the Northern and Northwestern Lakes and President of the Mississippi River Commission, presented the sum of $10,000 "to advance knowledge in electricity, magnetism, and radiant energy, by the giving of money prizes for important investigations or discoveries in those subjects." It was General Comstock's wish that the principal of the fund should be maintained at the market value of $10,000. After providing a plan for increasing the capital fund to $15,000, the deed of trust requires that once in every five years, about two-thirds of the accumulated interest shall be awarded as a prize, to be known as the " Comstock Prize," " to the *bona fide* resident of North America, who, not less than one year nor more than six years before the awarding of the prize, shall have made in the judgment of the trustee the most important discovery or investigation in electricity or magnetism or radiant energy." In case no such discovery or investigation is deemed worthy of the prize the trustee is permitted, under certain conditions, to allot the prize-money in aiding research. The " Comstock Prize " has not as yet been awarded.[95]

During the period under consideration, 1903 to 1907, the following delegates were appointed to represent the Academy at meetings of various international associations, or celebrations at universities: Professor Simon Newcomb was delegated to attend a meeting of the Council of the International Association of Academies in London, June 4, 1903. The same year Dr. S. F. Emmons, President Van Hise and Dr. Geo. F. Becker, represented the Academy at the International Geological Congress held at Vienna on August 27. On the occasion of the 50th anniversary of the founding of the University of Wisconsin, in 1904, Professor Grove K. Gilbert and Dr. Geo. E. Hale were the representatives of the Academy, and at the meeting of the International Association of Academies held in London on May 25, 1904, the Academy was represented by its Foreign Associates, Sir Archibald Geikie and Sir E. Ray Lankester. The following year Dr. William Trelease was designated to attend the International Botanical Congress held in Vienna, June 11 to 18, 1905, while Dr. George E. Hale and Professor W. W. Campbell were the representatives on the Committee on Solar Research which met at Oxford in September, 1905. In 1906 Dr. Arnold Hague represented the Academy at the quaternary celebration of the University of Aberdeen. The following year Professor T. C. Chamberlin was the delegate of the Academy at the celebration

[95] For the deed of trust and other documents, see Rep. Nat. Acad. Sci. for 1907, pp. 13-15.

of the 50th anniversary of the founding of the Michigan Agricultural College, May 28 to 31; Dr. Alexander Agassiz represented the Academy at the Seventh International Zoölogical Congress held in Boston, August 19 to 23; Dr. Arnold Hague, at the centenary celebration of the Geological Society of London, September 26 to 28; Dr. George E. Hale, at the meeting of the International Association of Academies, and at the third meeting of the Union for Coöperation in Solar Research, in Paris, in May; Professor W. C. Brögger, at the bicentenary celebration of the birth of Linnæus at Upsala, May 23 and 24; and Professor Henry F. Osborn at a similar celebration in New York.

1908–1912

The proceedings of the Academy in 1908 and the events of that year were important from many points of view. The last of the incorporators of the Academy, Professor Wolcott Gibbs, died on December 9. He was Vice-President of the Academy from 1872 to 1878 and President from 1895 to 1901. He had also been the first Home Secretary, serving in that capacity from 1863 to 1872. In a brief sketch of his life published in 1908, it is remarked: "His long life was devoted to the cause of research in the field of pure science, and his influence was always on the side of the highest ideals." He was succeeded in the presidency by Alexander Agassiz.

The subject of the preservation of the forests of the United States had become one of strong public interest in the country in 1908, and the Academy again voiced its opinion regarding this matter in so far as it related to the forests of the White Mountains and the Appalachians in the following resolutions of the Council which were transmitted to the Senate and House of Representatives:

"*Whereas* under the present drain upon the forest timber supply of the entire United States will be exhausted within twenty years, while in the Eastern States, where no adequate means have been employed to protect the forest, the end of the supply is even nearer;

"*Whereas* the headwaters of all important navigable streams to the west of the Mississippi River are now protected by national forests, while the Appalachian Mountains, which form the waterheads of many navigable streams of great importance, are entirely unprotected and are being damaged to a menacing extent by the wasteful cutting of the forest, unrestricted fires, and injudicious clearing;

"*Resolved,* That the council of the National Academy of Sciences heartily favors the extension of the national forest system to the Appalachian Mountains for their protection and permanent utilization.

"*Resolved,* That we urge upon Congress the passage at the present session of a bill to acquire in the southern Appalachian Mountains and the White Mountains such forest lands as are necessary to protect the navigable streams which have their sources therein and to make permanent the timber supply of the eastern part of the Unietd States."[96]

The important results obtained through coöperative methods of research led the Academy in 1908 to appoint additional committees for the promotion of such activities. One of these, the Committee on International Coöperation in Research, was to serve as the adviser of the Academy in its relations with the International Association of Academies. Its duties were "to keep in close touch with the work of the International Association of Academies, and to assist in securing suitable representation of the Academy at the council and general meetings of the Association"; and also "to consider plans for coöperation in research, and to recommend from time to time the initiation of such coöperative investigations as may warrant the support of the Academy." In 1909, this committee submitted a very interesting report, which, as it briefly summarizes the activities of the Academy in this connection, seems to demand quotation in full. It is as follows:[97]

"The committee on cooperation in research met in Boston on April 5. Reports of progress were received from the committees on solar research, on chemical research, on paleontologic correlation, and on brain research.

"The International Union for Cooperation in Solar Research has held three meetings, a preliminary one at St. Louis, and largely attended meetings at Oxford and Paris. The second volume of Transactions has recently been published. Arrangements are now being made for the next meeting, which is to be held at

[96] Rep. Nat. Acad. Sci. for 1908, p. 20.

[97] Rep. Nat. Acad. Sci. for 1909, p. 13.

Pasadena and Mount Wilson in 1910. A large amount of cooperative work is in progress under the auspices of the union.

"The committee on chemical research has prepared a circular letter to investigators, inviting their cooperation, and the work will be developed rapidly as soon as Doctor Noyes is relieved from his present duties as acting president of the Institute of Technology (in a few weeks).

"The committee recognized the importance of cooperative investigations in this country, as well as those of international scope, and decided to encourage promising opportunities in either field.

"The chairman was authorized to invite several other members of the academy (selected by the committee) to join the committee, namely, Messrs. Mall, Moore, Chittenden, Chamberlin, Davis, and Wilson.

"The importance of providing for *adequate means of publication of short papers,* as well as complete volumes of transactions, was recognized by the committee, and it was decided to request you to bring this matter to the attention of the council.

"It was announced that the academy would be represented by one of the members of the committee (George E. Hale) at the council meeting of the International Association of Academies, to be held in Rome June 1-3 next. The appointment of Professor Hale was made by President Remsen.

"SIMON NEWCOMB,
"A. A. NOYES,
"C. S. MINOT,
"H. F. OSBORN,
"GEORGE E. HALE, *Chairman.*

"Communicated by
"HENRY F. OSBORN."

The second coöperative committee appointed in 1908 was one on International Paleontological Correlation. The committee on this important subject divided itself into a Vertebrate Section and an Invertebrate Section. The Vertebrate Section submitted a report in 1909, which was published in the *Annals* of the New York Academy of Sciences, under the title of "Geologic Correlation Through Vertebrate Paleontology by International Cooperation."[98]

The Academy published this year a comprehensive report on the trust funds of the Academy, comprising transcripts of wills

[98] Annals N. Y. Acad. Sci., vol. xix, no. 2, part 1, pp. 41-44, April 20, 1909, "Correlation Bulletin, no. 1, Plan and Scope."

and deeds of trusts, lists of donors, subscribers, trustees, committees, etc., data regarding the amount of the principal of the several funds, the amount of the income, the amount and object of expenditures, and a summary of the action of the Academy relative to the funds from year to year. As already mentioned, the trust funds of the Academy in 1895 were six in number, the combined principal of which amounted to $94,000. In 1908 two funds had been added, and the total amount of the capital aggregated $170,359.17.[99]

From these funds, between the years 1871 and 1908, 175 grants were made, ranging in amount from $25 to $2500 each. The majority were from the Bache Fund and from the Gould Fund. In addition, the income of the Wolcott Gibbs Fund was regularly alloted, and gold medals were presented from the funds which provided for them.

The grants from the Bache Fund between 1871 and 1908 amounted to about $76,000, distributed in the following manner:[100]

Astronomy and Astrophysics	$25,650
Physics	14,634
Magnetic Surveys	8,260
Physiology and Pathology	6,600
Miscellaneous[101]	5,350
Chemistry	5,150
Zoölogy	5,050
Botany	3,100
Paleontology	1,200
Psychology	600
Meteorology	550
Seismology	100
Total	$76,244

The grants from the Gould Fund between 1899 and 1908 were all for astronomical investigations and amounted to $9,430.

[99] Of this sum, $40,000 is not yet available.

[100] The classification is not entirely exact, as the object of the grants is not always definitely stated.

[101] Some of the items under this heading are probably chargeable to astronomy.

Grants from other funds for astronomical purposes amounted to $7,645. The total for astronomical and astrophysical investigations was about $42,725 or nearly one-half the amount of all grants made between 1871 and 1908, the sum total of which was about $94,000.[102]

In 1909, a first installment of the bequest of Professor O. C. Marsh, was sent to the Academy by the executor of his estate, with the following letter:

"NEW HAVEN, CONN., November 17, 1909.

"PROFESSOR S. F. EMMONS,
"Treasurer of the National Academy of Sciences,
"Washington, D. C.

"DEAR SIR: I think you are perhaps already aware that the late Prof. O. C. Marsh left a bequest to the National Academy of Sciences. The seventh clause of his will is as follows:

"'I give, devise, and bequeath to the corporation known as the National Academy of Sciences, in Washington, D. C., the sum of $10,000 as a trust fund, the income to be used and expended by it for promoting original research in the natural sciences.'

"When Prof. Marsh died he was somewhat in debt, and we have just succeeded in paying the last of his notes, and have a small balance over, so are sending you with this a check for $1,250 as a first payment of the above legacy. We hope later to be able to pay the whole amount, as we receive from time to time certain moneys from the George Peabody estate, as certain trusts fall back into that estate, and it is probable that the amount still to be received from that source will be enough to do this. Will you kindly acknowledge the receipt of this payment, and at a later date send us the acceptance of the academy of the above trust?

"With great respect, I am, sir,
"Very truly yours,
"WM. W. FARNAM,
"Executor Estate of O. C. Marsh."

The Academy, upon recommendation of the Council, accepted this bequest and directed that it be accumulated until it should amount to the sum of $10,000 before any grants were made from it.

[102] The income of the Watson Fund since 1901, which was also devoted to astronomical researches, and some minor items of a miscellaneous character, are not included in the foregoing figures.

In 1910 the Henry Draper Medal was awarded to Mr. Charles Greeley Abbot, Director of the Smithsonian Astrophysical Observatory "for his researches on the infra-red region of the solar spectrum and his accurate measurements, by improved devices, of the solar 'constant' of radiation."[103] The medal was presented to Mr. Abbot at the annual dinner, April 19, 1911. Five years having elapsed since the last award of the Barnard Medal, a committee of the Academy recommended that it be given in 1910 to Dr. Ernest Rutherford, Langworthy Professor of Physics and Director of the Physical Laboratory in the University of Manchester, for his investigations on the phenomena of radio-activity. The committee remarked, in part, as follows:

"Prof. Rutherford has been identified with this branch of physical science since its inception by the discovery of the so-called X-rays in 1895. His researches, published in numerous communications to current journals, appear to have contributed more than those of any contemporary to the establishment of the salient properties of radio-active substances. Not content with the experimental determination and verification of these properties, he has recently gone further and pointed out the convincing evidence they afford of the correctness of the ancient doctrine of the atomic structure of matter. In addition to his contributions in this field of investigation of many original, ingenious, and penetrating methods of observation and measurement, he has also furnished the best general account of its origin, development, and present status in his book on Radio-active Transformations (published in 1906) and in his presidential address read before the section of mathematics and physics of the British Association for the Advancement of Science, in August, 1909."[104]

The medal was awarded to Professor Rutherford, in accordance with the recommendation of the committee.

The Academy was represented at the meeting of the council of the International Association of Academies held in Rome in June, 1909, by the chairman of the Committee on International Coöperation in Research, Professor George E. Hale, who was also the delegate to the Darwin Celebration at the University of Cambridge, June 22 to 24, 1909. The committee recommended that the Academy should vote in favor of admitting the Swiss Society

[103] Rep. Nat. Acad. Sci. for 1910, p. 12.
[104] *Loc. cit.*, p. 14.

of Natural Sciences to membership in the Association and also in favor of publishing annually a volume of physical and chemical tables in accordance with a plan presented to the Association. These tables were to be compiled from current periodicals, and to be classified under five general heads: general physics, heat, electricity and magnetism, light and sound, physical chemistry. It was expected that they would be useful to students, investigators and those concerned with the practical applications of physics and chemistry, as they would bring together in convenient form a variety of tables that might otherwise be overlooked or difficult of access. The first volume of tables was published in 1912.[105]

The Academy was invited in 1910 by the American Philosophical Society to consider the question of the establishment of a seismological laboratory. The project was favorably recommended by the Council and at the meeting of April, 1910, the Academy adopted the following resolution:

"*Resolved,* That the academy strongly approves the establishment of the proposed Seismological Laboratory, and its organization under the direction of the Smithsonian Institution." [106]

Two delegates were appointed in 1910 to represent the Academy at international conventions held during that year. At the International Association of Academies held at Rome in May, and at the International Zoölogical Congress, held at Gratz, in August, the Academy was represented by Mr. E. G. Conklin; at the International Geological Congress, held in Stockholm in the latter month, by Mr. S. F. Emmons.

Dr. Arnold Hague represented the Academy on the occasion of the celebration of the 100th anniversary of the University of Berlin, October 10 to 12, 1910.

The sixth President of the Academy, Alexander Agassiz died on March 27, 1910. He held the presidency from 1901 to 1907, and was also Foreign Secretary from 1891 to 1901. Professor Mayer remarked of him: "His remarkable energy and exec-

[105] For the full plan see Rep. Nat. Acad. Sci. for 1910, pp. 16, 17.

[106] Rep. Nat. Acad. Sci. for 1910, p. 20.

utive ability fitted him in an eminent degree to be the leader of scientific expeditions. Each exploring trip was planned to a day even to its minute details, every course charted, distances measured and every station decided upon, before he left his desk in the Harvard Museum, so that all of its achievements were actually prearranged. . . . It is due chiefly to his forethought that in more than 100,000 miles of wandering over tropical seas he never met with a serious accident. . . . Among scientific men be became the greatest patron of zoölogy our country has known. In 1910, at the time of his death, the fifty-fourth volume of the *Bulletins*, and the fortieth volume of the *Memoirs* of the Museum of Comparative Zoölogy were appearing. These publications had been started in 1863 and 1864, and in the number of important and beautifully illustrated papers they contain they have been excelled by only a few of the most active scientific societies of the world; yet the expense of producing them has largely been borne by one man—Alexander Agassiz." [107] He bequeathed the sum of $50,000 "for the general use of the Academy." [108]

The International Union for Coöperation in Solar Research in which the Academy is represented held its fourth conference at the Mount Wilson Solar Observatory from August 31 to September 2, 1910. At this meeting, which was attended by 37 delegates from foreign countries and 47 from the United States, the scope of the Union was extended to include all branches of astrophysics. "The resolutions adopted called for the continuation of the series of daily photographs of the calcium flocculi with spectroheliographs used by cooperating observatories in various parts of the world; the addition of a series of daily photographs of the hydrogen flocculi; the inclusion in the list of cooperating institutions of the observatories at Tacubaya, Mexico, and Madrid, Spain; the adoption of definite international standards of wave-lengths of the second order, based on interferometer determinations made at three laboratories;

[107] Pop. Sci. Monthly, November, 1910, pp. 425, 430.

[108] This sum was paid into the treasury on February 1, 1911.

the use of barium lines in the neighborhood of λ 5800, where sharp iron lines are not sufficiently numerous for standards; the extension of the system of standards of the second order to shorter and longer wave-lengths; the measurement of standards of the third order by concave gratings at various cooperating institutions; the use of the name International Ångström (I. A.) for the unit on which the system of standards of the international system is based; the publications of the report of the sun-spot spectrum committee and of the cooperating observers in the next volume of the Transactions of the Solar Union; the continuation of visual observations of spot spectra in accordance with a revised and extended scheme; the preparation of a general catalogue of the lines in the photographic spectra of sun-spots; the preparation of a new photographic map of the sun-spot spectrum on a scale of 5 mm. to the Ångström; and the general adoption of the plan of measuring position angles around the sun's limb from the north to the east." [109] The last article of the tenth volume of the *Memoirs* was published in 1911.

A new trust fund was placed under the control of the Academy in 1911 when Sir John Murray presented the sum of $6,000 to establish a gold medal to be known as the " Alexander Agassiz Medal," and to be awarded " to scientific men in any part of the world for original contributions to the science of oceanography." The following year the Academy, upon recommendation of a special committee, accepted a design for the medal prepared by Mr. Theodore Spicer-Simpson.[110]

The vertebrate section of the committee on paleontologic correlation submitted a second and final report in 1912 from which it is learned that with the aid of grants from the Bache Fund, amounting to $1,000, it had prepared and published three " correlation bulletins," entitled respectively " Plan and Scope," " Fossil Vertebrates of Belgium," and " Patagonia and the Pampas Cenozoic." Lists of North American fossil vertebrates were also prepared, and matter relating to correlation was also

[109] Rep. Nat. Acad. Sci. for 1912, p. 14.
[110] *Loc. cit.*, p. 14.

published in Professor H. F. Osborn's book entitled "Age of Mammals" and an article by him entitled "Correlation and Palæogeography." Upon recommendation the section of the committee was discharged.[111]

The Academy sent Dr. George F. Becker as its delegate to the meeting of the American Philosophical Society held on April 18, 19 and 20, 1912. At the 250th anniversary of the Royal Society of London, which was celebrated on July 16-18, 1912, the Academy had as its delegate Dr. Arnold Hague, Home Secretary. The President of the Academy was its representative at the inauguration of President Hibben at Princeton University on May 12, 1912.

The will of Morris Loeb, who died on October 8, 1912, contained the following item, adding to the trust funds of the Academy: "I give and bequeath to the National Academy of Sciences in Washington, in the District of Columbia, the sum of two thousand five hundred dollars as a contribution toward the Wolcott Gibbs Fund, founded in 1892."

[111] Rep. Nat. Acad. Sci. for 1912, p. 13.

CHAPTER III

BIOGRAPHICAL SKETCHES OF THE INCORPORATORS

THE tumultuous days of a great war would hardly seem a propitious time for the formation of an association to promote the arts of peace. Men of science, like men from every other department of life, were engaged directly or indirectly in the struggle, and it seems unlikely that any of them, and especially those in prominent positions, would find the leisure, or be in a mood, to consider the qualifications of their confrères for membership in an academy. The peculiar circumstances of the time must have greatly increased the difficulties of this delicate task. It has been suggested that the exigencies of the day account for the large number of men connected with the military and naval branches of the Government that were included among the incorporators. This may be true, as the founders of the Academy undoubtedly had the idea that it would be a help to the Government, but a more just view is, perhaps, that so many men of high scientific attainments were connected with the Army and Navy that the choice naturally lay in that direction.

It would be interesting to know how the selection of incorporators was guided, but no records at present available reveal the facts. A clew is, perhaps, to be found by a study of the membership of scientific organizations already in existence when the Academy was founded. There were three general societies, the American Philosophical Society, the American Academy of Arts and Sciences, and the American Association for the Advancement of Science. From a comparison of the lists of those who were members between 1860 and 1863[1], it appears that from two-thirds to nearly three-fourths of the incorporators of the

[1] The meetings of the American Association for the Advancement of Science were suspended during the Civil War.

National Academy were connected with one or the other of these societies, and that of the whole number of incorporators only four were not members of any of them. It would seem almost certain that the little group of men that guided the Academy movement had these lists before them when engaged in the selection of incorporators. Doubtless there were good reasons why the fifty original members, or some of them, were not notified of their inclusion in the list in advance of the passage of the Act of Incorporation, but it is significant that only two declined membership, or resigned in the months immediately following that event.

The Academy has published sketches of the lives of nearly all the incorporators in the series known as the *Biographical Memoirs,* of which seven volumes have been issued. It has not seemed necessary or desirable to gather the same information again from original sources, but an attempt has been made to summarize, in the pages which follow, the principal events in the lives of the original members. The matter has been derived in the majority of cases from the *Biographical Memoirs,* and in each instance the authority is cited.

The original list of incorporators as it appears in the Act of 1863 is as follows:

Louis Agassiz, Massachusetts.
J. H. Alexander, Maryland.
S. Alexander, New Jersey.
A. D. Bache, at large.
F. A. P. Barnard, at large.
J. G. Barnard, United States Army, Massachusetts.
W. H. C. Bartlett, United States Military Academy, Missouri.
U. A. Boyden, Massachusetts.
Alexis Caswell, Rhode Island.
William Chauvenet, Missouri.
J. H. C. Coffin, United States Naval Academy, Maine.
J. A. Dahlgren, United States Navy, Pennsylvania.
J. D. Dana, Connecticut.
Charles H. Davis, United States Navy, Massachusetts.
George Engelmann, St. Louis, Missouri.
J. F. Frazer, Pennsylvania.
Wolcott Gibbs, New York.
J. M. Gilliss, United States Navy, Kentucky.
A. A. Gould, Massachusetts.
B. A. Gould, Massachusetts.
Asa Gray, Massachusetts.
Arnold Guyot, New Jersey.
James Hall, New York.
Joseph Henry, at large.
J. E. Hilgard, at large, Illinois.

EDWARD HITCHCOCK, Massachusetts.
J. S. HUBBARD, United States Naval Observatory, Connecticut.
A. A. HUMPHREYS, United States Army, Pennsylvania.
J. L. LE CONTE, United States Army, Pennsylvania.
J. LEIDY, Pennsylvania.
J. P. LESLEY, Pennsylvania.
M. F. LONGSTRETH, Pennsylvania.
D. H. MAHAN, United States Military Academy, Virginia.
J. S. NEWBERRY, Ohio.
H. A. NEWTON, Connecticut.
BENJAMIN PEIRCE, Massachusetts.
JOHN RODGERS, United States Navy, Indiana.
FAIRMAN ROGERS, Pennsylvania.
R. E. ROGERS, Pennsylvania.
W. B. ROGERS, Massachusetts.
L. M. RUTHERFURD, New York.
JOSEPH SAXTON, at large.
BENJAMIN SILLIMAN, Connecticut.
BENJAMIN SILLIMAN, JR., Connecticut.
THEODORE STRONG, New Jersey.
JOHN TORREY, New York.
J. G. TOTTEN, United States Army, Connecticut.
JOSEPH WINLOCK, United States Nautical Almanac, Kentucky.
JEFFRIES WYMAN, Massachusetts.
J. D. WHITNEY, California.

LOUIS AGASSIZ

Born, May 28, 1807; died, December 14, 1873

Arnold Guyot remarked of Agassiz in 1878:

"Agassiz, in more senses than one, is a unique figure in the history of the scientific progress of our day. In Europe he already occupied among men of science a position in some manner exceptional, I may say privileged, which no other scientific man of equal or even superior merit has enjoyed. In this country, during the last quarter of a century, he has been in the popular mind, more than any other man, the representative of the faithful, unflinching devotee of natural science.

"In both hemispheres he found crowds of enthusiastic admirers; in both he became the center of a marvelous scientific activity, the guide of numerous followers in the investigation of the mysteries of nature. Such facts reveal an individuality of uncommon power which deserves our special attention."

Louis Agassiz was born at Motier, in the Swiss Canton of Vaud, on May 28, 1807. He was the son of the pastor of the village church, and was descended from French Huguenots. His father accepted a call to the town of Orbe, at the foot of the Jura, and young Agassiz's boyhood was spent among those impressive surroundings, which doubtless first served to arouse in him an interest in the study of nature. He returned hither in later years to verify his geological deductions and to find materials for his work on echinoderms.

At the age of 11, Agassiz engaged in classical studies at the College of Bienne, and afterwards was a student for two years at the Academy of Lausanne. In 1824 he entered the Medical School of Zurich where two additional years were spent. Having been encouraged in his natural history studies by the zoölogist Schinz, according to the custom of the time he left Zurich and entered the University of Heidelberg, where he studied physiology and anatomy under Tiedeman, zoölogy under Leuckart, and botany under Bischoff. At this time Alexander Braun was studying at Heidelberg, and an intimate friendship was formed between the two young men, Braun inviting Agassiz to his home during the summer vacations. To this charming home, most delightfully situated at Carlsruhe, many naturalists and other men of learning were attracted, and by the intimate intercourse with those who like himself were engaged in the study of nature, and by comparison of investigations made, Agassiz broadened his own views, and laid the foundations for his future work. With Braun and Schimper, Agassiz spent the years from 1827 to 1830 at the University of Munich, continuing his medical studies and mainly occupied with zoölogical investigations. These three men formed the nucleus of a company of young scientists who organized a society called the "Little Academy of Sciences," where each gave lectures on his favorite topic. In these years were finished those preliminary studies which formed the basis of his life work. With Oken he discussed classification; with Döllinger, embryology; Von Martius instructed him in the geographical distribution of plants; and Schelling in philosophy. He published his first work at this time and prepared two others. Owing to the death of Spix, Agassiz was chosen by Von Martius, the Brazilian explorer, to describe the fishes collected during his expedition. So well was this done by Agassiz, then but twenty-one years of age, that it gave him rank among the best naturalists of the time.

Previous to the accomplishment of this work, Agassiz had taken the degree of Doctor of Philosophy at the University of Erlangen in 1829, and Doctor of Medicine at Munich in 1830. While continuing his preparations for the publication of a natural history of the fresh-water fishes of Europe and a treatise on fossil fishes, Agassiz visited Vienna and Paris, where he examined the collections in the museums, and received help from various sources, as well as offers of attractive positions. He became acquainted with Fitzinger in Vienna and in Paris Humboldt introduced him to Cuvier, who generously placed in his hands the whole of the material which he himself had intended to use as the basis of a work on fossil fishes. By the advice of Humboldt, Agassiz refused the various offers of positions that were made to him, but at last in the autumn of 1832 was appointed to the recently-established chair of natural history in the College of Neuchâtel, where for 14 years he labored assiduously and published extensively. His "Recherches sur les Poissons Fossiles," and his "Système Glaciaire," "those of his works which have made the deepest impress on progressing science," were written during this period. Always enthusiastic, he carried out his ideals in the publication of his books, and though often in pecuniary difficulties, aid came to him from many sources on account of his reputation for accurate scholarship and faithful devotion to research.

Other important works published by Agassiz while at Neuchâtel were a prodromus of the echinoderms and a treatise on the fossil echinoderms of Switzerland, Critical studies of fossil Mollusks, "Iconography of the tertiary shells believed to be identical with living ones," the "Nomenclator Zoölogicus," and the "Bibliotheca Zoölogica et Geologica."

In 1836 Agassiz's attention was directed to the subject of glaciers by his friend Jean de Charpentier, and he spent some months with him at Bex, near the mouth of the Rhône. As a result of his studies and reflections, he conceived the idea of an universal glacial epoch at the end of the Tertiary Age. He presented this before the Helvetic Society of Natural Science at

Neuchâtel in 1837 and produced a sensation throughout the scientific world. It was combated and ridiculed, but in course of time it has found universal acceptance, though in a modified form. Agassiz never lost interest in the subject, and made extensive and important contributions to it in later years. He intended to publish a comprehensive work on the results obtained through the researches of himself and his associates, but the enterprise was frustrated by the revolution of 1848, after the publication of the first volume. "If to Venetz and Charpentier belongs the honor of having first proved the transportation of the Swiss erratic boulders by the agency of ice, and the existence of great glaciers formerly extending to the Jura, to Agassiz we must award the merit of having given to these facts their full geological significance, of having brought them before the world at large and having made the glacial question, as it were, the order of the day." (Guyot.)

Important as were these glacial researches of Agassiz, his friend Humboldt thought it unfortunate that he should be diverted from natural history investigations, and on that account induced the King of Prussia to send him on a scientific mission for the comparison of the faunas of temperate Europe and America. At the same time Agassiz received an invitation to lecture before the Lowell Institute in Boston. He came to America in 1846, and, as is well known, made an extraordinary impression in scientific circles and on the public at large. "Before him America had had many able representatives of the science of nature, fully appreciated abroad, but too much ignored by the mass of the people at home, who had not yet espoused the cause. Sympathy and efficient aid had been wanting. The stirring appeals of Agassiz were heard and the nation nobly responded." (Guyot.)

Professor Bache, Superintendent of the Coast Survey, gave him opportunities for investigations of marine life on the Atlantic Coast and among the Florida Reefs. Means were found for an expedition to Brazil and the Amazon, and for the publication of his "Contributions to the Natural History of the

United States," for the establishment of a biological laboratory and school on Penikese Island, and many other enterprises. Greatest of all was the organization of the Scientific School and the Museum of Comparative Zoölogy at Harvard. In the latter, Agassiz's ideas on zoölogy were embodied in concrete form in the zoölogical, geographical, and embryological series which were there displayed. "By his large contributions to Science in America, by his power of developing a true scientific spirit, to excite and popularize the taste for scientific researches, by his vast influence on the American mind, and his universal popularity, which he kept to the very last, Agassiz had become emphatically a *national man*." (Guyot.) He died on December 14, 1873.

It was probably Agassiz who induced Senator Wilson to introduce and urge the bill incorporating the National Academy of Sciences, and when established he became its first Foreign Secretary.

(From ARNOLD GUYOT, in *Biographical Memoirs of the National Academy of Sciences*, vol. 2, 1886, pp. 39-73. See also ELIZABETH C. AGASSIZ, "Louis Agassiz; His Life and Correspondence," Boston, 1893; JULES MARCOU, "Life and Letters of Louis Agassiz," Boston, 1895.)

JOHN H. ALEXANDER

Born, June 26, 1812; died, March 2, 1867

Dr. Alexander was a man of remarkable versatility. A mathematician and a physicist, he was also a linguist and a poet. He was a successful man of affairs and a deeply-read student of theology and church history. His father, who belonged to a Scotch-Irish family, came to America before the Revolution and settled at Annapolis, Maryland. Here John H. Alexander was born in 1812. He was graduated from St. John's College in his native town when fourteen years old and entered upon the study of law. His attention being attracted, however, to the great possibilities of steam transportation and the utilization of the natural resources in iron and coal, he turned his energies in the direction of practical pursuits. He was at first connected with surveys for the Susquehanna Railroad (now part of the Northern Central Railroad) and soon afterward became interested in a topographical and geological survey of Maryland. In association with Professor Julius T. Ducatel, he prepared a plan for these surveys and in 1834 was appointed Topographical Engineer by the Maryland Legislature, Professor Ducatel at the same time becoming State Geologist. As the result of a trigonometrical reconnoissance, Alexander was enabled within four years to construct a map of the State on which geological data could be plotted, and was contemplating the preparation of a more accurate map, through the coöperation of the United States Coast Survey, when the Legislature withdrew its support from reasons of economy and the work was left incomplete.

Alexander in the meantime formed the George's Creek Coal and Iron Company and served as president of that organization from 1836 to 1845. In 1839 he visited Europe for the purpose of obtaining funds for the support of the enterprise. In 1840 he published a work entitled "Contributions to a History of the Metallurgy of Iron" which was followed in 1842 by a supplement, and constituted a "complete treatise on the subject up to his day." (Hilgard.)

To meet the needs of surveyors and engineers he then prepared a copiously annotated edition of "Simms' Treatise on Mathematical Instruments used in Surveying, Leveling, and Astronomy."

After the copies of the United States standards of weight and measure, which had been authorized by Congress for the use of the several States, had been completed, Dr. Alexander induced the Maryland Legislature to provide similar copies for the counties of that State, and was in turn charged with their construction and verification. In that connection, he prepared a comprehensive report "On the Standards of Weight and Measure for the State of Maryland," which included an account of the origin of Anglo-Saxon measures, and a résumé of legislation in England and the United States.

In 1850 Dr. Alexander published a " Universal Dictionary of Weights and Measures, Ancient and Modern " which was " one of the most complete and exact works of the kind ever published." (Hilgard.)

In 1855 he issued a pamphlet entitled " International Coinage for Great Britain and the United States," in which he explained his plan for equalizing the pound sterling and the half-eagle. He went to Europe in 1857 as the representative of the United States for the purpose of effecting arrangements for the unification of coinage, but his labors were unsuccessful, owing, as he believed, to the opposition of the bankers.

At the request of the Lighthouse Board, Dr. Alexander reported on Babbage's numerical system of lighthouses, on steam whistles as fog signals, and on illuminating oils.

At the outbreak of the Civil War he tendered his services to the Government and was appointed an engineer officer, in which capacity he aided in planning and constructing the defences of Baltimore. He also contributed largely from his own means for organizing and equipping a field battery of which his eldest son became the commander. He was about to be appointed Director of the Mint in Philadelphia in 1867, when he was attacked by pneumonia and died in his 55th year.

Dr. Alexander's published works include, besides books and pamphlets on scientific subjects (the more important of which have been mentioned above), two volumes of religious poems; and he also left behind a considerable number of manuscripts, among which was " a Dictionary of English Surnames " in 12 volumes, and " a Dictionary of the Language of the Lenni-Lenapé, or Delaware Indians."

(From J. E. Hilgard, in *Biographical Memoirs of the National Academy of Sciences*, vol. 1, 1877, pp. 213-226. See also Wm. Pinkney, " Memoir of John H. Alexander," Maryland Historical Society, 1867. 8°. Pp. 31.)

STEPHEN ALEXANDER

Born, September 1, 1806; died, June 25, 1883

Stephen Alexander was born in Schenectady, New York, and resided there until after his graduation from college. His father, Alexander Alexander, was a successful business man in Schenectady. He died when in middle life, but left his widow and two young children with sufficient means to live in comfort. Stephen was graduated from Union College in 1824, with high honors, and immediately after began teaching. He first taught in the Academy at Chittenango, New York, and later was probably connected for some time with the Academy in Albany. In 1832 he went to Princeton with Joseph Henry, who became Professor of Natural Philosophy there in that year. Henry was Stephen Alexander's first cousin and, some years later, he married Harriet Alexander, Stephen's younger sister, thus making a double relationship, which doubtless influenced Alexander's life and fortunes to a considerable extent. Alexander's first idea in going to Princeton to study was to prepare himself for the ministry of the Presbyterian Church, but in 1833 he was appointed to a tutorship in the college, and thus began his forty-three years' service as a member of the faculty. In 1834, he was made Adjunct Professor of Mathematics, and in 1840 Professor of Astronomy, which position he held until 1876, when he retired as professor emeritus.

In 1831 Alexander went to Maryland to observe the annular eclipse of February 12, and ever after that time he was intensely interested in such phenomena, never missing an opportunity to make similar observations. Between 1831 and 1875, he observed many annular eclipses, and several total eclipses. He journeyed from Georgia to Labrador to view eclipses which occurred at different dates, making many observations which he published later in a paper entitled "Physical Phenomena Attendant upon Solar Eclipses." He was not, however, a prolific writer. In fact, so much of his time was taken up with the duties of his professorship, that not a great deal was left for writing and research. He lectured almost entirely from notes, which, as a rule, were not afterwards elaborated for the press. His best and most important works, in addition to the paper mentioned above are, "The Fundamental Principles of Mathematics"; "The Origin of the Forms and the Present Condition of the Clusters of Stars and Several of the Nebulæ," and "Certain Harmonies of the Solar System." American astronomy owes much to the diligence with which he pursued his study of that branch of science and to his long-continued efforts in the training of youth.

Stephen Alexander had a scholarly interest in a great variety of subjects. He was a linguist of more than common attainments and was well versed and deeply interested in literature, history, philosophy, theology, mathematics, and several other branches of learning. He also wrote very good poetry. He died in 1883.

(From C. A. YOUNG, in *Biographical Memoirs of the National Academy of Sciences*, vol. 2, 1886, pp. 249-259.)

ALEXANDER DALLAS BACHE

Born, July 19, 1806; died, February 17, 1867

Professor Bache was in every way a remarkable man. His scholarship was without a flaw, he had a deep sense of responsibility, and he possessed to an extraordinary degree that rare power of influencing his fellowmen, beating down their opposition and molding them to his wishes, whereby he was enabled to carry out the plans which he conceived for the promotion of the welfare of mankind. He was a great-grandson of Benjamin Franklin, and was born in Philadelphia on July 19, 1806. His mental abilities were conspicuous even when he was in the lower schools. At the early age of 15 years he entered the U. S. Military Academy at West Point as a cadet, and was graduated in 1825 at the head of his class of which he was the youngest member. He was immediately appointed an assistant professor and afforded opportunities to extend his studies. At the end of a year he was at his own request detailed to assist Colonel Totten who was then engaged in the construction of Fort Adams at

Newport. In 1828 he was appointed Professor of Natural Philosophy and Chemistry at the University of Pennsylvania and soon afterwards joined the then newly-founded Franklin Institute where he enjoyed association with the principal engineers and artisans of Philadelphia. He engaged in original researches and took a prominent part in the activities of the Institute, and after a few years became the director of its scientific investigations. One of his most important labors at that time was an inquiry into the causes of the bursting of steam boilers. It soon came to the attention of the Government which made an appropriation for the expenses involved. "The conclusions arrived at were embodied in a series of propositions, which, after a lapse of more than thirty years, have not been superseded by any others of more practical value." (Henry.) At this time Bache was also a member of the American Philosophical Society and in association with Espy, Hare, Frazer and others spent much time and thought in investigations relating to meteorology and terrestrial magnetism. To the latter subject he continued to make contributions throughout his life.

In 1836 Professor Bache was prevailed upon to undertake the organization of Girard College for Orphans, then recently established in Philadelphia. He spent two years in Europe in its behalf, upon the study of the educational systems of France, Prussia, Austria and other countries, and his report, which was published in 1839, did "more, perhaps, to improve the theory and art of education in this country than any other work ever published."

A delay having occurred in the opening of Girard College, Bache undertook the reorganization of the public schools of Philadelphia and caused them to be looked upon as a model for the entire system of the United States.

In 1842, finding that the affairs of Girard College remained stationary, he returned to his professorship in the University of Pennsylvania, but the following year, on the death of Hassler, he was appointed Superintendent of the Coast Survey, for which station his qualities and his training seemed especially to fit him. He found it when its operations had extended only from Point Judith to Cape Henlopen, and when he died twenty-five years later its work had extended from Maine to Texas and throughout the Pacific Coast. When asked by members of Congress " When will this survey be completed? " he replied " When will you cease annexing territory? " At the beginning of his administration the work of the Coast Survey was not very thoroughly appreciated, but by his talents, and his industry he made it one of the strongest of the scientific bureaus of the Government. During the Civil War when the regular operations of the Survey were necessarily suspended, it gave important aid to the Government from the knowledge which as an organization it possessed regarding the coasts and harbors of the country.

In 1846 Professor Bache was named as a member of the Board of Regents of the Smithsonian Institution in the act of incorporation, and it was entirely owing to his influence that Joseph Henry was persuaded to become the Secretary of the Institution. He supported Henry in his program of organization, through the operations of which the Institution has attained its unique place among the scientific establishments of America.

Bache was also Superintendent of Weights and Measures of the United States, and a member of the Lighthouse Board, as well as of the commission of inquiry which preceded it.

During the Civil War Bache served as Vice-President of the U. S. Sanitary Commission, and also planned the defences of his native city, Philadelphia. He died at Newport on February 17, 1867, and was buried in the Congressional Cemetery in Washington where an imposing tomb was erected by the officers of the Coast Survey as a tribute to his memory.

Professor Bache was a leading mind in the formation of the National Academy of Sciences, if not its original projector. It was at his house that the plans for the Academy were formulated, and doubtless his sagacity and his knowledge of the conduct of affairs at Washington, which was probably greater than that of any other man of his time, formed a very important factor in their success.

He was elected first President of the Academy and served in that capacity from the date of its organization until his death in 1867. He was also a member of many important committees appointed on behalf of the Government, notably those on weights, measures and coinage, and on the collection of excise duties on distilled spirits.

(From JOSEPH HENRY, in *Biographical Memoirs of the National Academy of Sciences*, vol. 1, 1877, pp. 181-212*d*. See also B. A GOULD, "Address in commemoration of Alexander Dallas Bache," *Proc. Amer. Assoc. Adv. Sci.*, vol. 17, 1869, pp. 1-56.)

FREDERICK AUGUSTUS PORTER BARNARD

Born, May 5, 1809; died, April 27, 1889

President Barnard, brother of General John G. Barnard, was born at Sheffield, Massachusetts, May 5, 1809. He began the study of Latin at an early age, but later turned his attention from the classics to mathematics and allied branches of science. After his graduation at Yale in 1828, he became a teacher in the Hartford Grammar School and afterwards a tutor at Yale. In 1831 he was engaged as a teacher in the Deaf and Dumb Asylum at Hartford, Connecticut, and subsequently taught at the New York Institution for the Instruction of the Deaf and Dumb.

In 1837 he was connected with the University of Alabama in the capacity of Professor of Natural Philosophy and Mathematics for eleven years, and afterwards as Professor of Chemistry until 1854. During his connection with the University, Professor Barnard built an astronomical observatory for the institution. During this time he served as a member of a commission to settle a dispute concerning the boundary between Alabama and Florida. From 1854 to 1861 he was Professor of Mathematics and Astronomy in the University of Mississippi, was its president from 1856 to 1858, and chancellor from the latter year until 1861. The outbreak of the Civil War caused him to leave the South, and he then became director of printing and lithography in connection with the map and chart department of the United States Coast Survey.

In 1864 he was elected President of Columbia College and remained in that office until 1888 when ill health necessitated his retirement. During his administration he made many changes and improvements in the methods of instruction and the management of the University, and was also instrumental in adding the Law School, the School of Mines, the School of Political Science, and the Library of Economics. Barnard College for women, which was named for him, was established through his influence. In 1865 Dr. Barnard was president of the board of experts in the American Bureau of Mines and in 1867 served as a commissioner to the Paris Exposition. He published a report on machinery and industrial arts in 1868.

He was a man of wide learning but among the sciences his principal interest was in mathematics. Among his published works are a "Treatise on Arithmetic," "Analytic Grammar with Symbolic Illustrations," "Recent Progress of Science," the "Metric System of Weights and Measures," "Letters on College Government," and "History of the American Coast Survey."

In 1860 Professor Barnard was one of the party of astronomers who observed the eclipse of the sun in Labrador, and in 1862 he worked on Gilliss' observations of the stars of the Southern Hemisphere. He was President of the American Association for the Advancement of Science in 1860, of the American Institute in 1872, and of the American Metrological Society.

His death occurred in New York, April 27, 1889. He bequeathed his estate to Columbia University with which he had been so long connected.

JOHN GROSS BARNARD

Born, May 19, 1815; died, May 14, 1882

John Gross Barnard, born in Sheffield, Massachusetts, May 19, 1815, was descended on both sides from New England ancestors. He obtained his early education in the village school and from his uncle, who was a teacher at Hartford, Connecticut. When 14 years old, an opportunity was offered him by General Porter to enter the U. S. Military Academy at West Point.

Entering the Academy in 1829, probably the youngest pupil ever admitted there, Barnard was graduated second in a class of 43. Passing from brevet second lieutenant through all the grades, he became colonel on December 28, 1865, and later major-general in both the regular army and the volunteers.

As a civil engineer General Barnard's activities extended over all the United States, and also included surveys around the city of Mexico and on the Isthmus of Tehuantepec. Twice he was sent to Europe to collect information desired by the Government. During the Civil War, General Barnard took an active part in many battles, but his most important work was as chief engineer of the defences of Washington, where he built field-works which, while having some elements of permanency, did not require so long a time for construction as to defeat the purposes for which they were erected, and were of great value to the Government in more than one emergency. At the close of the war, General Barnard became president of the permanent Board of Engineers for Fortifications and River and Harbor Improvements. This position he held until his retirement in January, 1881. The increased size of heavy guns and the advances in naval construction having rendered the coast defences inadequate, a series of new experiments in fortification was commenced at Fortress Monroe and Fort Delaware by the engineer department. General Barnard, with a corps of assistants, visited Europe and by the study of the latest developments in the art was enabled to make most satisfactory recommendations to the board of which he was so long the president.

His writings on technical engineering were numerous. He wrote also on mathematical and other subjects, and was one of the associate editors of Johnson's Universal Cyclopedia, to which he contributed more than 90 articles. General Barnard had many intellectual interests besides his profession, among them a fondness for music. He was the author of a number of compositions, including a *Te Deum*. His death occurred on May 14, 1882, at Detroit, Michigan.

(From HENRY L. ABBOT, in *Biographical Memoirs of the National Academy of Sciences,* vol. 5, 1905, pp. 219-229.)

WILLIAM HOLMES CHAMBERS BARTLETT

Born, 1804 ~~1809~~; died, February 11, 1893

Professor Bartlett was distinguished both as a soldier and as a man of science. He was born in Lancaster County, Pennsylvania, in ~~1809~~, and early in life moved to Missouri. He was appointed to West Point from that State, graduated in 1826 at the head of his class and became second lieutenant of engineers. From 1827 to 1829 he was assistant professor in the Military Academy, and Acting Professor of Natural and Experimental Philosophy from 1834 to 1836. In the intervening years, from 1829 to 1832, he was engaged in construction work at Fortress Monroe and at Fort Adams, and from 1832 to 1834 was assistant engineer at Washington, D. C. Resigning his lieutenancy, he returned to West Point in 1836 and was appointed to the professorship of natural and experimental philosophy which he had held as an acting officer in previous years. In this position he remained until 1871. In that year, at his own request, he was retired, with the rank of colonel, and became actuary for the New York Mutual Life Insurance Company. d.o.b. 1st yr 5th Sept 1804

During the year 1840, Professor Bartlett went abroad to purchase instruments for observations at West Point and travelled extensively, visiting the principal observatories of the world. He made numerous contributions to the *American Journal of Science,* and also wrote a treatise on rifled guns which was published in *Memoirs of the National Academy of Sciences.* Among his other writings are a "Treatise on Optics"; "Synthetical Mechanics," in which are some original problems; "Acoustics and Optics"; "Analytical Mechanics"; and "Spherical Astronomy." He also wrote a textbook for military cadets, which is still used in colleges.

He died at Yonkers, New York, February 11, 1893.

(See EDWARD S. HOLDEN, in *Biographical Memoirs of the National Academy of Sciences,* vol. 7, 1912, pp. 171-193.)

ALEXIS CASWELL

Born, January 29, 1799; died, January 8, 1877

Alexis Caswell, who was descended from early settlers of New England and traced his pedigree back to Peregrine White, was born at Taunton, Massachusetts, January 29, 1799. His childhood was spent on a farm, and when he arrived at the proper age was prepared for college at Bristol Academy in Taunton. He entered Brown University at the age of 19 and was graduated in 1822, with first honors. For five years he was a tutor or professor in Columbian College, Washington, at the same time pursuing studies in theology under the guidance of the President, Dr. Staughton. After preaching a year in Halifax, he became assistant to the Rev. S. Gano, at the First Baptist Church in Providence, Rhode Island, but in the course of a few weeks he was appointed Professor of Mathematics and Natural Philosophy in Brown University. Except for a year spent in Europe, Professor Caswell performed the duties of this position for 35 years, adding to them those of the President, when Dr. Wayland's absence or indisposition necessitated a substitute. Resigning his professorship in 1863, he spent five years in pursuing his favorite studies, and was then called to the presidency of Brown University, and retained that office until 1872. A little later, Dr. Caswell was elected a member of the board of trustees of the University and in 1875 became a fellow in the corporation. The University had previously conferred on him the degrees of Doctor of Divinity and Doctor of Laws. For nearly 50 years he was closely associated with his Alma Mater, and his life work was that of an educator.

His greatest interest as a scientific investigator was in meteorology and astronomy. For 28½ years, with few interruptions, he made a regular series of meteorological observations at College Hill in Providence, the results of which were published in the *Smithsonian Contributions to Knowledge*. Adding later observations, a period of 45 years was covered. In 1858 Dr. Caswell delivered four lectures on astronomy at the Smithsonian Institution in Washington. He joined the American

Association for the Advancement of Science in 1850, and was twice elected President.

Dr. Caswell was an eminent speaker, a convincing writer, and a good citizen, taking an active part in all the interests of his city, his state and his country. He published a number of scientific papers, besides essays, biographical sketches, and sermons. His death occurred on January 8, 1877, at Providence, Rhode Island.

(From JOSEPH LOVERING, in *Biographical Memoirs of the National Academy of Sciences*, vol. 6, 1909, pp. 363-372.)

WILLIAM CHAUVENET

Born, May 24, 1820; died, December 13, 1870

William Chauvenet's father, William Marc Chauvenet was born in Narbonne, France, in 1790. Upon the downfall of Napoleon, he came to America and engaged in several unsuccessful business ventures, including a brief experiment in farming at Milford, Pennsylvania. Here his son, William, was born in May, 1820. William Chauvenet received his elementary education in the schools of Philadelphia, and at the age of 16 entered Yale College, from which he was graduated in 1840.

From an early age, he had shown a special aptitude for mathematical and mechanical studies, and soon after graduation was engaged to assist Professor Bache in magnetic observations at Girard College. Not long afterwards he was appointed a professor of mathematics in the Navy, and upon the death of Professor David McClure in 1842, was placed in charge of the naval schools, which were then located in the Naval Asylum in Philadelphia, but in 1845 were removed to Annapolis. The old plan of instructing midshipmen when at sea had proved unsatisfactory, and an eight months' course at the naval schools was substituted. This in turn seemed far from adequate, and Professor Chauvenet elaborated a plan for a regularly organized institution for the training of naval officers, and urged it upon the consideration of several successive secretaries of the Navy. It was not until 1851, however, that a regular four years' course was finally adopted. "The Naval Academy is more indebted to him than to any other for its development and organization. . . . . At first as professor of mathematics and astronomy, later of astronomy, navigation, and surveying, he was always the most prominent of the academic staff. The Academy derived reputation from his recognized ability." (Coffin.)

In 1855 Professor Chauvenet was offered the position of Professor of Mathematics in Yale College and in 1859 that of astronomy and natural philosophy. At the same time he received an offer from Washington University, then newly-founded, of the professorship of mathematics. After consideration, he accepted the position in Washington University, and in 1862, he became Chancellor of that institution. He labored assiduously and successfully in developing the University, but his health soon became impaired, and in 1869 he felt himself obliged to resign his position. He died the next year at St. Paul, Minnesota, at the age of 51 years.

Besides numerous papers on astronomical and mathematical subjects, Professor Chauvenet published several text-books of a high order of excellence. These included a work on trigonometry (1850), a manual of spherical and practical astronomy (1863), and a text-book of geometry (1870).

In addition to his abilities as a man of science and an educator, Professor Chauvenet possessed marked talent as a musical performer, and his enthusiastic interest in that art continued to the end of his life.

(From J. H. C. Coffin, in *Biographical Memoirs of the National Academy of Sciences*, vol. 1, 1877, pp. 227-244.)

JOHN HUNTINGTON CRANE COFFIN

Born, September 14, 1815; died, January 8, 1890

Professor Coffin was born at Wiscasset, Maine, in 1815. He was graduated from Bowdoin College in 1834. In 1836 he was appointed Professor of Mathematics in the United States Navy and served on various vessels. He was detailed to the Naval Observatory at Washington and placed in charge of the Mural

Circle in 1843. In 1853 he was appointed Professor of Mathematics in the United States Naval Academy at Annapolis, Maryland, and continued his work there until 1865. During the latter portion of this period, he was Professor of Astronomy and Navigation.

The same year, 1865, he had charge of the American Ephemeris and Nautical Almanac. This work was then published at Cambridge, Massachusetts, but the office was afterwards removed to Washington. Professor Coffin continued his labors in this connection until September, 1877, when he was retired from the Navy. He died at Washington, January 8, 1890.

He published a number of articles on the phases of astronomy and mathematics to which he had given special study.

JOHN ADOLPHUS BERNHARD DAHLGREN

Born, November 13, 1809; died, July 12, 1870

Admiral Dahlgren was born in Philadelphia on November 13, 1809. His father, Bernhard Ullrik Dahlgren, a Swede, was obliged to leave his native country in 1804, owing to his advocacy of republican principles. He came to America in 1806, and his government having withdrawn its opposition he obtained the post of Swedish Consul at Philadelphia. John Dahlgren attributed his inventive genius to his mother, while his desire for a seaman's life was stirred by the sight of the ships that lay at the wharves, or at the Navy Yard, at Philadelphia. Commencing his education at the Quaker School, he made such progress under the watchful care of his father that when application was made for a midshipman's place in the Navy, the heartiest recommendations were received from his instructors.

On the 12th of April orders came to proceed to Norfolk and report to Captain Barron for duty on the frigate *Macedonia,* sailing for Brazil. A cruise in the Mediterranean followed, with promotion to a lieutenancy. A little later he took part in the work of the Coast Survey. About this time a threatened loss of eyesight caused the young man to retire to a farm near Hartsville, Pennsylvania, and later he made a home for his family at Wilmington, Delaware. With restored sight, Lieutenant Dahlgren, in 1843, returned to active duty in the Navy and made a cruise of two years' duration in the Mediterranean in the ship *Cumberland*.

In 1847, being ordered to Washington on ordnance duty, Lieutenant Dahlgren began the studies and labors which in 16 years placed him at the head of the Ordnance Department of the Navy. In 1850 he announced the principles which he had evolved and after many discouragements and difficulties in protecting his inventions, and securing recognition for his ordnance system, on August 13, 1856, he was given command of the sloop-of-war *Plymouth,* with which to introduce his new weapons of naval warfare and especially his 11-inch gun. After a year's cruise, the ship returned, all objections to the heavy guns having been overcome, and their inventor after his 11 years of labor, having obtained a complete victory for his ordnance principles. At the outbreak of the Civil War, Commander Dahlgren was placed in charge of the Washington Navy Yard and made Chief of the Ordnance Bureau.

In July, 1862, he took command of the South Atlantic Squadron and the following year he was placed in charge of the fleet stationed before Charleston, S. C., succeeding Admiral Foote. For gallant conduct he received the thanks of Congress and was made a rear-admiral. At the close of the war, Admiral Dahlgren returned to Washington and subsequently was placed in charge of the South Pacific Squadron. Returning from the cruise, he took up his duties as Chief of the Bureau of Ordnance at Washington, continuing in this position until his death, July 12, 1870. He was the author of some important works on gunnery, including "Thirty-two pound Practice for Ranges," "Naval Percussion Locks and Primers," and "Shells and Shell Guns." During a period of 44 years he kept a journal which gives vivid pictures of his life and times.

(See MADELEINE V. DAHLGREN, "Memoir of John A. Dahlgren," Boston, 1882.)

JAMES DWIGHT DANA

Born, February 12, 1813; died, April 14, 1895

The Dana family is supposed to be either French or Italian in origin. Its earliest American representative was Richard Dana who came from England in 1690, and settled at Cambridge, Massachusetts. From him many men illustrious in science and literature trace their pedigree. James Dwight Dana, the oldest in a family of ten children, was born in Utica, New York, February 12, 1813. "Honesty, virtue, and industry seem almost to be our natural inheritance," was his own estimate of his home. His first instruction in science was obtained in a school conducted by Charles Bartlett at Utica, and known as the "Utica High School." In 1830 young Dana entered Yale College, attracted there, as he said, by the reputation of Professor Benjamin Silliman. Entering as a sophomore, he was graduated in 1833. By the recommendation of his professors, he received the position of instructor in the Navy, leaving New York, on August 14, of the same year, in the ship of the line *Delaware,* for a cruise to the Mediterranean. In July, 1834, he visited Mt. Vesuvius, and a letter written to Professor Silliman describing its state at that time was published in the *American Journal of Science* the following year. On his return to New York after a voyage of 16 months, Dana was invited to become assistant to Professor Silliman, which offer he gladly accepted and was thus brought into touch with the circle of scientific men at Yale. At this time he began work on his System of Mineralogy the first edition of which was published in 1837. When the United States Exploring Expedition, under Captain Wilkes, was preparing for its cruise in the Pacific Ocean, Professor Dana was selected as the mineralogist and geologist. This appointment was made in January, 1837, but the expedition did not sail until August 18, 1838. It returned to New York on June 10, 1842. Dana's letters written during the cruise are most entertaining, besides furnishing valuable geological and mineralogical information regarding the countries visited. While preparing his reports, which occupied him for a period of 13 years, Professor Dana resided for a part of the time in Washington, but after his marriage to the daughter of Professor Silliman, he made his home in New Haven, that city then offering better facilities for his work. Besides the report on geology, which formed a large quarto volume with 21 plates, he also wrote the reports on zoöphytes and crustaceans consisting of three quarto volumes, with atlases of more than 150 plates. Most of the drawings were made with his own hand.

On February 18, 1856, Dana delivered his inaugural address as "Silliman Professor of Natural History" at Yale, to which position he had been appointed in 1850.[2] During the 40 years that followed, he spent the greater part of the time not occupied by his duties as professor, in writing new general works on mineralogy and geology or preparing new editions of earlier ones, and in zoölogical and geological investigations. The titles of his communications to scientific societies and journals during this period number more than 100. The first edition of his "Manual of Geology" appeared in 1862, and in 1864 the first edition of his "Textbook of Geology." In 1868, the fifth edition of his "System of Mineralogy" was published; "a monumental work, the most complete treatise, indeed, that had ever been attempted."

In 1870, Dana began the study of the glaciers of New England and published a monograph on the geology of the New Haven region. Two years later his book on "Corals and Coral Islands" was published, and he began the study of the so-called "Taconic" rocks of New England. In 1875 he published a book called "The Geological Story Briefly Told." After some years in which ill health interfered seriously with his activities, in 1887 he visited the Hawaiian Islands, where he studied the volcanoes. He prepared at this time a work on volcanoes which was published in 1890, and another called "The Four Rocks of the New Haven Region" which appeared the following year. In 1892 he retired from his active duties as a professor in the

[2] The title was changed in 1864 to Professor of Geology and Mineralogy.

university and in 1894 became professor emeritus. He died at New Haven on April 14, 1895.

Dana took great interest in the development of the Sheffield Scientific School and the Peabody Museum at Yale. He was President of the American Association for the Advancement of Science in 1854, and of the Connecticut Academy of Arts and Sciences in 1857. For about 50 years he served as one of the editors of the *American Journal of Science.* He received the Wollaston Medal of the Geological Society of London in 1872, the Copley Medal of the Royal Society in 1877, and the Grand Walker Prize of the Boston Society of Natural History "for distinguished services in natural history" in 1892. He was the first Vice-President of the National Academy of Sciences.

(See GILMAN, D. C., The Life of James Dwight Dana, 1899; also the biographical sketch by E. S. Dana, in *Amer. Journ. Sci.,* ser. 3, vol. 49, pp. 329-356.)

CHARLES HENRY DAVIS

Born, January 16, 1807; died, February 18, 1877

Seventeen years of Admiral Davis' early life were spent almost constantly at sea, in the service of the Navy. He was born in Boston, January 16, 1807, and educated at the Boston Latin School and at Harvard College. He entered the Navy in 1823, having left college for that purpose before his course was completed, but taking his degree with the class of 1825. His first cruise was to the Pacific on board the frigate *United States,* with Commander Isaac Hull. In this cruise Davis was also with the *Dolphin,* visiting the then unknown islands of the Pacific, when a new island of the Society group was discovered. The *Dolphin* was the first American man-of-war to visit the Hawaiian Islands. Davis received his midshipman's warrant in 1829, was appointed acting sailing-master of the *Ontario,* and made a three years' cruise in the Mediterranean. Later he served as flag-lieutenant on the *Vincennes,* was connected with the naval rendezvous in Boston, and made a cruise in the *Independence.* During this voyage, the ship stopped at Southampton and Davis was in London at the time of the death of William IV, and saw the young queen Victoria. He also visited St. Petersburg and was presented at court.

During all these years he devoted himself to the study of astronomy and hydrography, and having had experience in navigation, he found the position offered him in the rapidly-developing Coast Survey most congenial to his tastes. The years 1842 to 1849 were spent in that service, during which he discovered "Davis' New South Shoal," 20 miles south of Nantucket shoals, and published several papers on the laws governing the geological action of the tidal and other currents of the ocean. His "Law of Deposit of the Flood Tide" is still an accepted authority. When the Navy Department resolved to publish an American Ephemeris and Nautical Almanac, Davis was placed in charge of the work, and by successfully establishing it, made an enduring monument to his abilities.

Enjoying the facilities of Harvard University and the Cambridge Observatory, and having built a house in Cambridge, Davis passed many happy years in the congenial society of the men of science and letters then residing there.

In 1853, he served as commissioner to the "Crystal Palace" Industrial Exhibition in New York.

After 31 years' service in the Navy, in June, 1854, he received his commission as commander, and in 1856 returned to active naval service, making several voyages, and taking part in the "Walker episode" in Nicaragua. He also published several works of value to navigators.

During the Civil War, Davis rendered efficient service on the Construction Board of the Navy, and as fleet captain in the expedition against Port Royal, and flag officer in command of the Mississippi flotilla. For his gallant conduct he was made Rear-Admiral, February 7, 1863, and received the thanks of Congress. During this year, Admiral Davis became the first Chief of the Bureau of Navigation and in 1865 assumed the superintendency of the Naval Observatory, raising it to a high degree of efficiency.

Called once more to service at sea, Admiral Davis in 1867 assumed charge of the Brazilian Squadron, when he encountered the unfortunate trouble with Lopez, which caused so much discussion in military circles. During his absence in Brazil, Harvard University conferred on him the degree of Doctor of Laws, the only instance up to that time in which it had been given to a naval commander.

Admiral Davis commanded the naval station at Norfolk for three years, returning to the superintendency of the Observatory in 1874, when he became chairman of the Transit of Venus Commission. In editing Captain Hall's journal of Arctic expeditions and in work on the naval exhibit at the Centennial Exhibition, he overtaxed his health and died at Washington, February 18, 1877. He was buried on the banks of the Charles River, overlooking the University and his old home, and a stained-glass window, bearing his record, has been placed in the Memorial Hall at Harvard.

Admiral Davis was one of the members of the "Permanent Commission" of the Navy Department, out of which the Academy appears in a measure to have developed. He was one of those most deeply interested in the Academy movement, and seems to have been the first to conceive the idea of having it incorporated under the Federal Government. He was a member of the first Council of 1863, and served on many important committees.

(From C. H. Davis, in *Biographical Memoirs of the National Academy of Sciences*, vol. 4, 1902, pp. 23-55; see also "Life of Charles Henry Davis, Rear-Admiral, 1807-1877," by the same author, 1899.)

GEORGE ENGELMANN

Born, February 2, 1809; died, February 4, 1884

Engelmann was descended on his father's side from a long line of ministers for the Reformed Dutch Church at Bacharach-on-the-Rhine, and on his mother's side from a family of Huguenot émigrés from the vicinity of Amiens. He was born at Frankfort-on-the-Main, February 2, 1809. His parents established a school for young ladies, to which both contributed their superior talents, and his earlier education was guided by them. At the age of 15 years he showed a great interest in botany, and began a collection of plants. Studying at home until his 18th year, he entered the University of Heidelberg, in 1827. Here he formed a friendship with Alexander Braun, which lasted until the death of that distinguished scientist.

Having joined in a political demonstration in Heidelberg, young Engelmann was obliged to leave the University, and went to Berlin. After two years spent there he entered the University of Würzburg, receiving the degree of Doctor of Medicine in 1831. His inaugural dissertation, relating chiefly to the monstrosities and aberrant forms of plants, and illustrated by plates made by himself, is still considered one of the most philosophical of its kind, and was highly commended at the time by the poet-philosopher Goethe. Spending the summer of 1832 in Paris with Braun and Agassiz as companions, where he says they "led a glorious life in scientific union in spite of the cholera" then raging in the city, Engelmann accepted a position as an agent of his uncles for the purchase of lands in the United States, and settled near St. Louis. He made many fatiguing horse-back journeys through the neighboring States, during which he kept a record of his botanical observations, which he afterwards used in his scientific work.

Deciding to remain in St. Louis, then only a trading post, Dr. Engelmann commenced the practice of medicine with so little means, that he was forced to part with his gun and his faithful horse to furnish his offices. Four years later, however, his practice had become very successful. Familiarity with French and German added much to this success among the early settlers who spoke those languages. This and his great professional ability brought him financial independence, but even to the last year of his life he did not hesitate to respond to the call of those desiring his aid. His vacations, spent at the Harvard gardens and herbarium in the company of his friend Dr. Asa Gray, or in Europe with his wife and son, were devoted to gathering data for his scientific work.

In later life Dr. Engelmann visited the mountain region of North Carolina and Tennessee, the Lake Superior region, the Rocky Mountains and the Pacific Coast, seeing for the first time in the native haunts many species of plants he had studied before from dried specimens, and adding to the great collections already made.

He was deeply interested in the land of his adoption and showed his devotion to its scientific welfare by his efforts in the founding of the St. Louis Academy of Science, of which he was 16 times elected President. He also delivered courses of lectures at Washington University, an institution in which he took great interest. In return, many marks of appreciation were given him, preëminently in the generosity of Mr. Shaw and others in collecting and republishing all his botanical works. His entire herbarium, comprising 100,000 specimens, and his library, including his notes and botanical sketches, have since been given by his son to the Missouri Botanical Garden, sometimes known as the Shaw Garden.

Crushed in spirit by the death of his wife and the illness of his son, in 1879 Dr. Engelmann's health was seriously impaired, but accepting Professor Sargent's invitation to accompany him to the forests of the Pacific Coast he gradually regained his spirit of cheerfulness, and though the journey was an arduous one for a man of his age he once more took up his work. In 1883 he revisited Europe, but soon after his return succumbed to the disease that had fastened itself upon him, and died February 4, 1884.

Dr. Engelmann's last publication was his meteorological work —the result of his observations for 47 years.

His botanical work was very extensive, the notes made in the examination of specimens amounting to 20,000 slips, constituting 60 quarto volumes. His studies of the cactus family, of the yucca and the agave, of the American oaks and conifers, and of North American vines, show marks of his indomitable energy and patience. His endurance as a traveller was remarkable.

His companions spoke of him as having "good spirits, good nature, and good fellowship."

(From Charles A. White, in *Biographical Memoirs of the National Academy of Sciences,* vol. 4, 1902, pp. 1-21.)

JOHN FRIES FRAZER

Born, July 8, 1812; died, October 12, 1872

The career of John Fries Frazer was largely connected with the city of Philadelphia. He was the son of Robert Frazer, an eminent lawyer, and was born on Chestnut Street, opposite Independence Hall, July 8, 1812. His grandfather was Lieutenant-Colonel Persifor Frazer, an officer in the Revolutionary War.

He first attended a school in Philadelphia, where he took high rank in study and likewise in sports, and after spending a year at the military school of Captain Partridge, at Middletown, Connecticut, became a pupil of Rev. S. B. Wylie. By him he was thoroughly drilled in the classics and in mathematics, as well as in ecclesiastical history. After graduation from the University of Pennsylvania, young Frazer served as laboratory assistant to Professor Bache. Later he held the position of assistant in the Geological Survey of Pennsylvania, and also took up the study of law in the office of John M. Scott. In due course he was admitted to practice. The physical and chemical sciences, however, proved more attractive to Frazer, and after being professor in the High School of Philadelphia for some time, he accepted the professorship of chemistry and physics in the University of Pennsylvania. This position he held till his death, when, from being the youngest member of the faculty, he had become senior professor and Vice-Provost.

As a teacher, Professor Frazer was most successful. His lectures were delivered with enthusiasm and enlivened by many anecdotes, and roused the deepest interest in the students. At the Franklin Institute, also, he carried on, with great satisfaction, the task of popularizing physical science.

After his marriage in 1838, his house became a center of social and intellectual intercourse. He had assembled a large library, with the contents of which he was so well acquainted that, on a great variety of subjects, he could turn to the exact pages of works rarely referred to, and give the desired information.

Ill health obliged him in 1867 to seek rest and recreation by journeying to Europe. He was so much benefited thereby that he was able to carry on his work again, which he did until his sudden death on October 12, 1872. This occurred on the day following the inauguration of the new University building, while superintending the transfer of his apparatus and scientific library to the shelves in his department.

(From John L. LeConte, in *Biographical Memoirs of the National Academy of Sciences,* vol. 1, 1877, pp. 245-256.)

WOLCOTT GIBBS

Born, February 21, 1822; died, December 9, 1908

Wolcott Gibbs belonged to a family in which scientific tastes were strongly manifested. His father, Colonel George Gibbs, wrote several memoirs upon mineralogical subjects, and his name was given to the mineral *Gibbsite.* His brother also attained some reputation as a geologist. On his mother's side, several of the Wolcott family held important positions under the Government, her father having been Secretary of the Treasury, a Justice of the U. S. Circuit Court, and finally Governor of Connecticut. An earlier representative of the family, another Oliver Wolcott, was one of the signers of the Declaration of Independence. The early childhood of Wolcott Gibbs was spent on the estate at Sunswick, Long Island. His father's death, when he was only 11 years old, left him to the care of his mother, who impressed on him the influence of her superior character. At a very early age, he showed a fondness for minerals and flowers. He was sent to a private school in Boston when seven years old, and his summers were spent near Newport at the home of Dr. Channing, who was a connection by marriage. Returning to New York, young Gibbs prepared for college, and entered Columbia, from which he was graduated in 1841. In his junior year he published a paper on a new kind of galvanic battery in which carbon was used, probably for the first time, as the inactive plate.

Though never practicing medicine, Gibbs obtained a diploma from the College of Physicians and Surgeons in New York, in 1845, having previously been associated with Professor Robert Hare in his laboratory at the University of Pennsylvania. To perfect his training in chemistry, Dr. Gibbs spent some time in Berlin, at Giessen, and in Paris, and among his teachers Heinrich Rose probably stands foremost in the influence which he had in turning Gibbs' attention toward analytical and inorganic chemistry.

After his return to America, Dr. Gibbs served as Professor of Chemistry in the Free Academy, now the College of the City of New York, for 14 years. Much of his time was given to research work, and in 1857, in connection with Genth, Dr. Gibbs published an important memoir on the ammonia-cobalt bases, which brought him prominently to the notice of the scientific world.

He became associate editor of the *American Journal of Science* in 1851, and furnished abstracts amounting to 500 pages to that periodical. In 1861 he published his researches on the platinum metals, which established his reputation as a chemist.

In 1863 he was called to the Rumford professorship at Harvard University. Besides lecturing on heat and light, Professor Gibbs had charge of the chemical laboratory in the Lawrence Scientific School. Associated in this school with Agassiz, Gray, Wyman, Peirce and Cooke, he carried on research work for eight years, at the same time supervising the work of the post-graduate students whose investigations were undertaken on their own initiative, with only a final examination for the bachelor's degree, after the pattern of the German schools, whose methods, through the influence of Gibbs, were thus introduced into the United States.

After the consolidation of the Scientific School with the College at Harvard, Professor Gibbs retained only the Rumford professorship. He equipped a small laboratory for himself and carried out those brilliant researches on complex inorganic acids, which brought him the highest praise. The chief piece of apparatus used in these important investigations was a cast-iron cooking stove, and the rest of the equipment was equally modest.

After the closing of the Scientific School laboratory, Dr. Gibbs lectured to small classes upon the spectroscope, and on thermodynamics. Upon his retirement as professor emeritus, he removed his private laboratory to Newport, where he had a summer home. Here he took pleasure in his garden and especially in the cultivation of roses. His death occurred on December 9, 1908, when he was nearly 87 years of age.

Gibbs wrote no books and delivered no popular lectures, but his researches and his voluminous scientific writings brought him honors from many scientific societies in Europe and America. He was the first Home Secretary of the National Academy of Sciences and its President for five years, and also presided over the American Association for the Advancement of Science in 1897.

As a citizen he was not devoid of public spirit. The Union League Club was founded at his house, and he took an active interest in the Sanitary Commission, the forerunner of the Red Cross Society.

(From F. W. Clarke, in *Biographical Memoirs of the National Academy of Sciences,* vol. 7, 1910, pp. 1-12.)

JAMES MELVILLE GILLISS

Born, September 6, 1811; died, February 9, 1865

Captain Gilliss was the eldest son of George Gilliss and Mary Melville Gilliss of Georgetown, D. C. His father, who was in the service of the Government, was a descendant of Thomas Gilliss, a native of Scotland, who settled at an early date on the Eastern Shore of Maryland. James Melville Gilliss entered the Navy, as midshipman, in 1826. He obtained leave of absence in 1833, and entered the University of Virginia, but was able to remain there only a year on account of a serious affection of the eyes, brought on by overstudy. In 1836 he was assigned to the Depot of Charts and Instruments, an office whose function was in part the rating of chronometers. Gilliss was soon placed in charge of this office and began to make observations for the determinations of time. In the winter of 1837-8 he observed a large series of transits of the moon and moon-culminating stars. When the United States Exploring Expedition sailed in 1838, Gilliss remained in Washington under orders to observe moon-culminations, occultations and transits, and continued in that work during the four years in which the expedition was absent. He published the first American volume of astronomical observations, prepared the first catalogue of stars and constructed a working astronomical observatory. At the same time he carried on magnetic and meteorological observations.

Gilliss pursued his investigations with remarkable energy and studious application and was possessed of extraordinary powers of sight which enabled him to make extremely accurate observations.

The establishment of the U. S. Naval Observatory in 1842 was brought about largely through the efforts of Gilliss, and he was charged with the preparation of the plans for the construction of the building and the arrangement of the instruments. In 1846 he was assigned to duty in the Coast Survey under Professor Bache.

At the suggestion of Dr. Gerling of Marburg, he initiated a movement for an expedition to Chile, for the purpose of observing the planet Venus and in 1849 established a station at Santiago where for nearly three years he carried on observations of Venus and Mars, together with meridian observations of 2,000 stars and also zones of about 23,000 stars, as well as observations on earthquakes, and barometer and thermometer readings.

From 1852 to 1856 he was occupied in preparing the report of this expedition which comprises six quarto volumes. In 1858 he made a brief expedition to Peru and in 1860 to Washington Territory for the purpose of observing the total eclipse of the sun. In 1861 he was placed in charge of the U. S. Naval Observatory, in which office he remained until his death in 1865.

(From B. A. GOULD, in *Biographical Memoirs of the National Academy of Sciences*, vol. 1, 1877, pp. 135-179.)

AUGUSTUS ADDISON GOULD

Born, April 23, 1805; died, September 15, 1866

Dr. Gould was born in New Ipswich, New Hampshire, April 23, 1805. His father was a teacher of music and a skilful engraver, but turned his hand to many things, among which was the management of a small farm on which he lived. From 1817 to 1820 he was a member of the State Legislature. The care of the little farm among the hills demanded the help of his son Augustus, who at 15 years of age took entire charge of it. Having a desire to obtain more education than he had received at the common school, young Gould by great industry succeeded in gaining the preparation for entering Harvard College, which he did in 1821. During his whole course he maintained himself by hard work and in strict economy. He studied medicine in Boston, and after spending one year as resident student in the Massachusetts General Hospital, received his doctor's degree in 1830. He was still obliged to perform many hard tasks to gain the means of support, and among these we find mention of cataloguing and classifying 50,000 pamphlets in the Boston Athenæum Library. Natural history was always his favorite study, and he became a member of the Boston Society of Natural History soon after its formation, and labored afterwards for it until his death, rising at four o'clock in the morning and working on the collections before his professionial duties began. His first collections were of insects, but afterwards he turned his attention to mollusks. He prepared a volume of nearly 400 pages, on invertebrate animals of Massachusetts, illustrated by more than 200 drawings which he made with his own hand from nature. This attracted much attention from naturalists both at home and in Europe, and received special commendation from the elder Agassiz. In 1848, Dr. Gould, in collaboration with Agassiz, published a text-book for schools on the principles of zoölogy. He also edited the unfinished work of his friend, Dr. Amos Binney, on the terrestrial air-breathing mollusks of the United States.

Dr. Gould made his greatest contribution to natural history by the work done on the collection made by Captain James P. Couthouy, U. S. N., when attached to the United States Exploring Expedition. As all the notes were lost, and various restrictions were made as to the manner of doing the work, the task was a perplexing one.

Besides his papers on natural history, which number more than 100, he also published medical addresses and reports, which were of great value to his profession. He was President of the Massachusetts Medical Society, and for several years consulting physician of the Massachusetts General Hospital. The church to which he belonged, and the public schools were benefited by his labors. Untiring in his work he was still hoping to attain better results as a physician and naturalist, when he was suddenly attacked by cholera, and died on September 15, 1866.

(From WYMAN and DALL, in *Biographical Memoirs of the National Academy of Sciences*, vol. 5, 1905, pp. 91-113.)

BENJAMIN APTHORP GOULD

Born, September 27, 1824; died, November 26, 1896

The life of Benjamin Apthorp Gould was intimately connected with the city of Boston. Born there on September 27, 1824, he received his early education from his father, a teacher of acknowledged merit, and entered Harvard College in 1844. For a short time after graduation, he was head-master of the Roxbury Latin School. Though early in his college course he showed a fondness for the classics, the later years were devoted largely to mathematics, and he thus laid the foundation for his future work.

In 1845 Gould went to Europe, and spent three years in astronomical study at Berlin, Paris, Göttingen and other cities. He received the degree of Doctor of Philosophy from the

University of Göttingen, and contracted friendships with many distinguished scholars. It is said that through the influence of Alexander von Humboldt, Gould obtained a home in the family of the astronomer Gauss. The favorable impression he made at that time was no doubt the cause of his being offered the chair of Professor of Astronomy in the University of Göttingen, and Director of the Observatory. Though this was considered a high honor, the first of the kind, probably, paid to an American, Dr. Gould declined the position, in spite of the fact that it was urged upon him a second time. His desire was to mark out for himself an astronomical career in America.

From 1852 to 1867 Dr. Gould was connected with the Government service, carrying forward, under the Coast Survey, the work begun by Bache and Walker in fixing the longitude of places in the United States.

During this period he served as Director of the Dudley Observatory at Albany, assisted in reducing and computing astronomical observations made at the Naval Observatory in Washington, and made some valuable contributions to astronomical literature, which added greatly to his European reputation. During the Civil War, Dr. Gould served for a time as Actuary of the United States Sanitary Commission.

In 1861, he married Mary Apthorp Quincy, daughter of Rev. Josiah Quincy, and by her aid he was able to build an observatory at Cambridge, and engage in astronomical observations, which he did for several years.

In 1870 Dr. Gould went to the Argentine Republic for the purpose of organizing a government observatory at Cordoba. He remained in Argentina for 15 years and devoted himself to the study of the southern celestial hemisphere, the crowning work of his life. The loss of his two elder children by drowning and afterwards the death of his wife, who had ever aided him in his labors, bore heavily upon his spirits, but after the last of three trips to his home in Boston, he resolutely returned alone to Cordoba to complete his task. When in 1885 he finally came back to this country he brought with him 1400 photographic plates of southern stellar clusters. To the measurement and reduction of these he devoted the rest of his life, and had the satisfaction of seeing the last of these results printed in the *Astronomical Journal,* which was brought to him a few hours before his death. For the continued publication of the *Journal* he had made adequate provision. A public dinner was given Dr. Gould on his arrival in Boston, presided over by Hon. Leverett Saltonstall, Dr. Oliver Wendell Holmes welcoming him by a poem from "his celestial wanderings back to earth." In his later years Dr. Gould did valuable work for the American Metrological Society of which he was at one time president.

He was one of the founders, and first president, of the Colonial Society of Massachusetts, and received the honorary degree of Doctor of Laws from Harvard and Columbia. Many distinguished societies enrolled him among their members, and he was made a Knight of the Order of Merit in Prussia, a distinction given to only two other Americans. His life ended by an accident on the evening of Thanksgiving Day, November 26, 1896.

(From the biographical sketch by ANDREW McF. DAVIS, in the *Proceedings of the American Antiquarian Society,* April, 1897.)

ASA GRAY

Born, November 18, 1810; died, January 30, 1888

Asa Gray was of Scotch-Irish ancestry, and was born at Paris, New York, November 18, 1810. His father was a farmer and tanner. Asa, the oldest of eight children, assisted his father, and attended the country school. Later, he attended the grammar school at Clinton, New York, and was also a student at Fairfield Academy for four years. His first interest in natural science was aroused by the lectures of Dr. James Hadley at the Fairfield Medical School.

His taste for botany was aroused by reading in Brewster's Edinburgh Encyclopædia and Gray soon became interested in collecting plants about Fairfield, besides making excursions to other parts of the State of New York. In 1829 he became a student at Fairfield Medical School and received a doctor's degree in 1831, but never practiced. While a student, Dr. Gray assembled quite an extensive herbarium, and many mineralogical specimens, and began a correspondence with Dr. Lewis C. Beck of Albany and Dr. John Torrey of New York. After teaching at Bartlett's High School, giving a course of lectures on botany at the Fairfield Medical School and on botany and mineralogy at Hamilton College, Dr. Gray was called to New York as assistant to Professor Torrey. From this time, his attention was chiefly given to botany, and some original papers were soon published. In 1835 Gray became Curator and Librarian of the Lyceum of Natural History in New York, and issued in 1836 his first text-book, the "Elements of Botany." The Wilkes Exploring Expedition, to which he had been appointed botanist, failing to sail until two years later than the time originally set, he accepted the chair of botany at the newly-founded University of Michigan, with the condition that he be permitted to spend a year in Europe. The University proved unable, however, to meet its engagements and Dr. Gray returned to New York and continued work on the "Flora of North America," which he had begun in 1836, in collaboration with Professor Torrey. The first volume of this important treatise appeared in 1838, and the second in 1843.

Attracting the favorable notice of President Quincy of Harvard, the newly-endowed Fisher Professorship of Natural History was soon offered him. Dr. Gray entered on his duties there in 1842.

Having married, he established himself in Cambridge and surrounded himself with books and plants. His home soon became a center for the study of botany by students both old and young. Out of his small salary, Gray contrived to find means to carry on his investigations in botany and to accumulate specimens, so that in 1865, when he presented his collections to the Harvard College, the herbarium contained more than 200,000 specimens and the library about 2,200 books.

From the beginning of his botanical work, Dr. Gray believed that the description and classification of the flowering plants was of the utmost importance and after thirty-five years spent in the development of this branch of botany he could safely be said to stand at the head of American systematists, and ranked with the great botanists of the world. His "Botanical Text-book," "Manual of the Botany of the Northern United States," and "How Plants Grow," and "How plants Behave" have been of inestimable value to American students of botany. He died on January 30, 1888.

(From W. G. FARLOW, in *Biographical Memoirs of the National Academy of Sciences,* vol. 3, 1895, pp. 161-175. See also the biographical sketches in the "Memorial of Asa Gray," published by the American Academy of Arts and Sciences, 1888, and by JAMES D. DANA, in *Amer. Journ. Sci.,* ser. 3, vol. 35, 1888, pp. 181-203.)

ARNOLD GUYOT

Born, September 28, 1807; died, February 8, 1884

Guyot was descended from one of the Protestant families which settled in Neuchâtel after the revocation of the edict of Nantes, and was born at Boudevilliers on September 28, 1807. He was named after the Swiss patriot Arnold von Winkelried. His boyhood was passed at Hauterive, and from his home there he had glorious views of the Bernese Oberland, the Jungfrau, the Schreckhorn, and other mountain peaks, which must have helped to inspire in him the love of nature which he manifested early in life.

Young Guyot's first school days were spent at La Chaux-de-Fonds, a village "at the foot of a narrow and savage gorge of the Jura," 3,070 feet above the sea. At the age of 14 he entered the College of Neuchâtel, where he pursued classical studies and also formed a friendship with Leo Lesquereux, the botanist, which lasted throughout his life. In 1825 Guyot went to Germany to complete his education. He spent some months at Metzingen, and later at Carlsruhe in the family of Mr. Braun, the father of Alexander Braun, the distinguished botanist and philosopher, where he met Agassiz, Schimper, Imhoff, and other naturalists. After a short sojourn in Stuttgart, Guyot returned to Neuchâtel in 1827. Here, under the preaching of the Reverend Samuel Petit-pierre, he turned from science to theology, and began to prepare himself for the church, although his leisure hours were still spent in collecting plants and shells, and in other scientific activities.

In 1829 he went to Berlin, chiefly to attend the lectures of Schleiermacher, Neander and other historians and theologians at the University of Berlin, but he also became interested in those of Hegel, Steffens, Hofmann, Dove, and other professors of the scientific faculty, and made the acquaintance of Humboldt. After a little time he found his inclinations toward the study of nature so strong that he abandoned theology for natural science. While in Berlin, Carl Ritter, the geographer, made an especially strong impression on him and turned his mind in the direction of geographical studies. At the end of five years at the University of Berlin, he received the degree of Doctor of Philosophy, taking as the subject of his graduating thesis "The Natural Classification of Lakes."

After leaving the university, he went to Paris and became tutor to the children of Count de Pourtalès-Gorgier, and with them he visited the Pyrenees and travelled in Italy, Belgium, and Holland, and along the Rhine. While in Paris in 1838, he was urged by Agassiz to take up the study of the glaciers of the Alps, to which he himself had attracted the attention of the scientific world the preceding year by the announcement of his glacial theory.

Guyot acceded to the request of his friend and spent some weeks in an examination of the Alpine glaciers. He made several important original discoveries regarding their structure and action, but as it had been agreed between himself and Agassiz that his special field should be considered to be the phenomena of the Swiss erratic boulders, his results were withheld from publication for forty years. He did, however, present a communication on the "blue bands" of glaciers and the inclination of their strata before the Neuchâtel Society of Natural Sciences in December, 1841, the substance of which was cited by Agassiz in his " Système Glaciaire " in 1847.

In 1839 Guyot returned from Paris to Neuchâtel, joined the Society of Natural Sciences, and accepted the chair of history and physical geography at the post-graduate school known as the " Academy." Here he remained for ten years, during which time he engaged in extensive investigations; " meteorologic, barometric, hydrographic, orographic and glacialistic." For seven years his principal work related to the Swiss erratic boulders. His results were to have appeared in the second volume of Agassiz's work on glaciers, but unfortunately the enterprise was terminated abruptly by the outbreak of the revolution of 1848. The Academy was suppressed, and the professors, including Guyot, were left without occupation. Guyot was urged by Agassiz to come to the United States, which he finally decided to do. He arrived in August, 1848, and the following winter delivered a course of lectures before the Lowell Institute in Boston on " Comparative Physical Geography," which he spoke of as " a brief epitome of his teaching in Neuchâtel." They were delivered in French and afterward translated into English by Professor Felton, and published under the title of " Earth and Man."

After this time Guyot was occupied for six years, under the auspices of the Massachusetts Board of Education, in lecturing to teachers on geography and methods of teaching, and also prepared a series of geographies and maps for schools which had a very extensive use throughout the country.

In 1854 Guyot was appointed Professor of Physical Geography and Geology at Princeton. Besides carrying on his professional duties, he lectured in the State Normal School of New Jersey, and the Princeton and Union Theological Seminaries. He delivered two courses of lectures at the Smithsonian Institution, one in 1853 on the " Harmonies of Nature and History," and the second in 1862 on " Unity of Plan in the System of Life." He also interested himself at Princeton in organizing a museum, which Libbey has called "The most substantial monument that Professor Guyot has left behind him in Princeton."

Soon after coming to the United States, Guyot made the acquaintance of Joseph Henry, who consulted him regarding the development of the system of meteorological observations, and also entrusted him with obtaining improved instruments. He prepared directions for meteorological observations for the Smithsonian Institution in 1850, and a volume of meteorological and physical tables, which was published originally in 1852, and has passed through several editions. Under the joint auspices of the Smithsonian Institution and the State governments of New York and Massachusetts, Guyot located meteorological stations throughout the States mentioned. In 1861, on the occasion of a visit to Europe, he instituted a comparison of American and European barometers. "It is believed that these comparisons establish a correspondence of the European and American standards within the narrow limit of one or two thousandths of an inch." (Henry.)

For thirty years Guyot carried on, largely with the encouragement of the Smithsonian Institution, extensive barometric investigations throughout the mountain ranges of the Atlantic slope, from the White Mountains of New Hampshire to the Smoky Mountains of North Carolina. He made thousands of barometric measurements of altitudes, including those of Mount Washington and other high peaks, which were remarkable for their exactness.

He died at Princeton on February 8, 1884.

(From JAMES D. DANA, in *Biographical Memoirs of the National Academy of Sciences*, vol. 2, 1880, pp. 309-347.)

JAMES HALL

Born, September 12, 1811; died, August 7, 1898

James Hall was of English parentage, and was born in Hingham, Massachusetts, on September 12, 1811. In 1831, he began studies in natural history under Amos Eaton at the Rensselaer School (now the Polytechnic Institute) in Troy, New York, where he afterwards occupied the chair of geology until 1876, at which time he became professor emeritus. He was appointed assistant geologist in the geological survey of the Fourth District of New York in 1836, and the following year, as geologist, was placed in charge of the work of this western district. He published reports annually from 1838 to 1841, and in 1843 a final report in quarto form—one of the series of volumes on the natural history of the State printed by order of the Legislature. In this, the fossils, the lithological characters of the rocks, and the succession of the strata are fully described. The same year Hall was appointed paleontologist of the State and continued in that position until 1874. The principal work of these years is embodied in the eight volumes of the "Paleontology of New York" which has been described as "one of the most remarkable monuments of scientific labor, zeal, and industry, which this country has produced." In order to trace the western extension of the New York strata, Hall studied the formations of the Mississippi Valley and the Rocky Mountains. In 1855, he was appointed Geologist of Iowa, and in 1857 Geologist of Wisconsin, and the results of his western investigations are largely embodied in the reports of the surveys of those States. In 1858, he received the Wollaston Medal of the Geological Society of London, of which he was a foreign member. At about this time he took up the study of the graptolites of the so-called Quebec group, and in 1865 published an elaborate monograph in the 20th Report of the New York Cabinet of Natural History. He was the Director of the New York State Museum from 1866 to 1893.

In 1876, he aided in organizing the International Congress of Geologists, and was Honorary President of the Congress held in Washington in 1891. He was also the first President of the Geological Society of America in 1889.

In addition to his work on the paleontology of New York, Professor Hall wrote the paleontological portions of the reports of various surveys of the Western Territories under the Government, including those of the Frémont Expedition, the Stansbury

Expedition, and the first United States and Mexican Boundary Survey. He also contributed many papers to the *American Journal of Science* and to the transactions of American and foreign scientific societies.

Besides paleontological investigations, he engaged in the study of the crystalline structure of the rocks, and "was the first to point out the persistence and the significance of mineralogical characters as a guide to their classification." He also devoted attention to questions of dynamic geology, especially in relation to the structure of mountain ranges. He died on August 7, 1898, at the advanced age of eighty-seven years, at Echo Hill, New Hampshire.

JOSEPH HENRY

Born, December 17, 1799; died May 13, 1878

The life of Henry may be properly divided into three periods; his early years, the period during which he was a professor in the Albany Academy and at Princeton University, and the period during which he was Secretary of the Smithsonian Institution. Simon Newcomb said of him in 1880:

> "Few have any conception of the breadth of the field occupied by Professor Henry's researches, or of the number of scientific enterprises of which he was either the originator or the effective supporter. What, under the circumstances, could be said within a brief space to show what the world owes to him has already been so well said by others that it would be impracticable to make a really new presentation without writing a volume."

Henry was born on December 17, 1799, at Albany, New York. He was of Scotch descent, and both his maternal and paternal grandparents came to New York at the same time in 1775. His early years were spent at Albany and at Galway, a village near Saratoga. His father was William Henry, his mother Annie Alexander, an aunt of Stephen Alexander, also one of the incorporators of the Academy.

As a boy he was imaginative. His mind ran on romance and adventure, and his reading was made up largely of novels, poetry and plays. He even organized an amateur dramatic company, and took part as an actor or directed the acting of others. When about sixteen years old a copy of Gregory's "Lectures on Experimental Philosophy, Astronomy and Chemistry, intended chiefly for the Use of Young Persons" fell into his hands and, "although by no means a profound work," made so strong an impression on him that he at once resolved to devote himself to the pursuit of knowledge. He attended a night school, and afterwards the Albany Academy, and also engaged in the study of medicine. Having occupied himself for a little time as a private tutor and a surveyor, at the age of twenty-six he became Professor of Mathematics in the Albany Academy.

Here in 1827 he began that most important series of investigations which in a few years placed him at the head of American men of science. In 1832 he was elected Professor of Natural Philosophy at Princeton University, then the College of New Jersey, and during the fourteen years in which he occupied this position, all his spare time was spent in original research in electro-magnetism, the results of which were published at frequent intervals. Regarding these investigations the Academy registered its opinion in 1876 in the following terms:

"*Resolved,* That in response to the letter of the British Minister, Sir Edward Thornton, asking the Academy for a suggestion as to the names and services of persons considered eligible to receive the Albert Medal of the Society of Arts, to reward 'distinguished merit in promoting arts, manufacture, or commerce,' the Academy suggest the name of Professor Joseph Henry as most worthy of all living Americans to receive that recognition. They base this suggestion upon his distinguished merit in the following respects, viz.:

"1. As being the first to develop the power of the electro-magnet as actuated by an intensity or a quantity battery.

"2. As the first to apply the electro-magnet in the invention of an electro-magnetic telegraph.

"3. As the first to invent a machine to be moved by electro-magnetism.

"4. For the application of the electro-telegraph to forecasting the weather.

"5. For the plan of the Smithsonian Institution for the increase and diffusion of knowledge among men, and the successful development of this plan during an administration of more than twenty-five years as Scientific Director of this Establishment.

"6. For the improvement in fog-signals in connection with the United States Light House Board, and discoveries in sound." [3]

[3] Proc. Nat. Acad. Sci., vol. 1, p. 114, April, 1876.

In 1846 Henry resigned from Princeton and became the first Secretary of the Smithsonian Institution, then just established. The following year he presented his plan of organization and from that time until his death in 1878, a period of 31 years, he devoted all his energies to its practical development, whereby he gained an unique position among American men of science and made the Smithsonian Institution better known throughout the world than any other American institution. "His original investigations during his thirty years at the Smithsonian Institution," remarks Dr. Goode, "were not of great extent; but his influence, not only upon the development of scientific work in the United States, but upon its character, cannot be overestimated. His official position brought him into constant contact, either personally or by letter, with all in the United States who were engaged in scientific work, and the inspiration and direct control which he exercised were constant and far-reaching." Such researches and studies as he undertook had their origin chiefly in problems encountered or brought to his attention in the course of his administrative work. They related to a great variety of subjects—acoustics, meteorology, education, the phenomena of physical and organic forces, evolution, the qualities of building materials and of illuminating oils, etc.

In 1852 he was appointed by President Fillmore a member of the Lighthouse Board. Early in the Civil War he, with Professor Bache and Admiral Davis, was appointed by the Secretary of the Navy on the commission to investigate various practical questions connected with the operations of the Navy. It was the work of this commission that appears to have suggested the organization of the National Academy of Sciences in the form which it finally assumed. Henry, according to his own utterances, did not take part in its organization but he was one of the charter members and the chairman of the first committee of the Academy, that on weights, measures and coinage. In 1866 he was elected Vice-President, and in 1868 became President, his term of office extending over eleven years.

(From SIMON NEWCOMB, in *Biographical Memoirs of the National Academy of Sciences*, vol. 5, 1905, pp. 1-45, and G. BROWN GOODE, in "The Smithsonian

Institution, 1846-1896, the History of Its First Half Century," Washington, 1896, p. 115. See also the sketch by WM. B. TAYLOR, entitled "A Memoir of Joseph Henry," in *Bulletin of the Philosophical Society of Washington*, vol. 2, pp. 230, and 368, 1879; and that by JAMES C. WELLING, entitled, "Notes on the life and character of Joseph Henry," in the same publication, pp. 203-229.)

JULIUS ERASMUS HILGARD

Born, January 7, 1825; died, May 9, 1890

Julius Erasmus Hilgard was born at Zweibrücken, Rhenish Bavaria, January 7, 1825. His father, Theodore Erasmus Hilgard, was for many years Chief Justice of the Court of Appeals, but on account of his liberal opinions was so dissatisfied with conditions in his native country that in 1835 he emigrated to America. The journey from his native place to Havre was made in wagons. After a voyage of 62 days, the family landed at New Orleans at Christmas, and journeyed up the Mississippi to St. Louis, and thence to a farm at Belleville, Illinois. As the oldest son, Julius gave valuable help by his practical talents. His education was carried on at home. Music, chemistry, ancient and modern languages and mathematics (the higher branches of the latter being studied without outside help), occupied his attention until 1843, when he went to Philadelphia to study engineering and to obtain employment. In that city he made the acquaintance of Professor Bache, and commenced a life-long friendship with Elisha Kent Kane, the arctic explorer.

The first work obtained was in the preliminary surveys of the Bear Mountain Railroad. Soon, however, Professor Bache, recognizing his abilities, procured young Hilgard a position in the Coast Survey, in which service he continued, with short interruptions, until his death. In the field work, in computations and investigations in the office, in the publication of the records and results of the Survey, in his influence on political leaders, Mr. Hilgard rendered highly intelligent and valuable aid to the service. During the failing health of Professor Bache, Hilgard, who was at that time in charge of the Coast Survey office, was obliged to perform the duties of Superintendent, which he did without extra compensation until the appointment of Benjamin Peirce to the position. Though it seems fitting that Hilgard should have become Superintendent upon the death of Bache, he did not receive the appointment until 1881. At that time his health was so impaired that, as he said, " it came too late." He was soon forced to resign. While Assistant Superintendent, his work in the Office of Weights and Measures gained him most favorable notice in Europe and he was invited to the directorship of an International Bureau of Weights and Measures about to be established in Paris. Declining this, but continuing his connection with the International Committee, a beautiful Sèvres vase was presented to him by President Thiers on behalf of the French Government in recognition of his services. He also had great satisfaction in being instrumental in bringing to a successful ending the operations for the telegraphic determination of trans-atlantic longitudes.

Among his other valuable services, Hilgard delivered in 1876 a course of twenty lectures at Johns Hopkins University on the subject of " Extended Territorial Surveying."

Resigning his position in July, 1885, he lived in retirement for five years, and died at Washington, May 9, 1890.

(From E. W. Hilgard, in *Biographical Memoirs of the National Academy of Sciences*, vol. 3, 1895, pp. 327-338.)

EDWARD HITCHCOCK

Born, May 24, 1793; died, February 27, 1864

Edward Hitchcock was born in Deerfield, Massachusetts, in 1793. His parents were intellectual, high-minded, and deeply religious people, and from them he inherited on the one hand his interest in religion and theology, and on the other his love of learning, and the inquiring turn of mind which early in life led to a persevering study of science. He began teaching when only 22 years of age, first in his native town, and later in Conway, Massachusetts. Ten years later, at the age of 32, he became Professor of Chemistry and Natural History at Amherst College. Although interested in many subjects, he devoted almost all of his time to geology, and in 1830 was made chief of the Geological Survey of Massachusetts. In 1836, he was appointed Geologist of the First District of New York, and in 1857, State Geologist of Vermont. Dr. Hitchcock was the first to suggest and carry on the survey of the State of Massachusetts, which was the first, not only in the long series of surveys subsequently carried on in the United States, but the first survey of an entire State under government authority inaugurated anywhere in the world. For his extensive and important work in geology he received the honorary degree of Doctor of Laws from Harvard at the age of 47. His name will always be closely associated with the beginnings of geology in this country. He has, indeed, been called one of the fathers of American geology. He was the first to give a scientific exposition of the so-called "bird tracks" in the Red Sandstone of the Connecticut Valley, and this new science, which began with him, he termed ornithichnology. The paper was published in 1836, and was followed from year to year by descriptions of his investigations, tables of species and other articles.

In 1840 he was elected the first President of the American Association for the Advancement of Science, which was organized at that time, and in 1845 was made President of Amherst College, and Professor of Natural Theology and Geology, which positions he held until 1854. His life was closely connected with Amherst, from the very beginning of the college, and in his own presidency he established it on a firm financial footing, besides elevating the standard of study. He also procured for it a number of buildings, increased and improved the equipment, and enlarged the number of students. He died the year after the National Academy of Sciences was organized.

(From J. P. LESLEY, in *Biographical Memoirs of the National Academy of Sciences,* vol. 1, 1877, pp. 113-134.)

JOSEPH STILLMAN HUBBARD

Born, September 7, 1823; died, August 16, 1863

As Hubbard died within a few months after the Academy was formed, his influence upon that organization was, of course, but slight. It is of interest, however, to summarize his scientific labors if for no other reason than to show why he was chosen a member of the Academy.

Hubbard's family settled in Ipswich, Massachusetts, in 1635, but afterwards moved to Meridian and New Haven, Connecticut. His ancestors were for the most part clergymen and physicians, and several of them held important public offices.

As a boy, Hubbard showed a decided taste for mechanics and astronomy. He was graduated from Yale College in 1843 and the following year went to Philadelphia as assistant to the astronomer Walker in the High School Observatory, working with such zeal as to seriously impair his health. After some months he went to Washington and computed the observations made by Frémont on his expedition to the Rocky Mountains and the Pacific Coast. The next year (1845), he was appointed a professor of mathematics in the Navy and assigned to duty at the Naval Observatory.

Here he made observations for several years with the transit instrument and meridian circle, working particularly on a system of zone observations devised by Professor Coffin and himself. These observations were interrupted soon after 1850, but taken up again in 1862 and continued by Hubbard until his death.

His first extended computation consisted in the determination of the zodiacs of all the known asteroids. This was followed by a study of the orbit of the great comet of 1843. In 1846 Hubbard began an extended investigation of the peculiar phenomena presented by Biela's comet, and later published three memoirs relating to them. He also undertook an investigation of the Fourth Comet of 1825.

Hubbard was deeply interested in the establishment of the *Astronomical Journal,* and his contributions to it occupy more than 200 columns. His astronomical calculations also fill many pages of the Washington Observations. One of his last researches related to the magnetism of iron ships, a subject which a committee of the Academy afterwards investigated at the request of the Navy Department.

Hubbard was present at the meeting in New York at which the Academy was organized and welcomed its inauguration in his enthusiastic manner as " the most important epoch ever witnessed by science in America." He was not destined, however, to contribute to its developments as he died a few months later, his demise having been hastened, as some have believed, by the unhealthy surroundings of the old Naval Observatory at Washington in which he labored.

(From B. A. GOULD, in *Biographical Memoirs of the National Academy of Sciences,* vol. 1, 1877, pp. 1-34.)

ANDREW ATKINSON HUMPHREYS

Born, November 2, 1810; died, December 27, 1883

Andrew Atkinson Humphreys was of Welsh ancestry. He came from a family of naval constructors—his grandfather having been the architect of the *Constitution,* and her five sister frigates. After his graduation from the U. S. Military Academy at West Point, Lieutenant Humphreys was assigned to the Second Artillery, and served in the South, taking an active part in the Florida War. Resigning his commission on account of impaired health, he served for two years as a civil engineer under Major Hartman Bache. On July 8, 1838, he became assistant in the Bureau of Topographical Engineers at Washington. While in this position he prepared the first project for the extension of the National Capitol. In 1844 he was detailed as assistant in charge of the Coast Survey Office. After eighteen years of work in his profession he entered upon the great labors of original research and administrative direction, which have made his name illustrious. The Government having turned its attention to the question of reclaiming the lands along the Mississippi subject to inundation, and subsequently making two appropriations of

$50,000 each, the Delta Survey was formed, and Captain Humphreys undertook with what would now be considered inadequate means, the task of solving the problems of controlling the mighty river, which the sufferers from flood personified as "an evil spirit, which periodically reared his tawny front from the chasm where he writhed in uneasy slumber at low water." "Captain Humphreys conducted for ten years a series of researches which accomplished their object, and which have placed his name high on the list of the distinguished hydraulic engineers of the world." (Abbot.) His arduous labors performed under a burning sun, caused a "coup de soleil" in the summer of 1851, which obliged him to suspend work. When somewhat recovered, he obtained permission to visit Europe for the purpose of studying methods of protection against inundation and returned in 1854 ready to renew operations on the Mississippi. In the meantime, however, the question of a railroad to the Pacific Coast had arisen, and the Secretary of War, appreciating Humphreys' great ability, insisted upon having him as his confidential adviser. In this work, and in preparing reports on the Mississippi enterprise, he was occupied until the Civil War. He served throughout that war with the Army of the Potomac, and rose to the command of an Army corps. The two corps of engineers having been consolidated during the war, he was appointed brigadier-general and chief of engineers, discharging the duties of this office until, at his own request, he was placed on the retired list on June 30, 1879. After his retirement he contributed to the Scribner's Series a history of his campaigns in two small volumes based on an analysis of the official records of both armies, that has been said by General Abbot "to be worthy of a place beside Cæsar's Commentaries or Xenophon's Anabasis."

In 1857 General Humphreys was elected a member of the American Philosophical Society. He was also an honorary member of the Imperial Geological Institute of Vienna, and a fellow of the American Academy of Arts and Sciences.

Subsequent to 1863 when he became one of the incorporators of the National Academy of Sciences, many honors and degrees were conferred on him at home and abroad. General Abbot remarks that the keynote to his whole life may be found in his own words: "I cannot understand how any man can be willing to assume charge of a work without making it his business to know everything about it from A to Izzard."

(From HENRY L. ABBOT, in *Biographical Memoirs of the National Academy of Sciences,* vol. 2, 1886, pp. 201-215.)

JOHN LAWRENCE LE CONTE

Born, May 13, 1825; died, November 15, 1883

Among the many families of Huguenots who fled from France after the revocation of the edict of Nantes, may be found the name of LeConte. The family was of noble birth and possessed of wealth, and no small number of its members had that spirit of scientific investigation, which characterized so many of the refugees. John Lawrence LeConte traced his descent from Guillaume LeConte who was born in Rouen in 1859. John Lawrence LeConte was born in New York, May 13, 1825. After taking a collegiate course at St. Mary's College in Emmettsburg, Maryland, he entered the College of Physicians and Surgeons in New York, from which he was graduated in 1846.

Possessing an independent fortune, he practiced his profession but to a limited extent, though during the Civil War he entered the army medical corps of the volunteers, becoming medical inspector, with the rank of lieutenant-colonel. After this, he held no regular position until 1878, when he became connected with the United States Mint in Philadelphia, remaining there until his death on November 15, 1883.

As early as 1848, Dr. LeConte made several journeys to Lake Superior and California to study the fauna, and later travelled more extensively, visiting the Rocky Mountains, Honduras and Panama, Europe, Egypt and Algiers. He inherited from his father a taste for natural history and at the early age of nineteen he published a paper describing over twenty new species of Carabid beetles from the eastern United States.

His attention was next drawn to certain anomalies of geographical distribution and his extensive studies of the problems resulted in the publication of several important papers on that general subject. Dr. LeConte's father had made the Coleoptera his favorite study and had also published papers on mammals, reptiles, batrachians, and crustaceans. He had collected a large amount of material relating to the natural history of our insects, and made a series of water-color illustrations of them and also of plants. The son carried on the work thus begun, and during his lifetime published more than 60 monographic essays—some of them large works—on the Coleoptera and other groups of insects, investigating as far as practicable all the various phenomena connected with their life-histories. He devoted himself especially to systematic work, in a manner new in America in his time, defining more than 1,100 of the higher groups, and forming nearly 250 synoptic or analytic tables. Half of the Coleoptera of the United States were described by him for the first time. So extensive and important was his work that he may with safety be called the greatest of American entomologists. That he was so regarded abroad is evidenced by the fact that he became an honorary member in all the older and larger entomological societies of Europe.

In 1861, as the result of many years of systematic study of American beetles, he published the first part of a classification of the Coleoptera of North America, the second part appearing the following year, and in 1873, a third part of the same work. In the meantime, he had reached the conclusion that the Rhynchophora, or weevils, represented a quite distinct group of Coleoptera, and in 1876, in association with Dr. Horn, his former pupil, he published a thorough monographic revision of this group, which completely revolutionized the accepted classification of the day. Finally, in 1883, a few months before his death, he published (also with Dr. Horn as joint author) a new

"Classification of the Coleoptera of the United States," in which much of his previous work was revised and brought up to date.

Between 1848 and 1857, Dr. LeConte published minor essays on geology, on radiates, on recent and fossil mammals, and on ethnology, thus showing the wide range of his scientific studies and investigations. While accepting the modern evolutionary philosophy, he still believed, as he expressed it, in the "Providence which presides over and directs the system of evolution."

In his private life his friends speak of him as "a cultured scholar, a refined gentleman, a genial companion, a true friend."

(From SAMUEL H. SCUDDER, in *Biographical Memoirs of the National Academy of Sciences*, vol. 2, 1886, pp. 261-293.)

JOSEPH LEIDY

Born, September 9, 1823; died, April 30, 1891

At the memorial meeting held at the University of Pennsylvania, Dr. Joseph Leidy's scientific career was commemorated under five heads: "Work in Vertebrate Anatomy"; "Work in Invertebrate Anatomy"; "Work in Paleontology and Geology"; "Work in Mineralogy"; "Work in Botany." The catalogue of his writings contains five hundred and fifty-three titles, a remarkable contribution to scientific literature. This many-sided scientist, "almost the sole survivor of that class of intellectual giants which seemed able to assimilate as much as Science in her many forms could produce," was born in Philadelphia on September 9, 1823. He was the son of Philip Leidy. At an early age he showed a taste for the study of nature and a talent for drawing. He began the study of medicine at the age of nineteen, and received his degree at the University of Pennsylvania in 1844, immediately after which he was appointed Prosector to the chair of anatomy under Professor Horner. With the exception of one year, when he followed his teacher, Dr. Paul M. Goddard, to the Franklin Medical College, Dr. Leidy continued his connection with the University during his life. At the death of Dr. Horner, in 1853, he was elected Professor of Anatomy and held that position for thirty-eight years. In 1871 he became Professor of Natural History in Swarthmore College, in Swarthmore, Pennsylvania.

In 1881 he was chosen President of the Academy of Natural Sciences of Philadelphia; in 1884, Director of the Biological Department of the University of Pennsylvania; and in 1886, President of the Wagner Free Institute. Among the honors he received at this period should be mentioned the Walker Prize (which was doubled in special recognition of his services), the prize of the Royal Microscopical Society, the Lyell Medal of the Royal Geological Society, and the Cuvier Medal of the Academy of Sciences of Paris.

"The bare enumeration of his published works, extensive in length and in variety though it be, would give those who had never seen this great naturalist no idea of the man or of the source of this combination of versatility and accuracy which rendered almost every observation he made directly or indirectly an addition to science. In all that pertained to the acquisition of facts and to coördinating them afterwards he made of himself a perfect machine in so far as he was insensible to and unaffected by the ordinary passions of ambition or rivalry which influence even the best scientists. He had a marvelous eye for noting the minutest phenomena and appreciating the most insensible differences; he had an unusually retentive memory for recording and keeping in order the vast fund of his observations and the records of those made by others; and he was conscious of the limitations of pure inductive philosophy to an extent which made the conclusions reached by him safe." (Frazer.)

During the Civil War Dr. Leidy acted as surgeon of the Satterlee Hospital in Philadelphia. Leidy's name is not only remembered by his remarkable contributions to anatomy, paleontology, and other sciences, but in the lofty Rockies stands "Mt. Leidy," named by Dr. Hayden, the distinguished explorer and geologist; and "Cape Leidy," on the coast of Grinnell Land is a token of the devotion of Drs. Kane and Hayes to their college friend.

The love of flowers and of gems was a feature of Dr. Leidy's character. His knowledge of them often served to correct errors that had crept into collections as well as to entertain his friends. No one loved social intercourse better than he, and his conversation was always instructive and charming.

He died in his native city on April 30, 1891.

(From PERSIFOR FRAZER, "Joseph Leidy, M. D., LL. D.," in the *American Geologist*, January, 1892. See also WILLIAM HUNT, "An Address Upon the Late Joseph Leidy, M. D., LL. D.," Philadelphia, 1892; and "In Memoriam, Dr. Joseph Leidy, Personal History," read before the Academy of Natural Sciences, Philadelphia, May 12, 1891; HENRY F. OSBORN, "Joseph Leidy," in *Biographical Memoirs of the National Academy of Sciences*, vol. 7, p. 335.)

J. PETER LESLEY

Born, September 17, 1819; died June 1, 1903

Peter Lesley, the fourth of that name, was born at Philadelphia on September 17, 1819. The first Peter Lesley was remembered as the "Miller of Fifeshire," and his descendants were of mingled Scotch and German blood and were noted for their practical traits and thorough education. It appears to have been Lesley's father's intention to prepare him for the church, but his health was so precarious while he was in college that an out-of-door life was imperative. Through the interposition of Professor Bache, he obtained appointment in 1838 as an assistant on the first Geological Survey of Pennsylvania. The personal knowledge of the poor and ignorant German settlers, which he obtained during two seasons spent in the field, turned Lesley's thoughts toward missionary work, and in 1841 he entered the Princeton Theological School. After studying three years and obtaining his license, he determined on a trip to Europe, largely to perfect his knowledge of German. He travelled on foot through England and France and afterwards through Switzerland, where the geological features of the country aroused his strongest interest. He then settled at Halle to study German, and also attended the lectures of Tholuck and other theologians.

On his return to America in 1845, he spent two years in missionary work in Pennsylvania, after which he was invited to assist Professor H. D. Rogers in Boston in preparing a map of Pennsylvania, showing the work of the first geological survey of the State. After a winter spent in Boston, Lesley was for three years pastor of a church in Milton, Massachusetts, at the end of which time, his religious views having undergone a change which made it impossible for him to remain a clergyman, he resigned his parish in May, 1852, and went to Philadelphia. Afterwards he was engaged for a period of about ten years in surveys of iron, coal and oil fields for the Pennsylvania Railroad and other companies, as well as on his own account. During the summer of 1855, Lesley performed a notable piece of geological work, consisting of a survey of the Broad Top Mountain region of central Pennsylvania, which included a contour-line map of the semi-bituminous coal-field, " with over eleven thousand stations levelled." In 1856, he became Secretary of the American Iron Association, which necessitated his visiting all the iron works of the United States. He published at this time a large volume of statistics of the iron industries, also the " Iron Manufacturers' Guide," and his " Coal Manual."

In 1858 he was elected librarian of the American Philosophical Society, which position he held for twenty-five years, giving much time and attention to the duties of the office. In 1860 he became interested in a process for the desulphurization of coal, but it was not financially successful, and he confined his energies thereafter to scientific and literary work. In 1862 and 1863 he was engaged in surveying at Glace Bay, on the coast of Cape Breton, and in the latter year made a trip to Europe to study the Bessemer steel process.

During the season of 1865-66, Lesley delivered a course of lectures before the Lowell Institute in Boston, choosing for his subject " Man's Origin and Destiny."

Ill health again obliged him to desist from work, and he spent a year in Europe and a winter on the Nile. After his return, in 1869, he became editor of the *United States Railroad and*

Mining Register, and from that time until 1872 was engaged chiefly in surveys in the South. In the latter year he was appointed Professor of Geology in the School of Mines of the University of Pennsylvania. In the organization of the Towne Scientific School Professor Lesley took great delight and gave much time and thought to his teaching, which was always a favorite work, and aroused enthusiasm in his pupils.

The crowning event of his life was, however, his appointment to the office of State Geologist of Pennsylvania, which occurred in 1874. The second Geological Survey of Pennsylvania was an undertaking of great magnitude and extended over a period of 20 years. Lesley organized it with much care, and had as his assistants Frazer, Stevenson, Prince, Chance, D'Invilliers, Genth, and many other geologists and chemists. To the publication of results he gave the closest personal attention. His system was to publish numerous "reports of progress," each containing all the data relating to a single district or county. More than a hundred such volumes were issued, and at the end a final report summarizing the whole. He had nearly finished this latter work when in 1893 his health gave way completely, and he was obliged to desist. Sir Archibald Geikie said of the survey in a letter written at this time "It is in my opinion a monument of patient skill, thoughtfully organized, sympathetically carried on, and admirably co-ordinated, through all its branches and all its progress. I think it will be of the utmost value industrially to the State of Pennsylvania."

Lesley remained some years in Philadelphia, and afterwards returned once more to Milton, Massachusetts, where he died in June, 1903.

(From Mary Lesley Ames, "Life and Letters of Peter and Susan Lesley," 1909.)

MIERS FISHER LONGSTRETH

Born, March 15, 1819; died, December 27, 1891

Longstreth was born in Philadelphia in 1819. He was educated in the schools of the Society of Friends, and his early life was spent as a merchant. He devoted his leisure hours, however, to the study of astronomy, and had charge of the Friends' Observatory on Cherry Street, Philadelphia, until 1856. He entered the University of Pennsylvania, and was graduated from the medical department. Afterwards he removed to Sharon Hill, Pennsylvania, and engaged in the practice of medicine. He still devoted much of his time to astronomy, and wrote many valuable papers relating to that branch of science. These were published in the *Transactions of the American Philosophical Society,* of which Dr. Longstreth had been a member since 1848. He was of a retiring disposition and declined public office. For forty years, however, he served on private and public educational boards.

DENNIS HART MAHAN

Born, April 2, 1802; died, September 16, 1871

Dennis Hart Mahan was born in the city of New York, but his parents soon moved to Norfolk, Virginia, where his boyhood was spent. He was brought up with the idea that he would be a physician, but having a talent for drawing, and learning that this was taught at West Point, he sought and, through the good offices of a friend of the family, obtained admission into the Military Academy. From this institution he was graduated in 1824, at the head of his class, which numbered thirty-one students. In his third year at the Academy he was appointed Acting Assistant Professor of Mathematics. Following graduation he became a lieutenant in the Corps of Engineers, and after holding the position of instructor for two years in the Academy was sent to Europe to study engineering works and military institutions. In France, by special permission of the Government, he studied for more than a year in the military school at Metz, and became associated with many prominent French military engineers and artillerists, and was often the guest of the family of Lafayette.

He returned to America in 1830 and was detailed as acting professor at West Point. Two years later he vacated his commission in the Engineer Corps, and became Professor of Civil and Military Engineering. In this important position he remained for a period of more than forty-one years, during which both the Mexican War and the Civil War occurred. "His teachings bore glorious fruit upon the fields of Mexico," and during the Civil War, "with hardly an exception on either side, those who had studied under Professor Mahan had won the highest laurels." (Abbot.)

Mahan published many text-books on civil and military engineering. These comprised a "Treatise on Field Fortifications" (1836), "Course of Civil Engineering" (1837), one on "Permanent Fortifications," "Advanced Guard, Outpost and Detachment Service of Troops" (1847), "Industrial Drawing" (1855), and "Treatise on Fortification Drawing and Stereotomy" (1865). Some of these works passed through several editions. His treatise on civil engineering was reprinted in England and also translated into several foreign languages. Professor Mahan also published an American edition of Moseley's "Mechanical Principles of Engineering," in which many of his own ideas were incorporated. This was originally published in 1856 and reprinted in 1869.

In 1871, on account of his advanced age and impaired health he was recommended by the board of visitors to the Academy for retirement, and although the President gave him assurances that no action would be taken on the recommendation, he was so deeply wounded in spirit that overcome by dejection he threw himself from the steamboat on which he was journeying to New York to consult his physician.

(From Henry L. Abbot, in *Biographical Memoirs of the National Academy of Sciences*, vol. 2, 1886, pp. 29-37.)

JOHN STRONG NEWBERRY

Born, December 22, 1822; died, December 7, 1892

General Roger Newberry, grandfather of John S. Newberry, was one of the proprietors of the Connecticut Land Company, which owned the northern part of Ohio, known as the Western Reserve. His son, Henry Newberry, located his father's land on the Cuyahoga River and founded there a town, to which he moved with his family in 1824. John Strong Newberry, the youngest of nine children, was two years old at this time, having been born at Windsor, Connecticut, December 22, 1822. The flora and fauna about his home, and the fossils found in his father's coal mines roused in his youthful mind an interest in nature, and we find him making large collections before he entered college. Preparing in a special school, he matriculated at the Western Reserve School, and was graduated in 1846. During the last two years of his course he studied medicine and afterwards entered the Cleveland Medical School, from which he received the degree of Doctor of Medicine in 1848. Subsequently he spent two years in Paris in medical studies, and engaged in the practice of his profession for four years at Cleveland, Ohio. During all this time, he continued his natural history studies and published several papers. Dr. Newberry was appointed in 1855 assistant surgeon in the U. S. Army and botanist and geologist to the expedition, which, under the command of Lieutenant R. S. Williamson, explored the country between San Francisco Bay and the Columbia River. Returning to the capital in 1856, while preparing his report, Dr. Newberry served for one year as Professor of Chemistry and Natural History in Columbian College, now George Washington University. The following year he acted as physician and naturalist to the Ives Expedition, and in 1859 as geologist of the San Juan Exploring Expedition. In these two positions the work was very arduous, as journeys were made through some of the wildest portions of the Western country, but much valuable scientific material was gathered. The report of the San Juan Expedition was not published for seventeen years, owing to the unsettled state of the nation caused by the Civil War. Thus, Dr. Newberry lost much credit due to him as an original geological and ethnological observer.

Abandoning his scientific work at the breaking out of the War, Dr. Newberry entered the sanitary service, where, as secretary of the western department of the United States Sanitary Commission, he showed his great executive ability, and received the highest commendation. His report made to the Government consists of 543 octavo pages. At the close of the War, he became scientific associate of the Smithsonian Institution for one year. In 1866 he entered on his chief life-work as Professor of Geology and Paleontology at the School of Mines of Columbia University, which position he held for twenty-six years. The fine museum containing many fossils, rocks and minerals collected by him, and the rejuvenating of the old Lyceum, now the flourishing New York Academy of Sciences, are notable results of the efficient labor of that period.

Dr. Newberry retained his residence in Cleveland, and from 1869 to 1874 was Director of the Geological Survey of Ohio, but after the failure of the Legislature to provide funds, he returned to New Haven, where he died, December 7, 1892. He had served as President of the Torrey Botanical Club in 1880. His part in the U. S. Geological Survey was the investigation of the fossil fishes and some of the fossil plants of the United States. He was one of the organizers of the International Congress of Geologists, of which he was elected President for the Washington meeting of 1891. In 1888 he received the Murchison Medal of the Geological Society of London, and the same year was elected first Vice-President of the Geological Society of America.

Dr. Newberry's published writings numbered over two hundred, besides editorial work in geology and paleontology for Johnson's Cyclopedia.

(From CHARLES A. WHITE, in *Biographical Memoirs of the National Academy of Sciences*, vol. 6, 1909, pp. 1-24.)

HUBERT ANSON NEWTON

Born, March 19, 1830; died, August 12, 1896

Professor Newton was born on March 19, 1830, at Sherburne, New York. His parents were descended from early settlers of Massachusetts and Connecticut, who had moved westward into what was then the wilds of central New York. Newton showed at an early age a taste for exact studies which he seems to have inherited from his father. After attending the schools of Sherburne, he entered Yale College and was graduated in 1850. He became tutor there in 1853, and on the death of Professor Stanley, the Corporation appointed Newton, at the early age of twenty-five to the professorship of mathematics, a position which he held until his death. Early in his career he spent a year in studies in Europe, and was greatly influenced by the teaching of Chasles of Paris in higher geometry, which influence showed itself in his contributions to the *Mathematical Monthly* in 1858 and the three following years. Although this branch of science for many years was his favorite study, Professor Newton ultimately turned his attention to astronomy, and especially to the subject of meteors or "shooting stars." The wonderful display of meteors in 1833 had created such an interest in the country, and so much material had been collected concerning previous showers, that in 1861 the Connecticut Academy of Arts and Sciences appointed a committee of which Professor Newton was a member, to promote systematic observations on the August and November showers in different localities. As an aid to this work, he prepared a valuable map of the heavens for plotting meteor tracks, and as a result of his studies of the observations, published in 1865 a paper on the paths of more than a hundred meteors, observed on the nights of August 10 and November 13, 1863. Continuing his researches on the orbits of meteoroids, and the times of their reappearance, Professor Newton solved many important problems regarding them, and raised this branch of research to an honorable place in astronomical science. M. Faye remarked of his results in 1867, in the *Comptes Rendus,* "We may find in the works of Mr. Newton, of the United States, the most advanced expression of the state of science on this subject."

From meteors he turned his attention to statistical studies of the orbits of comets, and in the following years published several important papers containing the results of his investigations of the relationships of these two classes of celestial objects. Important as were these researches, his serious life work was that of an instructor in the University with which he was connected for so long a time. "If from all those who have come under his instruction we should seek to learn their personal recollections of Professor Newton, we should probably find that the most universal impression which he made on his classes was that of his enthusiastic love of the subject which he was teaching." (Gibbs.)

In 1882 the observatory was established at Yale and Professor Newton, to whom it largely owed its existence, was the first director. He introduced there the use of the photographic camera to record the tracks of meteors, and in one instance, through a simultaneous observation of Mr. Lewis at Ansonia, was able to calculate the course of a meteor in the earth's atmosphere.

He was naturally interested in collections of meteoric stones and the fine series in the Peabody Museum is largely the result of his efforts.

Professor Newton was one of the founders of the American Metrological Society, and for several years was President of the Connecticut Academy of Arts and Sciences. In 1864 he became associate editor of the *American Journal of Science.* He was awarded the first Lawrence Smith Medal by the National Academy of Sciences in 1888. He died in New Haven on August 12, 1896.

(From J. WILLARD GIBBS, in *Biographical Memoirs of the National Academy of Sciences,* vol. 4, 1902, pp. 99-124.)

BENJAMIN PEIRCE

Born, April 4, 1809; died, October 6, 1880

An important incident in Professor Peirce's boyhood was his acquaintance with Dr. Nathaniel Bowditch, whose son was a schoolmate. In the dedication of one of his books he speaks of Dr. Bowditch as "my Master in Science, Nathaniel Bowditch, the father of American Geometry."

Professor Peirce was born in Salem, Massachusetts, April 4, 1809, and entered Harvard College in 1825. Dr. Bowditch had at that time removed to Boston, and young Peirce assisted him in reading the proofs of his translation of Laplace's Mécanique Céleste.

For two years after his graduation, Professor Peirce taught at Northampton, Massachusetts. In 1831, he was appointed a tutor in Harvard College, and in 1833 was elected Professor of Mathematics and Natural Philosophy. Afterwards he was called to the Perkins chair of mathematics and astronomy, which he occupied until his death.

During the first years of his professorship, he published a series of text-books for use in colleges. The first was a "Treatise on Sound," and was followed by one on "Plane and Solid Geometry," a "Treatise on Algebra," and a treatise on "Plane and Spherical Trigonometry." These books produced very beneficial effects on the methods of teaching mathematics.

In 1841, Professor Peirce began a work on "Curves, Functions and Forces," two volumes of which appeared at intervals. In place of the third volume, he published in 1855, his "Analytic Mechanics." This was rather a treatise than a text-book, and exhibits in a striking manner Peirce's peculiar mathematical powers, and his concise and logical style. In 1842, he began work on the mathematical part of the "American Almanac," of which he prepared ten volumes. One of these contained a list of the known orbits of comets, to which he added several approximate orbits for historic comets that had been imperfectly observed.

In 1849, Congress established a bureau for the publication of the "American Ephemeris and Nautical Almanac," under the supervision of Admiral (then Lieutenant) Charles H. Davis, and Professor Peirce was appointed consulting astronomer. To his work while in this position may be attributed largely the high character which this publication attained. For it he prepared his "Tables of the Moon," which were used for many years. After the discovery of the planet Neptune, Professor Peirce took great interest in the researches of Leverrier and Adams, and his papers written on the disputed questions regarding this newly-found body excited much discussion among astronomers.

In 1852, Professor Bache, then Superintendent of the United States Coast Survey, obtained the help of Professor Peirce in preparing the longitude determinations in the Survey, and from the work he then did appears to have originated his article in Gould's *Astronomical Journal,* entitled " Criterion for the Rejection of Doubtful Observations." " It would seem almost certain that ' Peirce's Criterion,' or possibly some modified form of it, will in time secure general acceptance. In any case, it will ever stand as the first, and as a satisfactory solution of this delicate and practically important problem of probability."

For seven years Professor Peirce was Superintendent of the United States Coast Survey, having been appointed in 1867 after the death of Professor Bache. While in this position, he made several tours of inspection, and raised the standard of the service by giving greater freedom to the officers of the corps, placing responsibility on each person engaged in the work, and giving aid to all scientific work connected with the Survey. As Superintendent he took personal charge of the expedition to Sicily in 1870, to observe the eclipse of the sun which occurred in December of that year. By his efforts as a member of the Transit of Venus Commission, a party from the Coast Survey was sent to Nagasaki, and another to Chatham Island, to take part in the observations on the occasion of this important astronomical event.

In 1864, Professor Peirce read his first paper before the National Academy of Sciences, and from 1866 to 1870 a series of papers that were published later in his " Linear Associative Algebra." This work he pronounced " the pleasantest mathematical effort of my life," and a writer has said of it that it " must ever remain a monument to the comprehensive grasp of thought and analytical genius of its author."

Interested in all astronomical questions, and especially those concerning the solar system, Professor Peirce studied the nebular hypothesis, the rings of Saturn, the phenomena of comets and meteors, and many other topics, and published many papers relating to them. His last contributions to science were a series of eight propositions in cosmical physics, and his "Lectures on Ideality in Science."

Besides his additions to the literature of science, Professor Peirce assisted in the organization, in 1855, of the Dudley Observatory at Albany, and was instrumental in the establishment of the observatory at Harvard University. He died at Cambridge October 6, 1880.

(From *Proc. Amer. Acad. Arts and Sci.*, new series, vol. 8, 1881, pp. 443-454.)

JOHN RODGERS

Born, August 8, 1812; died, May 5, 1882

Admiral John Rodgers, the third of that name, was the grandson of John Rodgers, who came from Glasgow, and settled in Harford County, Maryland. The elder Rodgers was a colonel of the Maryland line in the Revolutionary War, and among his descendants were several sailors and soldiers who rendered valiant service to their country.

John Rodgers, third, was born at Sion Hill, near Havre de Grace, Maryland, on August 8, 1812. His mother was the daughter of Gideon Denison, who was a native of Connecticut and noted as an Indian fighter. With such an ancestry it is not strange that we find John Rodgers a midshipman in his sixteenth year. He served three and a half years at sea, spent one year at the Naval School at Norfolk, and another at the University of Virginia, then, three years on the South American Station. While he was on the Florida coast, Lopez, the Cuban insurgent, was pursued by the *Pizarro,* a Spanish sloop-of-war, but Rodgers with the *Petrel,* a small schooner of one gun, prevented his capture. The charts of the Florida coast prepared by Rodgers at this period have been of great service.

In 1852 Rodgers joined the North Pacific Exploring and Surveying Expedition in command of the steamer *John Hancock,* and on the retirement of Commander Ringgold, owing to ill health, was placed in charge of the Squadron. He made extensive explorations and deep-sea soundings in the northern waters, and obtained valuable knowledge of the surrounding territory. Nearly forty sea charts were based on these surveys.

During the Civil War, Commander Rodgers performed arduous and gallant service in southern waters. He was made captain in 1862 and given command of the *Weehawken,* one of the new monitors, which headed the line in the attack on Fort Sumter, April 7, 1863. For his bravery in the engagement with the *Atlanta,* Secretary Welles recommended that he be promoted to the rank of commodore, and receive the thanks of Congress. After the War, when in command of the Squadron which convoyed the monitor *Monadnock* to San Francisco, Commodore Rodgers so guarded the American interests, during the hostilities between the South American Republics and Spain, especially in the threatened bombardment of Valparaiso, that he received special commendation of the Navy Department.

From 1866 to 1869, Commodore Rodgers was in charge of the Boston Navy Yard, and in the latter year promoted to the grade of rear-admiral. Ordered to the command of the Asiatic Squadron, Admiral Rodgers, sailed in 1871 to Corea, where in consequence of treachery five forts were taken and destroyed.

In 1872 Rodgers became President of the Naval Examining and Retiring Board, and after four years of service at the Navy Yard at Mare Island, he was appointed Superintendent of the Naval Observatory in Washington. By his advice, a site on Georgetown Heights was bought for a new observatory, but the building was not completed until after his death. He was successful in obtaining from Congress an appropriation of $1000 a year for the purchase of new books, by means of which he formed one of the best astronomical and mathematical libraries in the country.

Added to his duties at the observatory, Admiral Rodgers was called upon for extra service as President of the Transit of Venus Commission, of the Naval Advisory Board, of the *Jeannette* Relief Board, and as chairman of the Lighthouse

Board. In the last position he visited many stations, and took part in many experiments, both in acoustics and optics. This work, while adding to his fame, was a severe strain upon his physical forces. A serious illness overtook him, and he died at the Barber house, the site of the New Observatory, on May 5, 1882, after fifty-four years of public service.

(From ASAPH HALL, in *Biographical Memoirs of the National Academy of Sciences*, vol. 6, 1909, pp. 81-92. See also CHARLES O. PAULLIN, " Services of Commodore John Rodgers in the War of 1812," and " In Our Wars with the Barbary Corsairs "; also " A Biography of Commodore John Rodgers.")

FAIRMAN ROGERS

Born, November 15, 1833; died, August 22, 1900

The faculties that gave Fairman Rogers prominence as a man of science seem to have been inherited in large part from his father, Evans Rogers, and from his maternal grandfather, Gideon Fairman, who was a noted inventor. He was born on November 15, 1833 in Philadelphia, and while yet in the preparatory school gave promise of a brilliant career. He entered the University of Pennsylvania in 1849, and was very successful in his studies, especially in the physical sciences, so much so that Dr. John F. Frazer, then Professor of Chemistry and Physics in the University, foreseeing a brilliant future for his pupil, not only aided him in his class work, but introduced him to his scientific acquaintances. Two years after graduation, Mr. Rogers became connected with the United States Coast Survey, and in 1857 assisted Professor Bache in determining the Epping base-line in Maine. At this time he was Professor of Civil Engineering in the University of Pennsylvania, and also lectured at the Franklin Institute, and later at Harvard University. In 1861 he delivered a course of lectures in the Smithsonian Institution, on the construction of roads and bridges, and, later, a course on glaciers. He also made a survey of the Potomac River for the United States Coast and Geodetic Survey.

At the beginning of the Civil War, Professor Rogers served as first sergeant of the Philadelphia city cavalry in a three months' campaign, and later, as a volunteer engineer officer, in the Philadelphia Militia, was present at the battles of Gettysburg and Antietam.

In his connection with the National Academy of Sciences, Professor Rogers made a study of the compasses of the iron vessels used in the service of the Government. This investigation led him to write a treatise on the "Magnetism of Iron Vessels" which was published in the van Nostrand Science Series.

Severing his connection with the University of Pennsylvania in 1881, after being nine years a trustee of that institution, Professor Rogers became chairman of the Committee on Instruction at the Academy of Fine Arts, reorganized its system and rendered valuable services in other directions for several years.

Professor Rogers was one of the founders of the Union League Club of Philadelphia. He exhibited the versatility of his mind by writing a treatise on horsemanship and a manual of coaching, in which he endeavored to show that these arts were properly based on scientific principles. Credit for suggesting to Professor Muybridge the principle to be employed in photographing animals in motion has been given to Professor Rogers and modifications of this principle form the basis of the present day biograph and cinematograph. He died at Vienna on August 22, 1900.

He was the first Treasurer of the National Academy of Sciences and served in that capacity for eighteen years.

(From EDGAR F. SMITH, in *Biographical Memoirs of the National Academy of Sciences,* vol. 6, 1909, pp. 93-107.)

ROBERT EMPIE ROGERS

Born, March 29, 1813; died, September 6, 1884

Robert Empie Rogers was the youngest of four brothers, all of whom became eminent as men of science. His father, Dr. Patrick Kerr Rogers, emigrated from Ireland in 1798, and after living in Philadelphia and Baltimore for several years, became Professor of Natural Philosophy and Mathematics in William and Mary College. Robert who was born at Baltimore, March 29, 1813, was only seven years old when his mother died. He was tenderly cared for, however, by Rev. Adam P. Empie and his wife, and in gratitude to them he adopted Empie as his middle name. Although his brothers, after his father's death, favored the idea of his becoming a civil engineer, he was more inclined toward teaching, and in preparation for this work continued his studies in botany, geology, and mineralogy. He added to these a medical course at the University of Pennsylvania. Though receiving a doctor's degree in 1836, he did not practice medicine but turned his attention to chemistry, in which he had become deeply interested, and joined his brother Henry as chemist of the first Geological Survey of Pennsylvania. In March, 1842, he had the gratification of receiving an appointment as Professor of General and Applied Chemistry in the University of Virginia. In conjunction with his brothers James and William, Dr. Rogers made many experiments, wrote numerous valuable scientific papers, and published text-books on chemistry. Indeed, so intimately were the four brothers connected in their researches that the results were often spoken of as those of "the brothers Rogers." No jealous rivalry existed among them.

At the death of James, in 1852, Robert was chosen to fill his place as Professor of Chemistry in the University of Pennsylvania, and afterwards became dean of the medical faculty. To his numerous duties he added those of assistant surgeon in the Military Hospital, and while showing a woman the dangers connected with the use of a steam mangle, he was so unfortunate as to lose his right hand. He soon learned to use his left hand and his right arm with great skill in carrying on his experiments. In 1872 Dr. Rogers took part in an investigation concerning the waste of silver in the United States Mint at Philadelphia, and devised new methods of refining precious metals. He also prepared the plan for the refinery at the San Francisco Mint. On account of changes in the administration of the University of Pennsylvania, Dr. Rogers, after twenty-five years of service in that institution, withdrew from it, and accepted in 1877 the chair of chemistry in the Jefferson Medical College. In 1884 he became professor emeritus, and died on September 6, of the same year.

As indicating the practical side of Dr. Rogers' mind it should be recalled that he was the inventor of a steam boiler, known as the Rogers and Black boiler, and also made improvements in electrical apparatus.

His courage in an emergency is shown by the fact that three times he rescued persons from certain death. His success as a teacher was undoubted, due probably in large part to the love and respect he inspired in his pupils, his fine literary style, and his great cleverness in experimentation.

(From EDGAR F. SMITH, in *Biographical Memoirs of the National Academy of Sciences*, vol. 5, 1905, pp. 291-309.)

WILLIAM BARTON ROGERS

Born, December 7, 1804; died, May 30, 1882

The name of Rogers is a prominent one in the history of American science. The son of Dr. Patrick Kerr Rogers, a native of the north of Ireland, William Barton Rogers was one of four brothers who attained celebrity in their chosen fields of research. He was born in Philadelphia and educated at William and Mary College, and delivered his first lectures at the Maryland Institute. He succeeded his father in 1828 as Professor of Chemistry and Physics in the college from which he was graduated.

In 1835 he was called to the University of Virginia as Professor of Natural Philosophy and also appointed Geologist of Virginia. Professor Rogers gained the greatest popularity by his scholarly exposition of the subjects which he presented in public addresses, not only at the University of Virginia, but also before the British and the American Associations for the Advancement of Science, and the other scientific bodies with which he was connected. His rare gifts of diction and poetic expression, united with a voice of commanding quality and a distinguished personal appearance, gave him preëminence among the scientific lecturers of his time. He and his brothers Henry and Robert performed most important work for American geology by presenting the results of their observations in a series of papers of enduring importance. The wave theory of mountain chains, which was the result of extended study of the Appalachian chain in Pennsylvania and Virginia, excited great interest at the time of its presentation and was confirmed by later observations.

Removing to Boston in 1853, Professor Rogers was associated with the American Academy of Arts and Sciences, and the Boston Society of Natural History. At this time, his work was largely in physics. The variations of ozone in the atmosphere, improvements of the Ruhmkorff coil, some phenomena of sight and the properties of sonorous flames were among the subjects he investigated. He was appointed by Governor Andrew inspector of gas and gas-meters for the State of Massachusetts, and made a visit to Europe, in 1864, to study the latest methods. At this time he delivered at Bath a paper before the British Association for the Advancement of Science. The establishment of the Massachusetts Institute of Technology of which Professor Rogers was the first president, was due to his labors which continued until his death. Physical inability obliging him to desist for a while from active work and finally to resign the presidency, though remaining professor emeritus of physics and geology, his last act was performed in the interest of the students. Rising to present the diplomas to the graduating class he had uttered but a few words, when he fell lifeless to the platform. Thus on the 30th of May, 1882, was closed a life devoted to the search of scientific truths and their presentation in a manner so attractive and so convincing as to impress their importance on the minds of others.

Professor Rogers was the third President of the National Academy of Sciences and served from 1879 to 1882.

(From Francis A. Walker, in *Biographical Memoirs of the National Academy of Sciences,* vol. 3, 1895, pp. 1-13.)

LEWIS MORRIS RUTHERFURD

Born, November 25, 1816; died, May 30, 1892

Lewis Morris Rutherfurd numbered among his ancestors some who were prominent in the early history of the United States, including Senator John Rutherfurd, Lewis Morris, Chief Justice of New York and New Jersey, who was also the first Governor of New Jersey, and that other Lewis Morris who signed the Declaration of Independence.

The subject of the present brief sketch was born in Morrisania, now a part of New York City, November 25, 1816. After his graduation from Williams College in 1834, he served as assistant to the professor of physics and astronomy in preparations for experiments, and in the construction of apparatus. Law studies in the office of William H. Seward occupied his attention for two years, and later he became a partner of Hamilton Fish.

Mr. Rutherfurd's greatest interest, however, had always been in astronomy, and through his marriage with Margaret Stuyvesant Chandler, niece and adopted daughter of Peter Stuyvesant, he found the means of engaging in this study. The Stuyvesant home became a center for astronomical observations. Under Mr. Rutherfurd's direction, an observatory with an 11¼-inch telescope and a transit instrument was established, a workshop also being added in which excellent instruments were constructed.

After some years his law practice was given up, and on his return from Europe, which he had visited on account of his wife's ill health, he threw all his energies into scientific investigations. While in Paris, Mr. Rutherfurd became intimate with Amici, who was carrying on experiments upon achromatism of objectives for microscopes, and to this may possibly be attributed Rutherfurd's application to microscopes of the devices he had so successfully used for telescopes. The observatory in New York was, by courtesy, used as a primary station for the determination of longitudes, by the Coast Survey, "Stuyvesant Garden," being named as one of the points.

In 1858 experiments were begun in astronomical photography, which were carried on so successfully, that on the occasion of the total solar eclipse in 1860, observed in Labrador with the first telescope constructed especially for photographic purposes, a distinct difference was shown in the character of the limbs of the sun and the moon. In 1861 Rutherfurd constructed "a Cassegrainian reflecting telescope with silvered glass mirror, having 13 inches aperture and 8 feet focus," but the necessity for frequent resilvering and the tremors caused by the location in the city interfering with good work, the reflector was abandoned after a short trial.

Mr. Rutherfurd's first astronomical paper was published in 1862. In this he confirmed Clark's discovery of the companion of Sirius, having found the object with his 11-inch telescope. The next season he made seventy-nine measures of position-angle, and thirty-eight of distance. These observations, added to those made at Cambridge and at Pulkowa, gave the principal basis of knowledge of this newly-found body for two years.

In 1863 Mr. Rutherfurd published in the *American Journal of Science* his second scientific paper entitled "Astronomical Observations with the Spectroscope," in which he gives the result of his observations and measurement of the spectra not only of the sun, moon, Jupiter and Mars, but also for seventeen stars. He continued his observations of the companion of Sirius, and also published a paper in 1863 on "Observations on Stellar Spectra." Not long afterward he began to employ photography in these investigations, and obtained a fine representation of the solar spectrum which he exhibited to the National Academy of Sciences in 1864. He further improved his apparatus by the use of extraordinarily delicate diffraction gratings, the secret of making which he learned for himself, and with these obtained results in the study of solar and stellar light that were unequalled until Draper entered upon the same field some years later.

Even more interesting and important are the results which Rutherfurd obtained in the construction of telescopic object-glasses for photographing celestial bodies. After much thought and labor, he succeeded in 1864 in making a most excellent lens with which he obtained remarkable photographs of the Pleiades and other star-clusters, and an exquisite one of the moon. Next he turned to the problem of making measurements on the photographic plates and invented a micrometer. This work of photographing and measuring, and the constant introduction of improvements in the instruments employed, was carried on until 1877, when failing health obliged him to desist. In 1880 the city having encroached upon the home and the observatory, Mr. Rutherfurd removed to a rural estate named "Tranquillity" in northwestern New Jersey. His winters were passed in Florida and in visits to southern Europe. Finding his health steadily failing in 1884, he presented to the Observatory of Columbia College his 13¼-inch telescope, with its corrector and the improved micrometer, together with 1456 plates and records of the measures made, providing also means for continuing the work of measurement. His death occurred May 30, 1892, at Tranquillity.

(From B. A. Gould, in *Biographical Memoirs of the National Academy of Sciences*, vol. 3, 1895, pp. 415-441.)

JOSEPH SAXTON

Born, March 22, 1799; died, October 26, 1873

Joseph Saxton was a man of remarkable inventive ability. His imagination ran in scientific lines, and when he had grasped the principles underlying the action of natural forces, he knew how to make them subservient to the needs of his fellowmen. The town of Huntington, Pennsylvania, was a small village at the time of his birth, in 1799, and afforded few opportunities for education. His father, James Saxton, after engaging in a number of different pursuits, became the proprieter of a small nail factory. At the age of twelve his son Joseph entered the factory and it was not long before he had made improvements in the machinery which increased its efficiency. Tiring of the limitations of his work, however, he was permitted to apprentice himself to a watchmaker, but after two years his employer died, and while waiting for some new opening, he occupied himself by constructing a printing press and publishing a small newspaper. At the age of eighteen he resolved to leave his native village and seek his fortune in the world. Accompanied by two friends, he made his way down the Juniata River to Harrisburg in a boat which he had constructed as a model of a man-of-war, and hence proceeded to Philadelphia. Here he obtained employment for a short period as a watchmaker and afterwards as an engraver. Later he became associated with Isaiah Lukens, a noted machinist, and at this time constructed an astronomical clock with a compensating pendulum and an escapement of his own devising, and also constructed the town clock of Philadelphia.

His inventive ingenuity led to his election to membership in the Franklin Institute, where he came into contact with many prominent men of science. Having resolved to visit London, he accumulated savings sufficient for the purpose and about the year 1831 proceeded on his journey. The banking house in which he had deposited his money stopped payment soon after his arrival in London, and he was compelled to seek employment. He found an opening in the recently-established institution of practical science known as the Adelaide Gallery, where new scientific instruments and apparatus were exhibited by inventors and manufacturers. Here Saxton quickly rose to notice by a series of inventions, some of them of practical importance and others interesting as ingeniously devised scientific toys. Among these was a large magnet, a diving bell, an ingenious toy known as "the paradoxical head," and a series of miniature vessels moved by concealed clock work. Having made the acquaintance of a number of prominent English engineers and mechanicians, he was introduced into the Royal Institution and entered into friendly relationships with Michael Faraday. Faraday had already discovered induction currents, but it remained for Saxton to invent an instrument to make their effects manifest. This he did in an ingenious manner, and by means of the instrument which he constructed he decomposed water, exhibited a powerful spark, and an electrical light between carbons. The instrument was exhibited at the meeting of the British Association in 1833. "The poet Coleridge, who was present at its exhibition in Cambridge, spoke with enthusiasm, not only of the magnitude of the discovery of the inductive electrical effects of magnetism, one of the claims of Faraday—to imperishable reputation—but also of the ingenious invention of Mr. Saxton, by which the transient electrical currents might exhibit their effects in so brilliant and so powerful a manner." (Henry.)

Saxton produced many other inventions while in London, among them a locomotive differential pulley, an instrument to measure the velocity of vessels, another for measuring the height of water in a steam boiler, a fountain pen, etc. He also devised a method for locating the interior magnetic poles of the earth, and constructed the apparatus used by Wheatstone to measure the velocity of electricity in a long wire.

Leaving London in 1837, he was appointed constructor and curator of the standard weighing apparatus in the Mint at Philadelphia. While here his improved form of Gobrecht's instrument for reproducing the designs of medals by engraving was brought into use. He also constructed balances for weighing coins, of such delicacy that they would turn with one three-millionth part of their load.

In 1834 Saxton was awarded the Scott Medal of the Franklin Institute for the invention of a reflecting pyrometer, an instrument which was capable of indicating changes in the length of a metal bar to the one-hundred-thousandth part of an inch.

In 1843 Saxton was appointed by Professor Bache to take charge of the construction of the standard balances, weights and measures which were authorized by Congress for distribution to the several States of the Union. While in this position he also devised many instruments for use in the Coast Survey, including an automatic instrument for recording the height of tides, and an improved automatic dividing machine.

At the meeting of the American Association for the Advancement of Science in 1858, Saxton gave an account of the use of the revolving mirror in minute measurements, such as the expansion of building stones from heat, the motion of the axis of the aneroid barometer, changes in magnetic dip, etc. Other inventions of Saxton's were an automatic damper for stoves, a fusible metallic sealing compound for official papers sent to tropical countries, and a hydrometer.

About fifteen years before his death, Saxton suffered a partial stroke of paralysis, from which he never entirely recovered. He died in Washington on October 26, 1873.

(From JOSEPH HENRY, in *Biographical Memoirs of the National Academy of Sciences,* vol. 1, 1877, pp. 287-316.)

BENJAMIN SILLIMAN, SENIOR

Born, August 8, 1779; died, November 24, 1864

In common with several other founders of the Academy, the lifetime of Benjamin Silliman extended from the period of the Revolution to that of the Civil War. At the time of his birth, the independence of the United States was not yet an accomplished fact. His father, General Gold Selleck Silliman, bore an honorable part in the Revolutionary struggle. The Silliman family had resided for many years in the town of Fairfield, Connecticut, but in 1779 the British forces invaded the coast towns of that State and the family took refuge in Stratford (now Trumbull), and here Benjamin Silliman was born on the 8th day of August. He entered Yale College at the early age of thirteen years, and was graduated in 1796. Upon graduation he took up the study of law and after the lapse of three years also assumed the duties of a tutor in Yale College. He was admitted to the bar in 1802, but was not destined to follow the profession for which he had fitted himself. He was persuaded by President Dwight of Yale to abandon that calling and devote himself to chemistry and the natural sciences, which were then beginning to be looked upon as necessary to a college curriculum. Accordingly, he was elected the same year Professor of Chemistry and Natural History at Yale, though he did not begin to lecture on these subjects until two years later. These two years he spent in Philadelphia as a student of Dr. Woodhouse and in pursuing experiments with Dr. Hare with the oxyhydrogen blowpipe, which Hare had just then invented. In 1805 he visited Europe, spending much time in England and Scotland where he met or studied under Professors Hope, Murray, Playfair and other eminent men of science, at the same time recording his impressions of men and things which he published later under the title of a "Journal of Travels in England, Holland, and Scotland in 1805-06."

Upon his return to America, Professor Silliman resumed his lectures at Yale, and continued in the duties of his professorship for half a century. In 1811 he conducted an extensive series of experiments in melting refractory minerals with Hare's blowpipe, of which he published an account the following year. At the same time, while working with Hare's "galvanic deflagrator," he observed that the charcoal of the positive pole was transferred to the negative pole and that it was fused. "It is claimed for Professor Silliman that he was the first to establish this transfer of the particles of carbon, and the first also to fuse carbon in the voltaic arch." (Caswell.)

In 1819 he established the highly important scientific periodical, the *American Journal of Science,* with which his name is most widely associated, and of which he was the sole editor for twenty years, and the senior editor for eight years in addition.

In 1820 he published an account of a journey from Hartford to Quebec, in 1829 an edition of Bakewell's Geology, with an appendix containing a summary of his own lectures on that subject, and in 1830 the whole body of his lectures on chemistry at Yale, under the title of "Elements of Chemistry, in the order of the lectures given in Yale College."

From 1834 to 1845 Professor Silliman delivered courses of lectures on scientific subjects in the principal cities of the United States from Boston to New Orleans. He visited Europe again in 1851, and in 1853 published an account of his observations in three duodecimo volumes.

Regarding Professor Silliman's labors, Caswell remarks "His special field was the diffusion of science; and his special gifts and acquirements made him one of the most popular scientific lecturers in the country. . . . It seems to me that the utility of science, in its broadest sense, was always uppermost in his mind. He is always tracing abstract principles to their practical applications."

(From ALEXIS CASWELL, in *Biographical Memoirs of the National Academy of Sciences*, vol. 1, 1877, pp. 99-112.)

BENJAMIN SILLIMAN, JUNIOR

Born, December 4, 1816; died, January 14, 1885

Benjamin Silliman, Junior, was born in New Haven, December 4, 1816. His father was Professor of Chemistry in Yale College, and the son spent his early life in the wholesome intellectual atmosphere of that institution. He graduated from Yale in 1837, and became assistant to his father the following year, being instructor in chemistry, mineralogy, and geology. In 1842, at his own expense, he equipped a chemical laboratory in a room in one of the college buildings for the instruction of private pupils. His zeal in the work and his efforts to arouse an interest in others were prominent factors in the founding of the Yale Scientific School, now known as the Sheffield Scientific School, in 1847. He was appointed Professor of Applied Chemistry in 1846, and succeeded his father in the chair of chemistry in 1853. This position he held until his death on January 14, 1885. From 1849 to 1854 he had been Professor of Medical Chemistry and Toxicology at the University of Louisville, Kentucky.

During the year 1847, Professor Silliman visited California and engaged in professional work connected with the mines and made extensive geological explorations. He also delivered an oration before the College of California in 1869. As an expert in chemical arts and manufactures he was often called by the courts to testify in law cases.

He also delivered popular lectures throughout the country. For many years he was one of the editors of the *American Journal of Science.*

His collection of minerals was bought by Cornell, and called the Silliman Cabinet. Another collection was added to Yale College Scientific School, and Professor Silliman personally solicited the money to buy the mineralogical collection of Baron de Lederer in 1843.

During the World's Fair in New York in 1853, Professor Silliman had charge of the departments of chemistry, mineralogy, and geology, and in 1869 he became one of the State Chemists of Connecticut.

He was a trustee of Peabody Museum and a member of numerous European and American scientific societies.

Of his principal writings, the "First Principles in Chemistry" was published in 1846, and "Principles of Physics" in 1854, and "American Contributions to Chemistry" in 1875.

Investigations in mineralogy and chemistry formed the basis of Professor Silliman's scientific work, but he engaged also in studies relating to geology, to meteorites, and to physical optics.

(See ARTHUR W. WRIGHT, in *Biographical Memoirs of the National Academy of Sciences,* vol. 7, pp. 115-141.)

THEODORE STRONG

Born, July 26, 1790; died, February 1, 1869

Theodore Strong was descended from Puritan ancestors. His father Joseph Strong and also his grandfather were clergymen of the Congregational denomination. His mother, Sophia Woodbridge, was a daughter of the Rev. John Woodbridge of South Hadley, Massachusetts. In this town Theodore Strong was born on July 26, 1790, in the house of his uncle, Colonel Benjamin Ruggles Woodbridge. Joseph Strong, having a large family of children to provide for, was induced to transfer the responsibility for the education and training of his son Theodore to Colonel Woodbridge by whom he was practically adopted. Theodore Strong's schooling began at an early age and when he entered Yale College at eighteen he was well prepared in languages, though not in mathematics. Having, however, on one occasion been subjected to ridicule by a classmate for his poor mathematical recitation, he set himself to master the science, and in 1812, when he was graduated from college, he was awarded the mathematical prize. Immediately after graduation, he was recommended by Dr. Dwight (then President of Yale) for a tutorship of mathematics, then vacant, in Hamilton College, Clinton, New York. He accepted the position and held it for four years, after which he became Professor of Mathematics and Natural Philosophy. He found more time for study and research at Hamilton than he would have enjoyed at a larger institution, and he was able while there to contribute largely to a number of scientific journals and magazines. One of the most prominent of these was the *American Journal of Science,* to the first volume of which, published in 1818, he contributed a very clever demonstration of a geometrical problem. His papers always attracted attention because of their originality and depth of learning.

His reputation as a man of power and originality in his subject was constantly growing, and in 1825-26 he received several calls from different colleges and universities to accept the chair of mathematics. Late in 1827 a second invitation, which was finally accepted, came from Rutgers College, in New Jersey, and here he spent the rest of his long life. In 1859, the trustees, thinking that he needed an assistant, as he was then 69 years of age, appointed an associate professor. It was at this time that he published his work on algebra. In 1861 he was made professor emeritus, and two years later severed his connection with the college. In spite of his rather advanced age, he was in full possession of his mental faculties and employed this time in writing a treatise on differential and integral calculus, which, however, was not published until after his death. Both this and his treatise on elementary and higher algebra, display Strong's profound knowledge of these branches of mathematics, and the remarkable logical power of his mind. In fact, his power of reasoning was far better than his memory, so much so that he seldom relied on the latter for a formula or theorem, but worked them out anew.

In the field of pure mathematics, Dr. Strong was one of the leading minds of his day. But two of his contemporaries among American mathematicians may be mentioned as sharing his preëminence—Dr. Bowditch and Dr. Adrian—to whom and to Dr. Strong more than to any others, is due the introduction of the study of the higher mathematics into the schools of this country.

(From J. P. BRADLEY, in *Biographical Memoirs of the National Academy of Sciences*, vol. 2, 1886, pp. 1-28.)

JOHN TORREY

Born, August 15, 1796; died, March 10, 1873

Although most widely known as a botanist, Torrey's life was spent as a professor of chemistry. His father, William Torrey, was of New England ancestry. He served throughout the Revolution in a New York infantry regiment of which his uncle, Joseph Torrey, was a major, and returned to that city at the close of the war. Here his son, John Torrey, was born on August 15, 1796. His early education was obtained in the schools of New York and Boston. While still a youth, he became acquainted with Amos Eaton, who taught him the elements of botany, and he soon developed a taste for other branches of natural science. At the age of nineteen years he began the study of medicine in the College of Physicians and Surgeons, and three years later began medical practice in New York. His first scientific papers were published while he was still a medical student, the earliest being one on plants growing near New York, which appeared in 1817. In 1824 he published the first volume of his " Flora of the Northern and Middle Sections of the United States," an important descriptive work, which, however, was never completed. The same year he became Professor of Chemistry, Mineralogy and Geology at West Point, and three years later transferred his field of labor to the College of Physicians and Surgeons, New York, where he became Professor of Chemistry and Botany (" practically that of chemistry only, for botany had already been allowed to fall out of the medical curriculum in this country ").[4]

While in this position he published many important botanical papers, including an account of the plants collected by Edwin James, the botanist of Long's Expedition to the Rocky Mountains, the first part of which appeared in 1823. In 1826 he published a fuller account of the botany of this expedition in which the plants, for the first time in an American botanical publication, were arranged in accordance with the natural system. At this time he began the study of the sedges of the genus *Carex,* and, jointly with Von Schweinitz, published a monograph of the genus in 1825. Some ten years later his monograph of the other North American Cyperaceae appeared, together with a revision of the *Carices.*

In 1836 Torrey was appointed Botanist of the State of New York and undertook the preparation of a flora of the State. After many delays and discouragements, this extensive work was published in 1843 in two large quarto volumes. "No other State of the Union has produced a flora to compare with this." (Gray.)

At an early date Dr. Torrey projected a flora of North America, or of the United States. About 1836 he invited Asa Gray, then his pupil in botanical studies, to join him in the enterprise, and in 1838 the first two parts of the first volume made their appearance. The remainder of this volume, and also the second were published between 1840 and 1842 and the third and last volume in 1843. From this time nearly to the close of his life Torrey labored constantly to improve and extend this epoch-making work.

Torrey published a long series of papers, many of them large and important works, on the botanical collections of the Government expeditions and surveys of the West, beginning with Long's Expedition and including those of Nicollet, Frémont, Emory, Sitgreaves, Stansbury, and Marcy, and of the surveys of the Pacific Railroad and the Mexican Boundary.

[4] He also became a professor in Princeton College.

These botanical labors, as already mentioned, were supplementary to his regular duties as a teacher of chemistry and other branches of science, which he performed for more than thirty years. In 1857 Torrey entered upon the office of United States Assayer, and while thus engaged carried out many commissions of a confidential or especially difficult nature.

In his last years, as professor emeritus in Columbia College, he continued to lecture at intervals. He also served as a trustee of the College and bequeathed to it his very valuable herbarium and his botanical library.

Torrey was twice President of the New York Lyceum of Natural History and also presided over the American Association for the Advancement of Science. He was a member of the Order of the Cincinnati.

(From ASA GRAY, in *Biographical Memoirs of the National Academy of Sciences,* vol. 1, 1877, pp. 265-276.)

JOSEPH GILBERT TOTTEN

Born, August 23, 1788; died, April 22, 1864

The lifetime of General Totten extended nearly from the close of the Revolution to the close of the Civil War, and his period of public service covered more than fifty years. He was born in New Haven, Connecticut, August 23, 1788. His father, Peter G. Totten, was the son of Joseph Totten who came to America from England before the Revolution. Totten's mother died when he was three years old and his father having been appointed consul of the United States at Santa Cruz, in the West Indies, he was placed in charge of his uncle Jared Mansfield, "a graduate of Yale College, 1777, and a learned mathematician."

Upon the organization of the Military Academy at West Point in 1802, Mansfield was appointed a teacher in that institution. Young Totten accompanied his uncle to West Point and afterwards was appointed a cadet. He remained in the Academy during the term of 1803, but in November of that year his uncle Captain Mansfield became Surveyor-General of Ohio and the Western Territories, and Totten accompanied him to his new station as an assistant. While in Ohio, his inborn curiosity regarding novel or unusual objects and phenomena led him to make a description and survey of the remains of the so-called "mound builders," particularly at Circleville; probably the earliest observations on these singular works.

In 1808 Totten re-entered the Army, was re-appointed Second Lieutenant of Engineers, and began his career as military engineer. He was assigned to duty in connection with the construction of Castle Williams, and Castle Clinton, in New York harbor.

During the War of 1812 Totten served as Chief Engineer of the armies under command of Generals Van Rensselaer, Dearborn, Izard and Macomb. He obtained the rank of captain in 1812, and was brevetted major in 1813 for "meritorious service," and in 1814 lieutenant-colonel for "gallant conduct at the battle of Plattsburg."

At the close of this war, Totten entered upon the most important epoch of his career, in which he was engaged in the construction of coast defences. Congress in 1816 constituted a board of engineers whose duty was to formulate a system of defensive works. After some vicissitudes, the permanent board, through circumstances which cannot be detailed here, finally consisted of General Simon Bernard (an eminent French engineer who was invited to America to assist in this important undertaking) and Colonel Totten.

The reports of this board, which were prepared by Colonel Totten, "exhibit in a masterly manner the principles of sea-coast and harbor defence, and their application to our own country." "They are themselves the best expressions of the life labors and services of the subject of our memoir." (Barnard.) These plans having been decided upon, Colonel Totten was assigned to the construction of Fort Adams in the harbor of Newport. This work, "the second in magnitude of the fortifications of the United States, is one of the best monuments of genius as a military engineer." (Barnard.)

In connection with the construction of this great work, Colonel Totten instituted extensive investigations into the qualities and strength of materials, the expansion and contraction of building-stone through variations in temperature, the composition of mortars, and many other matters of importance in engineering operations.

While engaged in the construction of Fort Adams, Colonel Totten also served as a member, and for six years as President, of the Board of Engineers whose duty was to plan new works authorized by Congress. His advice was also sought in connection with various harbor improvements, chiefly on the Great Lakes.

When Fort Adams approached completion in 1838, Totten was appointed Colonel of the Corps of Engineers and Chief Engineer, with headquarters in Washington. While occupying this high office he directed his energies toward the development of the system of coast defences, especially in the South, and personally inspected every fort in the United States at intervals not exceeding two years.

During the Mexican War, Colonel Totten directed the engineering works at the siege of Vera Cruz, and on March 29, 1847, was brevetted a brigadier-general for gallant and meritorious conduct. In 1855 General Totten, Commander Charles H. Davis and Professor Bache, by invitation of the State of New York, served as an advisory commission on the preservation of the harbor of New York. The members of this commission had previously reported on Cape Fear River and harbor, and on the harbor of Portland, Maine, and later rendered similar service to the State of Massachusetts relative to the port and harbor of Boston.

To General Totten is due the credit of perfecting the casemated battery and casemate embrasures. He was a member of the first Lighthouse Board and while serving in this capacity induced the board to accept his views regarding the proper site for the Minot's Ledge lighthouse, prepared the plan for its construction, and selected the engineer to build it. He was a member of the first Board of Regents of the Smithsonian Institution and favored the plan of Joseph Henry for the organization of that establishment.

General Totten was deeply interested in many branches of natural history, and particularly in mineralogy and conchology. While Fort Adams was under construction, he spent his spare hours in collecting shells in the vicinity of Newport and also about Provincetown, Massachusetts. He published descriptions of several new species, and a list of the shells of Massachusetts, and furnished much important information for Gould's "Invertebrata of Massachusetts." He presented his collection of rare shells to the Smithsonian Institution.

(From J. G. BARNARD, in *Biographical Memoirs of the National Academy of Sciences*, vol. 1, 1877, pp. 35-97.)

JOSIAH DWIGHT WHITNEY

Born, November 23, 1819; died, August 19, 1896

Josiah Dwight Whitney, the oldest of a family of thirteen children, was of English ancestry. Both the Dwight and Whitney families were descended from early New England settlers, who counted in their numbers graduates of Yale and Harvard, college presidents, able business men, missionaries, soldiers, and members of all the professions. Whitney was born at Northampton, Massachusetts, November 23, 1819, and at eight years of age left the district school in his native village and went to Plainfield, where according to the custom of the day, Rev. Moses Hallock took boys into his family for instruction. After further schooling at Round Hill, Northampton, New Haven, and Andover, he entered Yale College as a sophomore in 1836. Returning to New Haven after graduation, young Whitney entered his father's bank, and for a time enjoyed the delights of a cultured home, where music played a prominent part. Art, science, music, law, and business attracted him by turn, but finally in 1839 he yielded to his love for chemistry and entered the University of Pennsylvania to study under Dr. Robert Hare. The following year he made the acquaintance of Dr. Charles T. Jackson, and under him assisted in the Geological Survey of the State of New Hampshire. Again uncertain as to a remunerative profession, Whitney turned to the law and was about to enter Harvard Law School, when, on the advice of Dr. Jackson, his father offered to send him to Europe, where three years were spent in travel and study. During this time he made a translation of Berzelius' work on blowpipe analysis. While yet at Giessen, Dr. Jackson offered Mr. Whitney the position of first assistant in the Government Survey of the Lake Superior Mines. From chemistry his attention was now turned to geology which thenceforth became his special study. As assistant, or as the head of a division, several years were spent in the survey of the Lake Superior mines and by the knowledge thus acquired, added to his thorough German training, and his acquaintance with fossils, Whitney became an acknowledged mining expert. At this time he published his work on The Metallic Wealth of the United States. It was written at Clover Den in Cambridge, " an old bachelor hall," where Whitney kept his own extensive library, and returned after his excursions to enjoy the society of other scientists. This home was given up at his marriage in 1854. In 1855 Whitney became professor in the University of Iowa, his chief duties, however, being in connection with the state geological survey.

A Geological Survey of California was established in 1860 and Whitney was appointed to take charge of it. Accompanied by a corps of able assistants he left Northampton for California on October 18, 1860, and entered upon this new work with enthusiasm. Many important features of the geology and geography of the State were determined, but the Survey soon encountered difficulties, chiefly of a political and pecuniary character, and after a precarious existence extending over fourteen years, it was finally abandoned. Only a few volumes containing the results of the work were published.

Whitney's contributions to geology were numerous and many reports of official work were published at his own expense. In 1875 he was re-appointed to the Sturges-Hooper Professorship of Geology at Harvard which had been founded ten years previously largely in his behalf, and also became a member of the faculty of the Museum of Comparative Zoölogy. These positions he retained until his death. His works on "The Climatic Changes of Later Geologic Times" and on the "Azoic System" were written during this period. For eight years Professor Whitney gave his spare time to assisting his brother William D. Whitney in connection with the scientific part of the Century Dictionary.

After thirty-one years of teaching at Harvard, Professor Whitney died at Lake Sunapee, New Hampshire, August 19, 1896. He was buried at Northampton and a glacial boulder of rose quartzite of the geological age of the lead district about Galena and the rocks of the Upper Michigan which border the "Azoic System," marks his grave. The highest peak of the Sierra Nevada bears his name.

(See Edwin T. Brewster, "Life and Letters of Josiah Dwight Whitney," Boston, 1909.)

JOSEPH WINLOCK

Born, February 6, 1826; died, June 11, 1875

Though born in Kentucky, Joseph Winlock was of Virginia stock. His grandfather, after whom he was named, was a captain in the Revolution and in the War of 1812 held the rank of brigadier-general. In the latter war his son, Fielding Winlock, served as his aid.

Professor Joseph Winlock was educated at Shelby College, Kentucky, and was graduated from that institution in 1845. His abilities were already so manifest that he at once received an appointment as Professor of Mathematics and Astronomy from his Alma Mater. In 1851 he became acquainted with "the chief of American mathematicians," who recognized his intellectual capacity, and induced him to join the corps of computers in the Nautical Almanac Office in Cambridge the following year. He served in this capacity until 1857, when he received an appointment as Professor of Mathematics in the Naval Observatory at Washington. In this position he remained but a short time, after which he was appointed Superintendent of the Nautical Almanac. Not long afterwards, in 1859, he was given charge of the mathematical department in the Naval Academy at Annapolis, but at the outbreak of the Civil War, he again resumed the office of Superintendent of the Nautical Almanac in Cambridge. During the years in which he was connected with this office he made many contributions to mathematics and astronomy, the most important of which was his series of tables of Mercury.

In 1866 Professor Winlock was appointed Professor of Astronomy in Harvard College and Director of the Harvard Observatory.[5] Here he exerted himself in strengthening the equipment of the observatory by the addition of many important instruments and aids to astronomical work. The transit circle of the observatory, a costly instrument, had proved unsatisfactory, and Winlock succeeded in obtaining funds from friends of the Observatory to replace it. To arrange for the construction of the new instrument, he visited the principal observatories in Europe in 1867. He also devised improvements which were afterwards adopted by other astronomers. Between 1871 and 1875, 30,000 observations were made with this instrument, under Winlock's direction.

In 1869, Professor Winlock was appointed head of a party to coöperate with the Coast Survey in observing the total eclipse of the sun in Kentucky. On this occasion he succeeded in making the first photograph of the solar corona made during any eclipse. At the request of the Superintendent of the Coast Survey, he organized and led the party sent to Spain to observe the total eclipse of the sun occurring on December 22, 1870. During this eclipse a telescope of long focus, fixed horizontally, and without an eyepiece, which was devised by Winlock for photographic work, was used by all the observers.

Winlock devised many improvements in spectroscopic instruments, and also in 1872 greatly improved and extended the time-

[5] At a later date he also held the position of Professor of Geodesy in the Lawrence and Mining Schools of Harvard College.

signal service between Cambridge and Boston. In 1874 he was appointed by the Secretary of the Navy chairman of a commission established by Congress for the purpose of investigating the causes of the explosions of steam boilers and formulated plans for experiments which should test the truth or falsity of the accepted theories, but he was not destined to see them carried into execution. He died suddenly at Cambridge, Massachusetts, on June 11, 1875.

(From JOSEPH LOVERING, in *Biographical Memoirs of the National Academy of Sciences*, vol. 1, 1877, pp. 329-343.)

JEFFRIES WYMAN

Born, August 11, 1814; died, September 4, 1874

Jeffries Wyman, the third son of Dr. Rufus Wyman, was born on August 11, 1814, at Chelmsford, near Lowell, Massachusetts. In 1818, his father moved to Somerville where he was one of the physicians at the McLean Asylum. The early schooling of Jeffries Wyman began in Charlestown, Massachusetts, and later he was sent to the Academy at Chelmsford. He became interested in natural history when very young, and often searched for objects of interest along the Charles River, near his home. His talent for drawing also developed early, and he afterwards used it to great advantage in the lecture-room. He entered Harvard in 1829, was graduated in 1833, and the next year took up the study of medicine with Dr. John C. Dalton. He received his degree of Doctor of Medicine in 1837, and began his work in Boston by acting as demonstrator of anatomy under a well-known comparative anatomist, Dr. J. C. Warren. This occupation was not very lucrative, and was often a source of discouragement, but Wyman pursued his scientific studies in connection with his medical work, and never entirely gave them up.

At about this time the Lowell Institute was founded, and John A. Lowell, who was then in charge of its affairs, offered Wyman the curatorship. During the season of 1840-41, he delivered twelve lectures on comparative anatomy and physiology, and with the means thus procured went to Europe, where he came in contact with many prominent men of science, such as De Blainville, St. Hilaire, and Valenciennes. His sojourn was shortened by the illness and death of his father. In 1843, after his return, he was made Professor of Anatomy and Physiology at Hampton Sidney College in Richmond, Virginia. In 1847 he succeeded Dr. Warren to the Hersey chair of anatomy at Harvard College.

While here he established and developed a museum of comparative anatomy to which he devoted all of his spare time. On the many trips he made both North and South, he gathered great numbers of valuable specimens and added them to the collections in his museum, which was afterwards incorporated with that of the Boston Society of Natural History.

He spent the winter of 1852 in Florida on account of bad health, but in spite of his malady he was able at intervals to make investigations of the Indian shell-heaps, the results of which were afterwards published. Later, he made many trips to the coast of Maine and Massachusetts, and examined shell-heaps in as many as twenty-five localities, securing several thousand specimens. In 1856 he made an expedition to Surinam, and the same year was elected President of the Boston Society of Natural History, which office he held for fourteen years. In 1858-9, he went to the La Plata, and after ascending the Uruguay and Paraná rivers crossed the continent to Santiago and Valparaiso, with his friend G. A. Peabody, returning home by the Isthmus of Panama.

In 1866 the Peabody Museum of American Archaeology and Ethnology was founded by George Peabody, and Wyman was appointed one of the seven trustees. By vote of the board, he was named as curator of the museum. In the duties of this office there was great scope for Wyman's ability and enthusiasm and though he worked at all times under the disadvantage of ill health, he accomplished much for the museum. He was obliged, however, to spend his winters in Florida, and once or twice he visited Europe for the purpose of recuperating. Thus he continued until the summer of 1874 when he unfortunately undertook an unusual amount of work in the museum, enough indeed to overtax the strength of a man physically sound. In the fall of the same year he went to the White Mountains for a short rest, but he was unable to regain his energies and died on September 4, quite suddenly, while in Bethlehem, New Hampshire. Dr. Wyman's lack of physical vigor was probably the prime reason why he was not a voluminous writer. His papers though numerous are generally brief. He often summarized in a few pages the conclusions to which he had come after months, perhaps, of painstaking experiments. He wrote on many different zoölogical subjects, and his published papers relate to numerous classes of animals both recent and fossil, and to physiology and teratology, as well as to anatomy.

One of the most important and best known of his scientific papers is that on the Gorilla, of which he was the joint author with Dr. Savage, who sent him specimens for study. This great anthropoid ape was here first described under the name of *Troglodytes gorilla,* and Dr. Wyman gave a full account of the skeleton. It was this article which helped to establish his reputation among comparative anatomists. He also published an elaborate essay on the anatomy of the blind fish of the Mammoth Cave, another on the homology of limbs, and a third on the relationship between vertebrates and invertebrates, based on a study of the nervous system of the frog. His most original essay in physiology was one relating to experiments on vibrating cilia, published in 1871.

His anthropological writings were marked by care, ingenuity, judiciousness and extensive knowledge, and gave him rank among the principal anthropologists of his day. Besides the work on shell-heaps already referred to, he made numerous studies of human crania.

Wyman was one of the original members of the Association of American Geology and Natural History, and President of the American Association for the Advancement of Science in 1857; also a member of the faculty of the Museum of Comparative Zoölogy.

(From A. S. PACKARD, in *Biographical Memoirs of the National Academy of Sciences*, vol. 2, 1886, pp. 75-126.)

CHAPTER IV

THE ACADEMY AS THE SCIENTIFIC ADVISER OF THE GOVERNMENT

THE Academy started out in the stormy days of the Civil War with the idea and the intention of helping the Government. It has helped the Government. Its reports have been accepted, its recommendations have been adopted, and the Government has shaped its course in several matters of importance in the light of the counsel which it received from the Academy. If it has not sought that counsel as frequently and as eagerly as the founders hoped and expected, the defection has been due rather to the changes which time has wrought in the public service, than to any lack of confidence in the counsellors.

In an earlier chapter we have shown that the idea of helping the Government was prominent in the minds of some of the founders of the Academy, that it was incorporated in the charter and constitution, and that Professor Bache and others thought that in this direction lay a very important—if not the most important, function of the Academy. It remains now to consider more in detail to what extent and on what subjects the advice of the Academy has been sought by the Government, how far its recommendations have been adopted, and what results have followed. It will be readily understood that with the increase of large scientific organizations in the country, the growth of public opinion relative to scientific matters of more or less practical importance, and the development of the scientific bureaus of the Government, it has happened less frequently that the Academy has stood alone in its recommendations. Even at the outset some of the committees appointed to consider questions of public policy were joint committees of the Academy and of other kindred organizations, or had among their members officers of the Government, who were detailed to assist in the deliberations. It is well to note also that from the beginning the membership of the Academy included many officers of the Government and that these were frequently selected to serve on committees of the Academy. On one occasion at least this led to some embarrassment, for the reason that through this double relationship it was thought that the views of subordinate officers might control the action of those higher in authority.

As might be expected, there has been no regularity in the number of committees appointed on behalf of the Government from year to year. As many as seven have been appointed in a single year, while, on the other hand, two periods of five years each passed in which no calls were received from Congress or the Executive Departments. The records show, however, that of the whole number of committees more than one-third were appointed in the first five years. After this the number fell off in a marked manner, but increased again during the decade beginning with 1878. Between that year and 1888, twenty committees were appointed. In the twenty-four years that have elapsed since 1888, only seven committees have been appointed.

The subjects brought to the attention of the Academy by the Government have covered a wide range, but among them, matters in which physics, astronomy and chemistry were concerned have predominated. It should be remarked, however, that some of the most important questions which the Academy has been asked to consider, have not related to any particular branch of science, but rather to matters of public policy.

On the general subject of committees appointed at the request of the Government, Professor Bache in his first report as President of the Academy remarked as follows:

"It was obvious that the only effective and prompt mode of action by members scattered over the United States, as were the fifty named in the charter, must be through committees. Action must originate with committees, and be perfected by discussion in the general meetings of the Academy, or in the classes or sections. Decisions to be finally pronounced by the entire body.

"To avoid delay in reports which might be desired by the government to be promptly furnished, the President of the Academy was authorized to transmit such reports on their reception. It has not appeared to me, except, perhaps, in one case, and in that the conclusions of the Committee had not reached me, that there was occasion to present the reports until they had been discussed in the Academy itself, and the views had been adopted; especially as this was, as I have said before, a first trial of the working of our organization. One of the committees thus acting has been able to meet so often, and with so many members at a meeting, as to show that in important cases, where consultation and discussion must be had, there will be little difficulty in effecting meetings; while in most cases correspondence amply suffices for the settlement of the questions involved, and to bring out the results in the form of a report with suggestions.

"It will be seen by the spirit and words of our laws, enacted by the authority of the charter, that the members of the National Academy put their time and talents at the disposal of the country in no small or stinted measure, freely, fully, by the binding authority of an oath; asking no compensation therefor but the consciousness of contributing to judicious action by the government on matters of science. The more the wealth of such men can be drawn out from the treasury of their knowledge, the richer will the nation be; and I for one do not fear that even the suggestions which may be made to Congress on subjects in which that knowledge may be most profitably employed for our country and times, will be subject to any supposed taint of self-seeking as to power or influence. Subject to the taint of supposed desire for remuneration it cannot be, by our charter, and all our laws look away from such a center." [1]

COMMITTEES APPOINTED BY THE ACADEMY ON BEHALF OF THE GOVERNMENT

1. Committees appointed in accordance with Acts of Congress.

1871. On the Transit of Venus (p. 256).
1872. On Preparing Instructions for the *Polaris* Expedition (p. 40).
1878. On a Plan for Surveying and Mapping the Territories of the United States (p. 268).
1879. On a National Board of Health (p. 50).
1894. To Prescribe and Publish Specifications for the Practical Application of the Definitions of the Ampere and Volt (p. 313).
1908. On the Methods and Expenses of Conducting Scientific Work Under the Government (p. 330).

2. Committees appointed at the request of Joint Commissions and Committees of Congress.

1884. On the Signal Service of the Army, the Geological Survey, the Coast and Geodetic Survey, and the Hydrographic Office of the Navy Department (p. 295).

[1] Ann. Nat. Acad. Sci., 1863-6, pp. 49, 50. For an annotated list of committees to 1879, see Rep. Nat. Acad. Sci. for 1879, pp. 7-13.

1902. On the Establishment of a National Forest Reserve in the Southern Appalachians (p. 323).

3. Committees appointed at the request of the President of the United States.

1870. On the Protection of Coal Mines from Explosion by Means of Electricity (p. 253).
1902. On Scientific Explorations in the Philippines (p. 325).

4. Committees appointed at the request of the Treasury Department.

1863. On the National Currency (Confidential).
1863. On Weights, Measures, and Coinage (p. 206).
1863. On Saxton's Alcoholometer (p. 218).
1864. On Materials for the Manufacture of Cent Coins (p. 227).
1866. On the Prevention of Counterfeiting (p. 331).
1866. On Spirit Meters (p. 239).
1866. On Proving and Gauging Distilled Spirits and Preventing Fraud (p. 239).
1866. On Metric Standards for the States (p. 211).
1870. On the Effect of Chemicals on Internal Revenue Stamps (p. 254).
1873. On an International Bureau of Weights and Measures (p. 212).
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5. Committees appointed at the request of the Navy Department.

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COMMITTEE ON WEIGHTS, MEASURES, AND COINAGE. 1863

Five committees were appointed at the request of the Government within a month after the organization of the Academy. The first of these, which was known as Committee No. 1, was appointed at the solicitation of the Secretary of the Treasury, Salmon P. Chase, on May 4, 1863, not to consider any question relating to the conduct of the Civil War, but on the subject of the "Uniformity of weights, measures and coins, considered in relation to domestic and international commerce." Secretary Chase had previously referred to this matter in his annual report for 1861, p. 28, as follows:

"The Secretary desires to avail himself of this opportunity to invite the attention of Congress to the importance of a uniform system and a uniform nomenclature of weights and measures, and coins to the commerce of the world, in which the United States already so largely shares. The wisest of our statesmen have regarded the attainment of this end, so desirable in itself, as by no means impossible. The combination of the decimal system with appropriate denominations in a scheme of weights, measures, and coins for the international uses of commerce, leaving, if need be, the separate systems of the nations untouched, is certainly not beyond the reach of the daring genius and patient endeavor which gave the steam engine and the telegraph to the service of mankind." [2]

The committee was originally one of eight members, namely, Joseph Henry (chairman), J. H. Alexander, Fairman Rogers Wolcott Gibbs, Arnold Guyot, Benjamin Silliman, Jr., Wm. Chauvenet, John Torrey. To these members were added A. D. Bache, by resolution of the Academy, John Rodgers, L. M. Rutherfurd and Samuel B. Ruggles. Ruggles was not a member of the Academy, but was designated in accordance with a provision of the constitution which permitted the President "to call in the aid, upon committees, of experts, or men of remarkable attainments, not members of the Academy." (Act 2, sect. 4.) He was the delegate of the United States to the International Statistical Congress held in Berlin in 1863.

The original committee was discharged in 1866, but the following year another committee was appointed under the same

[2] Rep. Secr. Treas. for 1861, p. 28.

name. It became a standing committee, and, although rated as a committee on business of the Academy, it has reported a number of times on matters referred to the Academy by the Government. During the forty-six years that have elapsed since 1867, twenty-two members of the Academy have served on this committee, including three who belonged to the original Committee No. 1. These are J. H. Alexander, F. A. P. Barnard, C. B. Comstock, Henry Draper, Wolcott Gibbs, B. A. Gould, Henry, Hilgard, Lovering, Meigs, Mendenhall, Michelson, Morley, Newcomb, H. A. Newton, C. S. Peirce, Saxton, Sellers, W. P. Trowbridge, Webster, R. S. Woodward, Young.

In regard to the subject-matter which the original Committee No. 1 was to consider, Professor Bache remarked in his first report as President of the Academy (1863), as follows:

> "It is not a little strange in our country, where the decimal system of coinage proved at once acceptable, notwithstanding the capital errors committed in, for a long time, keeping in use foreign coins of no convenient relation to the decimal system, that nothing of the kind was effected for weights and measures, and still more strange that the antiquated and cumbrous variety of tables by which articles of different classes were bought and sold should have been retained, that even in our preparation of a national system intended for practical use neither the decimalization of the weights and measures nor the simplicity of one weight of one name should have been adopted. The influence of great names can alone probably explain this, without justifying it." [3]

The proceedings of the committee were not reported in full, but Professor Bache informs us that "the discussions in the body of this committee were strongly in favor of the adoption of the French metrical system, but more strongly, in fact unanimously, in favor of the effort to arrive at a thorough international system—a universal system of weights, measures, and coins, available for the general acceptance of all nations." [4]

It will readily be understood that the committee was not prepared to submit at once a general report on so comprehensive and important a matter. They adopted the plan of dividing into subcommittees, each of which should inquire into the system of weights and measures employed by one or more countries. Hav-

[3] Rep. Nat. Acad. Sci. for 1863, p. 4.

[4] *Loc. cit.*

ing made known this arrangement to the Academy on January 9, 1864, the committee was continued, with power to act. Two years later, on January 27, 1866, the committee submitted its first definite report in the following terms:

"Report of the Committee on Weights, Measures, and Coinage, to the National Academy of Sciences, January, 1866.

"The Committee are in favor of adopting, ultimately, a decimal system; and, in their opinion, the metrical system of weights and measures, though not without defects, is, all things considered, the best in use. The Committee therefore suggest that the Academy recommend to Congress to authorize and encourage by law the introduction and use of the metrical system of weights and measures; and that with a view to familiarize the people with the system, the academy recommend that provision be made by law for the immediate manufacture and distribution to the custom-houses and States of metrical standards of weights and measures; to introduce the system into the post offices by making a single letter weigh fifteen grammes instead of fourteen and seventeen hundredths or half an ounce; and to cause the new cent and two-cent pieces to be so coined that they shall weigh, respectively, five and ten grammes, and that their diameters shall be made to bear a determinate and simple ratio to the metrical unit of length." [5]

This report was considered by the Academy and was transmitted to the Secretary of the Treasury, Hugh McCulloch, with a letter, signed by Joseph Henry, Vice-President of the Academy, giving the views of the majority and minority on the general question under consideration. This very interesting communication was as follows: [6]

"SMITHSONIAN INSTITUTION, WASHINGTON, D. C.,
"February 17, 1866.

"SIR: I have the honor herewith to transmit a report of the National Academy of Sciences on weights, measures, and coinage, adopted at its late meeting in January, after considerable discussion, but not with entire unanimity.

"The subject is one of much perplexity. While, on the one hand, it is evident that a reform of our present system of weights and measures is exceedingly desirable, on the other, the difficulty of adopting the best system and of introducing it in opposition to the prejudice and usages of the people is also apparent.

"The entire adoption of the French metrical system involved the necessity of discarding our present standard of weights and measures—the foot, the pound, the bushel, the gallon—and the introduction in their place of standards of unfamiliar magnitudes and names.

[5] Rep. Nat. Acad. Sci. for 1865, p. 5.

[6] *Loc. cit.*, p. 4.

"Such a change, in my opinion, can only be, in a government like ours, the work of time and through the education of the rising generation, for this purpose, should the resolution now before Congress to establish a bureau of education be adopted, the French metrical system might be taught under the sanction of the government in all the common schools of the country.

"The system, however, is not considered by many as well adapted to the Anglo-Saxon mind as one which might be devised, and it was therefore the opinion of a minority of the academy, that, could England and the United States agree upon a system for adoption, it would in all probability in time become universal.

"The argument in favor of the French metrical system is, however, that it has been already adopted in whole or in part in several nations.

"I have the honor to be, your obedient servant,

"JOSEPH HENRY,

"Vice President of the National Academy of Sciences.

"HON. H. MCCULLOCH,

"Secretary of the Treasury."

The recommendations of the Academy reached Congress either through the President or the Secretary of the Treasury, and were printed in the report of the House Committee of the 39th Congress on Coinage, Weights and Measures on the bills relating to the metric system then pending. This report begins as follows:

"In considering the general subject of a uniform system of coinage, weights and measures, your committee had before them—

"First. That part of the message of the President and accompanying documents relating to these subjects.

"Second. The report of the National Academy of Sciences, embracing their resolutions approving the metric decimal system of weights and measures.

"Third. The report of the United States commissioner to the statistical congress at Berlin.[7]

"Fourth. Various memorials of universities and colleges of the United States, urging a uniform system of weights and measures, also invariably commending the metric decimal system.

"Fifth. The petition of the mayor, judges, and citizens of Baltimore praying for the adoption of the metric system of weights and measures.

"Sixth. Several memorials of citizens in different parts of the United States in behalf of the same object.

"Seventh. The bill H. R. no. 252, referred to them, and proposing the compulsory and exclusive use after a limited period, of the metric system. . . . .

[7] Hon. Samuel B. Ruggles.

" . . . . They also received the assistance of those distinguished members of the National Academy of Sciences who constitute the special committee of that learned society having charge of these subjects, and particularly Professor Newton, of that committee, whose efforts in aid of their purposes have been patient and persevering." [8]

After this follows a résumé of the history of the coinage, weights and measures of the United States, Great Britain and France, and a comparison of the existing weights and measures with the metric system. Finally, on page 20 of the report of the House Committee it is said "Your committee unanimously recommend the passage of the bills and the joint resolutions appended to this report. They were not prepared to go, at this time, beyond this stage of progress in the proposed reform." The reasons are then given and the report concludes with a list of the bills recommended. These are as follows:

"A bill making it lawful to use the metric system.

"A joint resolution directing the Secretary of the Treasury to furnish metric standards to the States.

"A bill to authorize the use in the post offices of weights of the denomination of grams.[9]

"A joint resolution to authorize the President to appoint a special commissioner to facilitate the adoption of a uniform coinage between the United States and foreign countries."

The bills legalizing the use of the metric system, directing the Secretary of the Treasury to furnish metric standards to the States, and authorizing the use in post-offices of weights of the denomination of grams passed the House on May 17, 1866, without discussion.

[8] House of Representatives, 39th Congress, 1st Session. Report no. 62. Coinage, Weights and Measures. (To accompany bills House Res. nos. 596 and 597, and House Res. no. 141.) May 17, 1866. Ordered to be printed. p. 1.

[9] The text of this bill is as follows:

"*Be it enacted by the Senate and House of Representatives*, etc., That the Postmaster General be, and he is hereby, authorized and directed to furnish to the post offices exchanging mails with foreign countries, and to such other offices as shall think expedient, postal balances denominated in grams of the metric system, and until otherwise provided by law, one-half ounce avoirdupois shall be deemed and taken for postal purposes as the equivalent of fifteen grams of the metric weights, and so adopted in progression; and the rates of postage shall be applied accordingly."

They were brought up in the Senate on July 27, 1866, by Senator Sumner, who made a speech on their merits, and were passed on that day without discussion. The last two above mentioned were approved on the same day, July 27, 1866, and the first on July 28, 1866.

Thus, it appears that in this instance the recommendations of the Academy were received and accepted by Congress, and that the action taken was in accord therewith. It is clearly a case in which the Academy helped the Government.

At the same time at which the use of metric measures was legalized, Congress enacted a law enabling the Secretary of the Treasury to supply a set of the standards to each of the States of the Union. The Secretary requested the National Academy to advise him as to the kind and form of standards that should be furnished, the material of which they should be made, and the proper means of verifying them. The request was referred to the Committee on Weights and Measures which reported to the Academy at the meeting of August, 1867. The report was transmitted to the Treasury Department and the recommendations which it contained were adopted.[10]

Congress passed a third act at the same time with the other two, as we have seen, authorizing the use in post-offices of weights of the denomination of grams. The Academy appears not to have been directly concerned in the passage of this measure, but at the annual meeting of the following year (1867) a resolution was adopted to the effect that the Academy considered it "highly desirable that the discretionary power granted by Congress to the Postmaster-General to use the metrical weights in the post offices (should) be exercised at the earliest convenient day." As we have noted in a previous chapter, a committee was appointed in 1868 to urge upon the Postmaster-General the importance of adopting the action mentioned in this resolution, but no results followed at that time.

The interest of the National Academy in metric measures did not end with these proceedings. It will be recalled that two

[10] Rep. Nat. Acad. Sci. for 1879, p. 13.

international conferences were held in Paris to consider the question of preparing new metric standards, one in 1870 and the second in 1872. In this connection a proposition was put forward for the establishment of an international bureau of weights and measures, and the matter was submitted to various governments including that of the United States for consideration. It was brought by the Secretary of the Treasury on March 7, 1873, to the attention of the Academy which in turn referred it to the Committee on Weights and Measures. On June 13 of that year a report was transmitted to the Treasury Department.

Two years later, in 1875, the metric convention at Paris voted for the establishment of an international metric bureau and in April of that year, as was noted in an earlier chapter, the Academy adopted resolutions proclaiming its belief in the usefulness of such a bureau, and its "solicitude that the Government of the United States should ratify the convention prepared to that effect." [11] A copy of the resolutions was transmitted to the President, with a request for his favorable consideration. This letter was as follows: [12]

"NATIONAL ACADEMY OF SCIENCES,
"WASHINGTON, May 3, 1875.

"To the President.

"SIR: I have the honor to transmit to you herewith, in conformity with a resolution of the National Academy of Sciences, the expression of their opinion of the usefulness of an International Bureau of Weights and Measures, which is now the subject of a diplomatic conference at Paris, and of their solicitude that this Government should ratify the convention which has been prepared to that effect, and to ask your favorable consideration of the same.

"Very respectfully, your obedient servant,
"JOSEPH HENRY,
"President National Academy of Sciences."

"Upon this recommendation the convention was ratified by the United States Senate." [13] It was signed at Paris, May 20, 1875, the United States being the first to sign.[14]

[11] Rep. Nat. Acad. Sci. for 1879, p. 13.
[12] Proc. Nat. Acad. Sci., vol. 1, p. 111.
[13] Rep. Nat. Acad. Sci. for 1879, p. 13.
[14] Encycl. Amer., vol. 10, 1904, article Metric System.

Further action in regard to the metric system was taken by the Academy in 1879, besides that mentioned on the preceding pages. This was in the form of resolutions urging that instruction in the principles of the metric system be introduced into the schools and colleges, that laws be enacted by Congress requiring the use of metric weights in the domestic mail service, and that the weights of coins be expressed in grams and milligrams rather than in grains and fractions of grains.

COMMITTEE ON PROTECTING THE BOTTOMS OF IRON VESSELS. 1863

The second committee appointed during the Civil War had for its task the consideration of means for protecting the bottoms of iron ships from injury by salt water. It was appointed May 9, 1863, at the request of the Navy Department, communicated by Admiral Davis May 8, 1863. This was a short-lived committee. It made a brief report on January 9, 1864, and was discharged.

The substance of the report was that, though many plans for protecting the hulls of iron ships had been devised, no one of them had proved sufficiently effective to justify the committee in recommending it for use in the Navy.

It was suggested that experiments should be tried by the committee of the Academy in case means were provided. No means being forthcoming, however, the investigations were never undertaken by the Academy, although the laboratory of the Smithsonian Institution was placed at its disposal.

It may seem strange that the committee, which included among the members the Sillimans and Wolcott Gibbs, should have been unable to make any suggestions in the line of the inquiry with which it was concerned, but it appears that the composition of paints, and the effectiveness or non-effectiveness of different mixtures against corrosion and the fouling of ships has only recently been the subject of scientific investigations. We learn from the writings of Naval Constructor Henry Williams that it has only been within the last five or ten years that the

United States Navy has conducted experiments with paints. Prior to that time commercial brands of paints were adopted, and when a vessel was painted with a particular kind that kind was ever afterwards used for the same vessel. This practice proved both inconvenient and expensive, and in 1906 the Navy Department began a series of experiments to determine what mixtures were most effective to prevent corrosion and fouling. The experiments resulted in the adoption of a paint, known in the service as the "Norfolk paint," for practically all vessels of the navy, two formulas being used, one for an anticorrosive paint and the other for an antifouling paint. Mr. Williams remarks:

"Estimates made in 1910 of the cost of paint for the bottoms of all vessels on the navy list, using the kinds of proprietary brands of paint that were purchased usually prior to 1908 and distributed among the ships in the proportions of each brand then customary and at the prices then current, show that the cost of paint for a single painting of the bottoms of all vessels of the navy, not including coal barges, etc., under the conditions noted, would have been somewhat more than $100,000. The cost of an equal amount of the Norfolk ship's bottom paint at the prevailing cost of manufacture would be less than $33,000. As a majority of the vessels of the navy are painted twice a year, it will be seen that the annual saving to the government by this means at the present time is probably not less than $100,000 annually. It should be noted, however, that largely as a result of the government entering the field with its own paint the prices asked for ship's bottom paint by various firms previously supplying the navy has been so reduced that if, for expediency or for some other reason, the Navy Department decided in the future to purchase all or a portion of its ship's bottom paint, there still would remain an appreciable saving to be credited to the Norfolk paint." [15]

He further remarks on this subject:

"The question of protecting the underwater bodies of sea-going ships always has been vital, and since the use of steel for hulls has become general, a suitable paint for this purpose has been in demand. Various manufacturers offer commerically, generally under proprietary names, so-called ship's bottom paints or compositions, which are designed to effect the double purpose of protecting the bottom plating from the corrosive action of sea-water and, also, of preventing the attaching of the various marine growths, such as grass, barnacles, hydroids, etc. The necessity for the periodic docking of ships, often at intervals of less than

[15] *Engineering News*, vol. 66, no. 5, August 3, 1911, p. 138.

6 months, bears witness to the fact that so far no satisfactory ship's bottom paint has been produced; those in general use represent the best available, but all leave much to be desired." [16]

The foregoing comments on the subject of ships' paint, which are from an authoritative source, and of very recent date, serve to make it clear why the committee of the Academy was unable to recommend definite compositions, or mixtures, and to justify it in proposing that experiments be made to determine the relative effectiveness of different substances. If the subject of ships' paints is still open to investigation, it is obvious that its condition a half century ago must have been much more unsatisfactory.

COMMITTEE ON MAGNETIC DEVIATION IN IRON SHIPS. 1863

The committee known as Committee No. 3, or "the Compass Committee," was appointed on May 20, 1863, at the request of the Navy Department, communicated by Rear-Admiral Davis on May 8, 1863, and had a direct bearing on the operations of the Navy during the Civil War. It grew out of a commission appointed by the Secretary of the Navy in accordance with an Act of Congress "to make experiments for the correction of local attraction in vessels built wholly or partly of iron," approved March 3, 1863, the same day as that on which the Act of Incorporation of the Academy was approved. When the Academy had been organized, the Secretary of the Navy turned the matter over to it, requesting that it would "investigate and report upon the subject of magnetic deviation in iron ships." The similarity of the personnel of the two bodies—the commission and the committee—is of strong interest in connection with the present history. We learn from Professor Bache that the Commission of the Navy Department consisted of himself as chairman, Joseph Henry, Wolcott Gibbs, Benjamin Peirce, and W. P. Trowbridge. The committee of the Academy was the same, with the addition of Charles H. Davis and Fairman Rogers. This transformation

[16] *Engineering News*, vol. 66, no. 5, August 3, 1911, p. 136.

goes far to convince us of the truth of Admiral Davis' assertion that the practical plan for the organization of an Academy was suggested by the Commission of the Navy Department. There appear to have been several such commissions and the one under consideration performed other duties besides the particular one for which it was established. It met in New York on March 19, 1863, to act, by request of the Secretary of the Navy, " as a scientific committee to superintend the placing of the standard compass on board the United States steamer *Circassian,* and to examine the correction and register of its deviations." Its second meeting while acting in this capacity was held in New York, April 21, 1863, the day before that on which the Academy met for organization, and on which a committee drafted the constitution. Not only so, but the committee met in the same place as the Naval Commission—the Brevoort House—and three of the members of the committee were also members of the Commission. These coincidences and relationships reveal to us how close was the interaction between the Naval Commission and the leading spirits in the founding of the Academy.

This committee performed an extraordinary amount of work and prepared a detailed report which covers 73 printed pages. It is difficult to understand how men charged with many onerous duties could devote so much energy to a special investigation, until one considers the condition of the times. Not only were many of the ordinary activities of life suspended or retarded by war, but every loyal citizen, and especially every officer of the Government, felt that he had a patriotic duty to perform in aiding, as far as in him lay, to sustain the cause of the Union.

The Civil War happened at a time when iron ships were fast superseding wooden ones. The Navy had in commission or under construction in May, 1863, some 88 vessels, the majority of which had wooden hulls protected above the water-line by plates of iron. These were known as iron-clads. The vessels with iron hulls were mainly prizes. They were built in England and employed as blockade-runners. The rigging of some vessels was all of rope, of others part iron and part rope, and still others, all iron. The decks of wooden vessels were also often of iron.

Vessels at this time appear to have carried several compasses which were sometimes arranged in pairs, and were placed in what were thought to be the most convenient locations. The presence of large masses of iron, often within a few feet of the compasses caused a large and variable amount of deviation on which account navigation was at times extremely precarious. Various plans had been proposed from time to time for overcoming the local attraction, some of which seem strange indeed, such as setting the compasses in iron pots four inches thick, placing them in zinc cases packed with charcoal, etc. The method which seems to have been most effective was the one invented by the English astronomer Airy, which consists in counteracting the local attraction by means of bar magnets placed in suitable locations. The committee of the Academy adopted this method for the war vessels which they inspected, making use of the services of an expert, A. D. Frye, of New York, to carry it into practical effect. They supervised the correction of the compasses on 27 vessels of all kinds, including sloops, monitors, gunboats, propellers, side-wheel steamers, tugs and transports, and were occupied in the task from March until late in September. Some of the vessels were at New York, others at Boston, Philadelphia, and Hampton Roads. At Philadelphia a compass station had not been established, and at the request of the Bureau of Navigation, one member of the committee, Fairman Rogers, gave personal attention to the ship *Ticonderoga,* which was lying there, and made a special report to the committee.

In addition, Charles A. Schott and G. W. Dean, assistants in the U. S. Coast Survey, made, by direction of Professor Bache, an extended series of magnetic observations on the first-rate iron-clad *Roanoke* and the monitor *Passaic* at the Brooklyn Navy Yard, and also some experiments in the iron-clad *Monadnock* at the Charlestown Navy Yard.

COMMITTEE ON SAXTON'S ALCOHOLOMETER. 1863

While the purpose of this committee was to advise the Government, it was peculiar in that it was appointed at the request of a member of the Academy to examine the invention of another member. The request came from Professor Bache who was at once President of the Academy and Superintendent of the United States Weights and Measures, while Saxton, whose invention was to be reported upon, was a member of the Academy.

The committee, which was appointed May 25, 1863, consisted of John F. Frazer, Joseph G. Totten, F. A. P. Barnard, and William Chauvenet. The hydrometer which the committee was to examine was patented by Saxton, who, however, took occasion to address a letter to the President of the Academy to the following effect: "In taking out a patent for the hydrometer I do not intend to interfere with its free use by the government. My object in patenting it is to have control of its manufacture in private establishments only."[17]

Saxton was a man of unusual inventive genius and had devised many curious and useful mechanisms. Among them was this novel form of hydrometer which he believed superior to that used by the Treasury Department. It consisted of a glass bulb of spheroidal form, to which was attached a chain of one hundred links, which were smaller in proportion as they were nearer the lower end of the chain.[18] The instrument was so constructed that when placed in pure water the bulb and the whole of the chain were suspended, while if placed in absolute alcohol the bulb alone remained suspended and the chain of one hundred links lay in the bottom of the vessel containing the fluid. The percentage of alcohol in any given mixture of alcohol and water could be determined by counting the number of links that remained suspended in the liquid. This instrument was readily portable and was so small that it could be placed in a box three-quarters of an inch in diameter and one inch high.[19]

[17] Rep. Nat. Acad. Sci. for 1863, p. 97.

[18] *Loc. cit.*, p. 96.

[19] *Loc. cit.*, p. 6.

At the time this new instrument was under consideration, the Bureau of Internal Revenue, which was organized the preceding year, was employing Tralles' hydrometer, which, as is well known, is a special form of Gay Lussac's hydrometer. It was not entirely satisfactory, as the committee pointed out, for the reason that the scale was not easily read, and because it was difficult to make the proper allowance for capillary attraction. The committee, which reported on January 7, 1864, recommended in favor of the adoption of Saxton's alcoholometer by the Government on the ground that it was more portable than Tralles', less easily broken, and less difficult to read, although the opinion was expressed that it would be reliable only in careful hands.

COMMITTEE ON WIND AND CURRENT CHARTS AND SAILING DIRECTIONS. 1863

This committee was the fifth among those appointed in 1863. The explanatory note regarding it contained in the *Annual* of the Academy for the year is as follows: "Appointed May 25th, 1863, at the request of the Navy Department, conveyed through Rear-Admiral C. H. Davis, May 23d, 1863, asking for an investigation and report on the subject of discontinuing the publication, in the present form, of the Wind and Current Charts and Sailing Directions."

The history of these publications, the circumstances that brought them to the attention of the Academy, the character of the committee that passed on them, and the verdict of science regarding them are all matters of more than ordinary interest.

They were devised by Matthew Fontaine Maury, whose singular career may be summarized for the benefit of those not already acquainted with it. Maury who was a Virginian by birth, entered the Navy in 1825 and a few years later was detailed to join the United States Exploring Expedition. As an officer of the ship *Vincennes,* he circumnavigated the globe. In 1836 he reached the grade of lieutenant and became astronomer to the expedition. Three years later he met with an accident which caused him to be permanently lame. He became interested during his cruise with the *Vincennes* and on subsequent voyages in studying the winds and other phenomena of the ocean. Rendered incapacitated for active service by the accident which he encountered, he was placed in charge of the Depot of Charts and Instruments, in the Navy Department. Out of this office a little later grew the Hydrographic Office and the United States Naval Observatory. Maury became the head of both these establishments. After it had become impossible for him to make meteorological observations himself he inaugurated a system of distributing specially prepared log-books to captains of vessels in which they might keep a daily record of winds and other phenomena of different parts of the ocean.

The data thus obtained were intended to lighten the labors of navigators, and it was expected that by the study of them sailing captains would be enabled to determine upon the best course in different latitudes and would be informed regarding the character of the storms and winds which they might encounter. The data were published by the Government in a series of charts and books which are described as follows in the report of the committee:

"The publications submitted to the committee consist of seventy-six charts of large dimensions, measuring generally twenty-four inches by thirty-five or six within the borders, and classified into six distinct series, distinguished by the letters *A* to *F*. These classes are entitled severally, 'Track Charts,' 'Trade Wind Charts,' 'Pilot Charts,' 'Thermal Charts,' 'Storm and Rain Charts,' and 'Whale Charts.' Besides these there are two thick quarto volumes of letter press, embracing pp. xxxxi, 383, and viii, 874, respectively. The first of these volumes is illustrated by sixty-three engraved plates, some of them colored, and the second by six. Supplementary to these are three thin tracts, also in quarto, entitled, 'Nautical Monographs,' and embracing in all pp. 48 and five plates." [20]

In addition, Maury, as is well known, published a treatise entitled "The Physical Geography of the Sea," and several other works. The publication of the meteorological data led to the organization of an international congress in 1853, and later, when

[20] Rep. Nat. Acad. Sci. for 1863, p. 98.

the British Meteorological Office was established, Maury's log-books were adopted. In recognition of his services to navigation and meteorology, Maury received many medals and decorations from European societies and Governments.

Regarding the value of Maury's work Sir John Murray and Dr. Johan Hjort recently remarked as follows:

"Maury's work had important consequences, for ship-masters following his directions shortened the voyage between North America and England by ten days, that from New York to California by about forty-five days, and that from England to Australia and back by more than sixty days. The profit derived from the use of Maury's charts by British ship-owners on the East India route alone amounted to 10 million dollars yearly.

"On Maury's suggestion it was decided, at an international congress at Brussels in 1853, that numbers of log-books should be sent out with captains of ships for the purpose of entering observations of wind and weather, of currents, and of temperatures at the sea-surface. This plan has been followed ever since, the notes being as a rule entered once every watch, so that a formidable pile of material has now been amassed. Up to 1904 the Meteorological Office in London had collected 7 millions of these notes, the Deutsche Seewarte in Hamburg more than 10½ millions, the Dutch Meteorological Institute in DeBilt 3½ millions, the Hydrographical Bureau at Washington 5½ millions, and so on." [21]

Upon the outbreak of the Civil War, Maury resigned his office under the United States Government and threw in his fortunes with his native State. Being unfit for active service, he went to England to reside and later became commissioner of immigration for Emperor Maximilian of Mexico. On returning to England in 1866 he was given a banquet in honor of his services as a hydrographer, which was attended by many eminent naval officers and scientific men of England and other parts of Europe. On this occasion he was presented with a purse of 3000 guineas, collected by popular subscription. His last years were spent as Professor of Physics at the University of Virginia.

When Maury left the Naval Observatory on April 15, 1861, his meteorological data, records and papers fell into the hands of James Melville Gilliss, who two days later was appointed to succeed him as the head of the Naval Observatory.

[21] Depths of the Ocean, by Sir John Murray and Dr. Johan Hjort, London, 1912, pp. 214, 215.

In September of the following year the Navy Department was reorganized and the Observatory was included in the new Bureau of Navigation of which Admiral Charles H. Davis became the head. It appears that the publication of the charts and sailing directions was unfinished, and the question arose in the Department whether it should be continued. This question was, on the suggestion of Admiral Davis, referred to the recently-organized Academy of Sciences.[22]

The Academy appears to have considered the question one of special difficulty and importance, as is evidenced by the size and character of the committee appointed to report on it. This was a committee of twelve members, ten of whom were ap-

[22] The correspondence, as given in the Report of the Academy for 1863, pp. 6, 7, is as follows:

"BUREAU OF NAVIGATION, NAVY DEPARTMENT,
"*Washington,* May 21, 1863.

"Sir: I have the honor to inform the department that the charts and sailing directions published by the late superintendent of the Observatory, at the expense of the government, are regarded by hydrographers and scientific men as being prolix and faulty, both in matter and arrangement, to such an extent as to render the limited amount of original information which they actually contain costly and inaccessible.

"I am prepared to recommend the discontinuance of the publication of these charts and sailing directions. But in order that this question of discontinuance may be decided with deliberation, I have to request permission to refer it to the National Academy of Sciences, for investigation, and report to this department.

"I am, sir, very respectfully, your obedient servant,

"CHARLES H. DAVIS,
"*Chief of the Bureau.*

"HON. GIDEON WELLES,
"*Secretary of the Navy.*"

"BUREAU OF NAVIGATION, NAVY DEPARTMENT,
"*Washington,* May 23, 1863.

"Sir: I transmit herewith a copy of a letter addressed by me to the Hon. Secretary of the Navy, on the subject of discontinuing the publication, in the present form, of the 'Wind and Current Charts,' and 'Sailing Directions,' accompanying them; and now, with the approval of the department, I have the honor to refer the same subject to the National Academy of Sciences, for investigation and report, requesting that, on account of the expense and the public interest, it may receive early attention.

"Very respectfully, your obedient servant,

"CHARLES H. DAVIS,
"*Chief of the Bureau.*

"PROFESSOR A. D. BACHE,
"*President National Academy of Sciences.*"

pointed on May 25, and the remaining two a little later. The personnel was as follows: F. A. P. Barnard (chairman), J. H. Alexander, Wm. Chauvenet, J. F. Frazer, J. E. Hilgard, Joseph Winlock, Alexis Caswell, J. H. C. Coffin, Arnold Guyot, Benjamin Peirce, J. P. Lesley, J. D. Dana.

The report of the committee, which was handed in on January 9, 1864, more than seven months after its appointment, occupies fifteen pages, and treats of the different aspects of the publication of the charts and sailing directions considerably in detail. It begins with a brief account of the size, number and character of the publications which were examined, and then discusses the purposes which they appeared to have been intended to serve. It points out that up to the year 1858 more than 200,000 copies of the "Wind and Current Charts" and 20,000 copies of the "Sailing Directions" had been distributed, from which it resulted that the publications and their compiler, Maury, had become widely known.

After showing that although the publications were primarily intended to serve practical ends they had, nevertheless, been regarded in part as containing the results of scientific investigation, the committee discusses them from both points of view.

Its opinion regarding both the scientific and the practical merits of the publications was unfavorable. On the scientific side, the opinion of the committee, which was fortified by quotations from the French writers Bourgois and Lartigue, was that the generalizations contained in the Sailing Directions did not follow from the data collected, that many of the data were left out of consideration, and that the principles enumerated were not correctly based.

On the practical side, the opinion of the committee was that while the data presented were valuable, the form in which they appeared was such as to confuse rather than aid and inform the navigator.

The committee sums up as follows:

"The original idea of these publications was a good one; it is the manner of its execution that is faulty. It was fitting that the laborious analysis of ships' records which has been carried on at the Naval Observatory should be made. It is greatly desirable that it should be continued, and extended to every point of interest in meteorological science and research. It is desirable that the collected and classified results should be compared and studied, and that abstracts of them should be exchanged with institutions and individuals engaged in similar investigations elsewhere, in our own or in other lands. But it is by no means desirable that the immense mass of facts thus collected should be embodied in an indigested or half digested state, into publications designed to be scattered broadcast over land and sea. Out of their careful study may be deducted principles which may form the basis of instructions to navigators worthy to be called 'Sailing Directions,' and such instructions in any suitable form may very fitly be published by the government and circulated among seamen.

"The committee, therefore, with entire unanimity, recommend the adoption of the following resolutions:

"'*Resolved by the National Academy of Sciences,* That, in the opinion of this academy, the volumes entitled 'Sailing Directions,' heretofore issued to navigators from the Naval Observatory, and the 'Wind and Current Charts,' which they are designed to illustrate and explain, embrace much which is unsound in philosophy, and little that is practically useful; and that therefore these publications ought no longer to be issued in their present form.

"'*Resolved,* That the records of meteorological phenomena and of other important facts connected with terrestrial physics, which, under the direction of the Navy Department, have been accumulated at the Observatory, are capable of being turned to valuable account, and that it is eminently desirable that such information should continue to be collected and subjected to careful discussion.

"'*Resolved,* That the president of the academy be authorized and requested to communicate to the Secretary of the Navy a copy of the foregoing resolutions, and of this report, as a response to the inquiry addressed to the academy upon this subject by that officer.'" [23]

Considering the circumstances under which this report was drawn up, it must be conceded that it is moderate in tone and not unappreciative of the labors of Maury. The criticisms of the committee were directed against the form in which the data were published and the deductions drawn from them, rather than against the data themselves. As a result of the committee's report, the publication was suspended. After the Hydrographic Office was regularly organized in 1866, however, the plates from which the charts were made were turned over to it, and in 1873 efforts were renewed to obtain additional meteorological data

[23] Rep. Nat. Acad. Sci. for 1863, p. 112.

from merchant vessels for a new edition. In 1884 the hydrographer reported that sufficient data from this source and from the naval vessels had been collected to form the basis of a new set of charts for the North Pacific.[24]

Commander J. R. Bartlett, the head of the Hydrographic Office remarked:

"The province of the meteorological division is to furnish blank meteorological journals to the masters of merchant vessels who are willing to post them, the masters receiving in return a set of charts covering the route to be traversed. The data obtained from these journals and from the log-books of ships of war are condensed for use in the construction of new editions of Maury's Wind and Current Charts." [25]

COMMITTEE ON THE QUESTION OF TESTS FOR THE PURITY OF WHISKEY. 1864

This committee, appointed to consider a subject which within the last few years has been repeatedly forced on the attention of the Government, was appointed on January 14, 1864, at the request of the Acting Surgeon General of the Army received on the fifth of that month, and consisted of Benjamin Silliman, Jr. (chairman), John Torrey, R. E. Rogers, J. L. LeConte and J. H. Alexander. On March 17, the committee asked for and obtained the use of the sum of $3,500 to be used in experimentation, but later decided that no expenditure of money was necessary.

A brief report was presented on January 6, 1865, as follows:

"In the absence of the chairman of the committee on the question of tests for the purity of whiskey, the members who are present beg leave to report, that after giving the subject their earnest consideration, they have come to the conclusion that in the present condition of chemical science no tests can be employed for determining the age of whiskey and other spirituous liquors. The common adulterations are readily detected. It is not difficult, however, to obtain alcohol that is free from all deleterious admixture. They therefore recommend, for use in the military hospitals in the United States, pure alcohol, medicated with such additions as will qualify it for the particular object for which it is prescribed.

[24] Rep. Nat. Acad. Sci. for 1884, p. 59.
[25] *Loc. cit.*, p. 61.

"No portion of the appropriation granted by the Secretary of War has been expended by the committee." [26]

This report appears at first somewhat enigmatic, because the inference from it would be that the purity of whiskey depended on its age. In one sense, however, this is true because, as is well known, some of the poisonous components of the complex distillate break up in the lapse of time into less harmful ethers, esters and higher alcohols. It follows, therefore, that the older the whiskey, the less harmful its ingredients, and in this sense it is purer.

The practice of prescribing alcohol instead of whiskey as a stimulant, as recommended by the committee, is sometimes adopted in hospitals and has the sanction of physicians.

COMMITTEE ON EXPERIMENTS ON THE EXPANSION OF STEAM. 1864

It is recorded in the first *Annual* of the Academy that on February 29, 1864, "the Hon. Gideon Welles, Secretary of the Navy, invited the appointment of a committee of three members of the Academy to act jointly with three members named by the Department and with three members of the Franklin Institute of Pennsylvania, for the promotion of the Mechanic Arts, to conduct, witness, and report upon experiments which may be agreed upon by the Commission on the expansion of Steam. The experiments are to be reported as early as practicable to the Department, and to be submitted also to the National Academy of Sciences for its judgment and suggestions." [27] The investigation was undertaken by authority of Congress.

The Academy appointed as its committee Fairman Rogers, F. A. P. Barnard and Joseph Saxton. The Navy Department appointees were Horatio Allen, Chas. H. Davis (a member of the Academy) and B. F. Isherwood, and those of the Franklin Institute, J. H. Towne, J. V. Merrick, and R. A. Tilghman.

[26] Rep. Nat. Acad. Sci. for 1864, p. 5. Only Torrey and LeConte signed the report. The other members were absent.

[27] Ann. Nat. Acad. Sci. for 1863-64, p. 39.

Whether any results were reached by this commission is doubtful. A preliminary report was made to the Academy on January 5, 1865, and another report of progress on January 26, 1866, but in 1880 we learn that "owing to the lack of appropriations these investigations have not yet been concluded."[28] In the meantime two members of the commission had died, and perhaps others. In view of this circumstance and the fact that fifteen years after the experiments were begun they were still unfinished, it is improbable that they were ever brought to a conclusion. The most that can be learned is that the object in view was to determine the measure of expansion that would give the best results in practice, that a program for the experiments was considered at a meeting held in New York on June 29, 1864, at the Novelty Iron Works, of which Horatio Allen was the president, that the apparatus proposed by him was approved by the commission, that after delay this apparatus was made ready for use, and that experiments were conducted by five assistant engineers detailed by the Navy Department, one of whom had general charge, while the other four kept regular watch of operations.[29]

A COMMITTEE ON MATERIALS FOR THE MANUFACTURE OF CENT COINS. 1864

This committee, which was misnamed in the reports of the Academy, was appointed on April 11, 1864, at the request of the Secretary of the Treasury, Salmon P. Chase, "to examine and report upon aluminum bronze, and other materials for the manufacture of cent coins."[30] It consisted of John Torrey (chairman), Joseph Henry, Wolcott Gibbs, F. A. P. Barnard and the President, A. D. Bache, who was added by request of the Treasury Department. The phrase from the first *Annual* of the Academy, quoted above, defining the duties of the committee, though occurring in substantially the same form in the report of the

[28] Rep. Nat. Acad. Sci. for 1864, pp. 2 and 5-7; also for 1866, p. 3, and for 1879, p. 9.

[29] See Rep. Secr. Navy, 1864, pp. xxix, xxx, and 1095, 1096, House Exec. Doc. no. 1, 38th Congress, 2d Session; also Isherwood's "Experimental Researches in Steam Engineering," vol. 2, 1865, p. xxxi.

[30] Ann. Nat. Acad. Sci. for 1863-64, p. 40.

President of the Academy, appears not to be quite accurate. If it be so, it may indicate that the views of the Secretary of the Treasury and the Director of the Mint were not entirely in accord regarding the cent coinage. The latter in his report for 1864 remarks: "During the past year some interesting experiments were made with aluminum as an alloy for coins; not with a view to displace the bronze coinage, but to propose a system of tokens for five and ten cents."[31] It is not surprising that the Director of the Mint should not have contemplated a change in the bronze coinage at that date, as the Government had just adopted bronze one cent and two cent pieces, more than 42,000,000 of the former and about 2,000,000 of the latter having been coined in 1864. It would seem that the idea was not at all to displace these new and popular coins, but rather to determine the properties of aluminum bronzes, particularly with a view of employing them for other forms of currency. The experiments were suggested by certain claims put forward in France that a small percentage of aluminum added to silver would prevent the latter from tarnishing when exposed to fumes containing sulphur, while at the same time forming an alloy of considerable hardness.

While the committee had the subject under consideration an article on aluminum bronzes was published by Moreau,[32] and it was found that he had fully covered all the points regarding the characteristics of those alloys which the committee was to investigate. The proceedings were on this account confined simply to preparing a bar of aluminum bronze, and having coins struck from it at the mint in order to ascertain to what extent the alloy was suitable for coinage. The bar was prepared by Joseph Saxton, a member of the Academy, and transmitted by Joseph Henry to the Director of the Mint, who in turn placed it in the

[31] Rep. Dir. of the Mint in Rep. Secr. Treas. for 1864, p. 214. House Exec. Doc. no. 3, 38th Congress, 2d Session.

[32] Moreau, G. Ueber die Eigenschaften der Aluminiumbronze. (Aus Armengaud's Génie industriel, December, 1863, S. 291; durch das polytechnische Centralblatt, 1864, S. 312.) *Polytechnisches Journal,* Herausgegeben von Dr. Emil Maximilian Dingler, vol. 171, 1864, pp. 434-442.

hands of the assayer, J. R. Eckfeldt. The report of the Director of the Mint, James Pollock, contains a statement regarding the nature of the experiments which were made with this bar, the results obtained, and the conclusions derived therefrom. He first remarks that experiments had been made two years previously to determine whether aluminum bronzes could be used for medals, that they had resulted negatively, and that then the use of such alloys for coins had been suggested. He continues:

"A further series of experiments was therefore undertaken here, at the desire of the Secretary of the Treasury and a committee of scientific gentlemen. The latter forwarded to the mint a bar for this purpose, which, by assay, was found to contain the proportion of nine parts copper to one of aluminum. Their directions were closely followed and the principal results may be briefly stated as follows:

"The aluminum bronze, in the proportion just stated, is very rigid under the rolls, requiring many annealings, and liable to crack and break into plates of oblique fracture. . . . . This hardness gives it a great advantage in wear. Coins of the cent size were made of this alloy, of legal bronze, and pure copper. The three varieties placed in boxes and rapidly shaken for a long time,[33] treated equally in all respects, lost by attrition in the following ratio: Assuming the aluminum bronze as the standard of comparison, the legal bronze lost about three times, and the copper about six times as much. This property, however, is of no great consequence in coins of little value.

"A point of much greater consideration is the avoidance or mitigation of the tendency to change color and become foul from the usual causes, viz., the action of oily and saline excretions of the hand; the chemical agencies which are met with in market-stalls, and the slops of drinking saloons, and the mere exposure to air and moisture. If any metal or alloy could be found that would look well, and keep clean with the usage to which our small coins are generally subjected, it would be deservedly popular. This can scarcely be expected. A silver coin can be deprived of its original beauty and become of such a hue as to have its genuineness called into question. Pure aluminum, white at first, assumes a bluish tint by atmospheric action; and aluminum bronze, although closely resembling gold at first, was found, after being held in the sweaty hand for a few hours, to have received an ugly tarnish which destroyed the last argument for employing it in currency.

"After these experiments were concluded others were started, in the hope of finding a binary or ternary alloy which would answer the required conditions, especially as to ductility and keeping color for coins of a grade a little above the cent and two cent pieces. After some progress had been made, it became evident,

[33] This experiment was suggested by Joseph Henry.

from the fact that cents were hoarded to such an extent as to keep them out of circulation, that in the present state of the currency it would be futile to attempt to carry out the project. More than this: we believe the end of our nation's troubles is nigh, and that peace will soon bless our country. With peace we may confidently expect an influx of silver, always more acceptable than any substitute, which will supply every want and furnish a currency of 'small coins' equal to any demand." [34]

Pollock's prophecy as to the return of peace and the return of fractional silver currency into circulation were both fulfilled, and further experiments with aluminum alloys became unnecessary. The work of this committee of the Academy, which was indeed limited in extent, led, therefore, to no practical results.[35]

COMMITTEE ON THE EXPLOSION ON THE UNITED STATES STEAMER *CHENANGO*. 1864

During the Civil War the Government ordered the construction of 27 light-draft side-wheel steamers, intended for use as gun-boats. Among these was the *Chenango*. These vessels were known as "double-enders," or "double-bowed," from the circumstance that they were fitted with a bow and rudder at each end. The *Chenango* was built at a private shipyard in New York. The boilers were constructed at the Morgan Iron Works

[34] Rep. Secr. Treas. for 1864, pp. 214-215. The report of the assayer to the committee of the Academy, which contains many interesting details, is given in full in the Annual Report of the Academy for 1864, pp. 8-10. (House Exec. Doc. no. 66, 38th Congress, 2d Session.)

[35] The experiments mentioned above seem not to have become generally known. We read in Richard's "Aluminum: Its History, Occurrence," etc., the following:

"Aluminum has often been proposed as a material for coinage, but the only recommendation it ever possessed for this purpose was its high price. . . . . It is said that the United States Government made experiments, in 1865, in making aluminum coins, but that the results were not sufficiently successful to induce its adoption. What the difficulties were I cannot find out, but they were—aside from the uncertain value—probably the fact of the great power required to stamp the coins, which is stated to be several times that needed for silver unless the metal is of exceptional purity. The problem of hardening it by adding a little silver or nickel did not probably stand in the way of its adoption. However, as an alloy in ordinary silver coins to replace copper, aluminum can be successfully used, since 5 per cent of aluminum added to silver makes an alloy as durable as ordinary silver coin with 10 per cent of copper, without giving it the yellow color of coin silver."

Aluminum: Its History, Occurrence, Properties, Metallurgy and Applications, including its Alloys. By Joseph W. Richards, M. A., A. C. 2d ed. 8°. Philadelphia, 1890, p. 370.

and were of a kind known as the Martin boiler, which had vertical tubes. A large number of vessels in the Navy were fitted with boilers of this type, while others had boilers with horizontal tubes, opinion being divided as to the relative merits of the two forms.

The *Chenango* was delivered at the Brooklyn Navy Yard early in 1864 and placed in command of Lieutenant Fillebrown. On the afternoon of April 15 the vessel left the Navy Yard for Sandy Hook to join the *Onondaga* for blockade service. She steamed slowly past Governor's Island and entered the Narrows, when one of her boilers exploded, scalding thirty-two of the crew of whom twenty-eight died.[36]

This terrible accident "appalled the whole country," and an inquest was immediately held in New York to ascertain if possible the circumstances under which it occurred. A very large number of witnesses were examined, and the testimony given occupies 141 printed pages.[37] The jury was unable to agree and two verdicts were rendered, the majority holding that the accident resulted from "the bursting of one of the boilers, which was caused by a greater tension exerted on the boiler than it could bear, the result of the unproper bracing," while the minority asserted that the boiler "exploded from low water and superheated steam."

The specifications for the boilers were prepared by the Navy Department, while the boilers themselves, as already mentioned, were built at private iron works in New York. It is probable that the majority verdict was unacceptable to the Navy Department because it could be interpreted as implying that the specifications were faulty. Doubtless on this account the Department, on April 30, 1864, through its Assistant Secretary, authorized the President of the Academy to appoint a committee to make an independent investigation of the cause of the accident. He appointed J. F. Frazer, Fairman Rogers and

[36] See the New York *Herald* for April 16 and 17, 1864.

[37] See "The Boiler Explosion of the Martin boiler on board the U. S. 'Double-ender' *Chenango*. The Coroner's Inquest. A full report of the testimony, the charge of Dr. Norris to the jury and the verdicts." New York, 1864. 8°.

L. M. Rutherfurd on May 2, 1864, as the committee. The committee visited the Brooklyn Navy Yard and made a painstaking examination of the boilers, " one of the committee having entered the boilers and made a minute and thorough examination of their internal condition." The detailed report submitted on August 5, 1864, contains the following conclusion; " The committee are unanimously of opinion that the rupture of the shell of the boiler of the *Chenango* was caused by the insufficiency of the vertical stays, by which the top of the boiler was fastened to the tube-boxes to withstand the pressure for which the boiler was intended, and that these stays were both deficient in number and injudiciously arranged," and again " the committee are of opinion that the boiler was not braced in accordance with the specifications, and that this difference was the cause of the disaster."[38] This report clearly throws the main responsibility for the accident on the private constructors rather than on the engineers of the Navy Department, though it would seem that the Government inspectors were not entirely absolved thereby. As a slight concession to the makers of the boilers, the committee in closing points out a certain fault in the specifications which they had corrected.

COMMITTEE ON GALVANIC ACTION FROM ASSOCIATION OF ZINC AND IRON. 1867

At the close of the Civil War and for some years afterwards the headstones which marked the graves of soldiers in the national military cemeteries consisted for the most part of wooden blocks, painted white, with the names of the soldiers, the numbers of the regiments to which they belonged, and other data in black lettering. It was felt both by the Government and by the general public that these perishable marks should be replaced by others of an enduring character before the records which they bore should become obliterated.

It was determined by the War Department, probably on the recommendation of General Meigs, Quartermaster-General,

[38] Rep. Nat. Acad. Sci. for 1864, p. 13.

that the permanent marks should take the form of cast-iron blocks coated with zinc. It was suggested to the Secretary of War, however, that these blocks might be injured or destroyed as a result of galvanic action between the two metals. He, therefore, requested through the Acting Quartermaster-General that a committee of the Academy be appointed to advise him as to the probability of such action in the metal headstones.

The letter was as follows:[39]

"QUARTERMASTER GENERAL'S OFFICE,
"*Washington*, D. C., *January* 8, 1867.

"SIR: It having been suggested to the War Department that the coating with zinc of the iron head-blocks, with which it is proposed to mark soldiers' graves, will produce galvanic action that will tend to a destruction of the iron blocks, the Secretary of War has directed me to submit the subject to the Academy of Sciences here, with a view to obtain an intelligent opinion on it, and to ascertain if there be any good ground for the apprehension.

"In obedience to this direction, I respectfully submit the subject to you with a request that you will present it to the Academy of Sciences and advise me of their opinion thereon, that I may make report thereof to the Secretary of War.

"I am, very respectfully, your obedient servant,

"D. H. RUCKER,
"*Acting Quartermaster General, Brevet Major General.*

"The PRESIDENT OF THE ACADEMY OF SCIENCES, *Washington, D. C.*"

A committee consisting of Joseph Henry, J. H. C. Coffin and Joseph Saxton was appointed by the President on the same day. It reported on January 17, as follows:

"NATIONAL ACADEMY OF SCIENCES,
"*Washington, January* 17, 1867.

"SIR: In compliance with your request, the undersigned, a committee of the National Academy, appointed to examine the proposed cast-iron head-blocks for soldiers' graves, and state whether, in their opinion, the coating of zinc will tend to produce a galvanic action destructive to the iron, respectfully report as follows:

"The head-block submitted to the committee is a hollow truncated pyramid of cast iron, on one side of which, in raised figures, is the No. 12,646, and on the top, also in raised letters, the name of a soldier, his regiment, and a date, probably that of his death. This block is entirely covered inside and out with

[39] Rep. Nat. Acad. Sci. for 1866, p. 17. Sen. Misc. Doc. no. 44, 40th Congress, 1st Session.

a coating of zinc, of greater thickness on the surface containing the letters and figures.

" From well-established principles of galvanism, and from the direct experiments of the committee, it is certain that while the zinc coating covers every part of the surface of the iron, no other galvanic action will take place than that exhibited in the ordinary corroding of a single metal, but that as soon as the smallest portion of the iron is exposed to the liquid precipitation from the atmosphere, a galvanic current will be established passing through the liquid from the zinc to the iron, that the former will be more rapidly corroded than it was previous to the exposure of the iron, and that this action will go on until all the zinc is dissolved. The iron, during the process, will be protected from the action of the atmosphere at the expense of the zinc. After all the zinc has been dissolved, the iron, being unprotected, will then be corroded in the usual manner.

" From this statement it is evident that the coating of zinc will tend to prolong the existence of the iron in its metallic state, though it will not afford a perpetual protection such as may be given by a coating of enamel like that used in covering the basins of iron sinks, kettles, etc.

" The experiment made by the committee consisted in attaching to one end of the wire of a galvanometer a plate of zinc and to the other end a plate of iron. These two plunged in a vessel of water slightly acidulated by sulphuric acid, gave rise to a powerful current of galvanism from the zinc to the iron. While the zinc was rapidly corroded the iron remained unaffected. By substituting for the zinc a plate of copper, a still more powerful current was produced in the opposite direction. The iron in this case was violently acted upon, while the copper retained its brightness.

" The committee may state, as a general rule, that when two different metals are placed in metallic contact, the one most readily acted on by an acid will be dissolved, while the other will be protected, and that the action on the metal dissolved will be increased in intensity by the association. Thus, iron in association with zinc is protected, while the same metal in connection with copper is more rapidly corroded than it is without such connection.

" Respectfully submitted,

" JOSEPH HENRY,
" J. H. C. COFFIN,
" JOSEPH SAXTON.

" GENERAL D. H. RUCKER, U. S. A.,
" Acting Quartermaster General."

It will be observed that this report refers exclusively to the metals composing the headstones and that the opinion expressed was that iron blocks would not endure perpetually. While the report was pending, a discussion of another character regarding these headstones took place in the Senate. The House of Representatives had passed a bill (House Res. no. 788) for the marking of soldiers' graves in the National Cemeteries, and this bill was reported from the Committee on Military Affairs to the Senate on January 18, 1867. It was in charge of Senator Wilson of Massachusetts, who, it will be remembered, introduced the bill for the incorporation of the Academy in 1863. The following discussion ensued:

" NATIONAL CEMETERIES.

"(Senate, January 18, 1867.)

" MR. WILSON. I am directed by the Committee on Military Affairs and the Militia to report back without amendment the bill (H. R. No. 788) to establish and protect national cemeteries; and I ask for its present consideration.

" By unanimous consent, the Senate, as in Committee of the Whole, proceeded to consider the bill. . . . .

" The second section provides that each grave shall be marked with a small marble or cast-iron headstone, with the number of the grave thereon corresponding with the number opposite to the name of the party inscribed on the monument. . . . .

" MR. WADE. I have seen some of these iron monuments provided for by this bill, and I think it is not creditable to the country to have such monuments over the graves of our soldiers. They are small cast-iron slabs, not more, perhaps, than eighteen inches high.

" MR. RAMSAY. Not over twelve inches.

" MR. WADE. Perhaps that is it; I did not measure them. They look more like a tin kettle than anything else, and are liable to be kicked off and kicked about and changed from one grave to another by any mischievous person. I think the Committee on Military Affairs cannot have seen a specimen of them. They seem to me to be totally inadequate for the purpose contemplated, and it is discreditable to the country to erect such things as monuments for its soldiers.

" MR. CONNESS. A kind of solemn toy!

" MR. WADE. Yes, a solemn toy, or whatever you please. It is a burlesque rather than a monument. If we cannot do any better than that, I would much rather that nothing should be done. I think it is discreditable to us, and must be a means of wounding the feelings of the relations of the soldiers who may have occasion to visit the cemeteries where their remains are deposited.

" I hope the bill will not pass in this form. I think it had better lie over, and let the Committee on Military Affairs inspect these monuments and see if some better model cannot be adopted. I was assured by persons in charge of some of the cemeteries that they were entirely opposed to the adoption of any such plan or style of monument, and I agree with them most heartily. I think if the Military Committee will look into the subject they will come to the same conclusion that I have arrived at. There are other gentlemen here who inspected some of these cemeteries at the same time that I did, and who as I understand came to the same conclusion.

"MR. WILSON. By existing law the War Department was authorized to prepare these monuments, and I am told they have agreed upon this plan. I have no particular reason for pressing this bill now if the Senate does not wish to act upon it at present. I am willing to take time to make further inquiries. The main feature of the bill, however, and the great object is to get possession of the land necessary for the sites of these cemeteries.

"MR. RAMSAY. I think if the chairman of the Committee on Military Affairs would inquire of the Quartermaster's Department in this city he would find a large number of protests there from all those who have charge of these national cemeteries in the South against the adoption of this plan, which seems to have met the approbation of the Department, of iron tombstones, so called. They almost universally object, and there are many representations on file upon the subject. I think the committee should take some steps immediately to check the further execution of the contract if it has already been entered into. It is unquestionably wrong.

"MR. WILSON. I have no objection to the bill lying over, and I shall call it up after I have made the necessary inquiries.

"The PRESIDENT *pro tempore.* Does the Senator make that motion?

"MR. WILSON. I do.

"The PRESIDENT *pro tempore.* It is moved that the further consideration of this bill be postponed.

"The motion was agreed to."[40]

On February 9, 1867, the bill was recommitted to the same committee and was reported back on February 13, 1867.

On February 14, 1867, it was taken up for discussion and the 1st and 2d sections amended and consolidated so as to direct the Secretary of War merely "to cause each grave to be marked with a small headstone, or block, with the number of the grave inscribed thereon," etc., without specifying the material. The bill was then passed.[41]

[40] *Congressional Globe,* January 18, 1867, pp. 539, 540.

[41] *Op. cit.,* pp. 1118, 1308.

The Secretary of War had, in the meantime, received the report of the Academy, which he acknowledged in the following letter: [42]

"WAR DEPARTMENT, WASHINGTON, D. C.,
"January 23, 1867.

"PROF. HENRY, ETC., ETC.

"DEAR SIR: The report made at my request by the National Academy, relative to the subject of galvanic action on the iron head-blocks proposed for marking soldiers' graves, has been submitted to this department, and I offer my thanks to the Committee for the valuable information it contains. I beg now to refer the case back again for report whether there is anything known to the Academy of a nature which would be more suitable on account of its durability, and at the same time not so expensive as to forbid its use for the purpose, than the combination of materials already submitted to your Committee for their opinion; and would be glad to have an opinion as to the fitness of these materials for the purpose designated.

"Very respectfully, dear sir, your obedient servant,

"EDWIN M. STANTON,
"Secretary of War."

There is no evidence in the records of the Academy that this second request was complied with, though in view of subsequent proceedings it is not unlikely that it was.

As indicated by the discussion in Congress, opinion in the War Department was divided on the subject of the headstones, some officials favoring the iron blocks and others regarding them as unsuitable. Quartermaster-General Meigs was absent from duty on account of illness during the year 1867 and a part of 1868 also, and on December 19, 1867, the acting officer, General Rucker, made a number of recommendations to the Secretary of War relative to the National Cemeteries, among which was the following:

"That proposals be speedily invited by the Quartermaster-General for cast-iron (zinked) head-blocks of the pattern enclosed, in quantities sufficient to mark all the graves not now supplied with proper wooden head-boards; and that the contract for them be let, and the blocks erected without delay (provided it shall be deemed too expensive to erect stone blocks, after definitely ascertaining the true cost of the same)." [43]

[42] Proc. Nat. Acad. Sci., vol. 1, pp. 61, 62.

[43] Rep. Secr. War for 1868, vol. 3, part 1, p. 908. Exec. Doc. no. 1, 40th Congress, 3d Session.

The paper was returned on January 3, 1868, with the following endorsement: " Erect the fences and lodges, but do nothing about the headstones. By order of the Secretary of War. (Signed) Ed. Schriver, Inspector General." [44]

Later, when General Meigs returned to duty, he submitted a report, dated October 20, 1868, in which he remarked:

" ON HEADSTONES IN NATIONAL CEMETERIES.

" No progress has been made in erecting, as required by law, permanent blocks at each grave.

" I am still of the opinion that the best monument for this purpose yet contrived is the small rectangular block of cast iron, galvanized to protect it from rust, and filled with earth or cement.

" This planted at the grave will last for many years. It is not costly, is easily transported, and not an object of plunder.

" With the wages of stone-cutters at $5 a day, the cost of 320,000 headstones properly lettered would be a very great charge upon the treasury.

" The wooden head-boards are now rapidly decaying, and to replace them is expensive.

" For the action of the department in this matter I refer to the detailed report of Colonel [C. W.] Folsom herewith." [45]

No further action appears to have been taken in the matter until 1872, when Congress amended the Act of 1867, so that the Secretary of War was directed merely to " cause each grave to be marked by a small headstone, with the name of the soldier and the name of the State inscribed thereon." [46] The question of material, which is here omitted, as it was from the Act of 1867, was finally settled the following year, when Congress directed that, " the headstones . . . . shall be of durable stone, and of such design and weight as shall keep them in place when set, ... and the Secretary of War shall first determine for the various cemeteries the size and model for such headstones, and the standards of quality and color of the stone to be used." [47]

[44] *Loc. cit.*

[45] Rep. Gen. M. C. Meigs, Quartermaster General, in Rep. Secr. War for 1868, p. 818. Colonel Folsom's report occurs in the same document, pp. 894-916.

[46] Stat. at Large, vol. 17, 1873, p. 345, 42d Congress, 2d Session, chap. 368. Act approved June 8, 1872.

[47] Stat. at Large, vol. 17, 1873, pp. 545, 546, 42d Congress, 3d Session, chap. 229. Act approved March 3, 1873.

Thus, after the lapse of more than six years the Government was committed to a course of action which was in harmony with the advice of the Academy, though it is probable that esthetic and sentimental considerations had more weight than that of permanence.

COMMITTEE ON PROVING AND GAUGING DISTILLED SPIRITS AND PREVENTING FRAUD. 1866

In the early history of the United States excises or internal revenue taxes were extremely unpopular on account of their association in the minds of the people with the despotism and extortions of colonial times. Nevertheless, the Government found it necessary to lay such a tax in 1791, which led to resistance and the well-known Whiskey Insurrection of 1794. In Jefferson's administration all internal revenue taxes were abolished, but it was found necessary to revive them again in connection with the War of 1812. After that war they were once more discarded and no excises were collected subsequently until the outbreak of the Civil War. The enormous demands then made on the treasury necessitated the establishment of a vast series of internal revenue taxes, which were levied on property and activities of every description, Nothing was too great or too small to be pressed into service and the revenue collected in this way in the year 1866 amounted to more than $300,000,000.

Among the articles subjected to taxation at this time were distilled spirits manufactured in the United States. At an earlier date only imported spirits were taxed and a simple system of inspection sufficed, but the collection of a high internal revenue tax on all domestic spirits necessitated much greater vigilance, a better form of proving instruments and a more elaborate system of inspection. By a singular coincidence the system of inspection employed for fifteen years prior to the Civil War was based on the recommendations of Professor Alexander Dallas Bache, the first President of the Academy. This system had now to be modified to adapt it to the new conditions.

On February 15, 1866, the Secretary of the Treasury Hugh McCulloch addressed a letter to Joseph Henry, then acting President of the Academy, requesting that a committee be appointed to report to the department on the best method of proving and gauging alcoholic liquors, with a view to the establishment of such rules and regulations as would insure a uniform system of inspection of spirits subject to duties.[48] Professor Henry accordingly appointed a committee to consider the subject, assuming the chairmanship himself and designating as his associates J. E. Hilgard and M. C. Meigs. At the same time, F. A. P. Barnard, John Torrey and B. F. Craig were requested to prepare tables of standard mixtures of alcohol and water. Dr. Craig was not a member of the Academy.

The chief difficulty regarding the system recommended by Professor Bache in 1848 was that the Tralles hydrometer, which was the one then proposed, gave percentage in alcohol, instead of percentages in "proof spirit," or a mixture of 50 per cent alcohol and 50 per cent water, upon which all commercial negotiations were based. While the former could readily be converted into the latter in most cases, it would lighten the labors of the inspectors if their hydrometers gave readings in proof spirits. Tralles' hydrometer, furthermore, was not adapted for quick observations within one per cent, which it was necessary should be recorded, on account of high duty; or for gauging large quantities of spirits out-of-doors in inclement weather, or under other unfavorable circumstances. It was also found that the tables used by the Treasury Department were not entirely correct.

In view of these circumstances, the committee set itself the laborious task of finding a more convenient hydrometer, and of preparing new tables. Its report was submitted on July 21, 1866. The recommendations were that following the custom of the trade, the strength of distilled spirits should be estimated according to their equivalent in proof spirits, and be expressed in terms of percentage of proof spirits rather than by the use of the

[48] Rep. Nat. Acad. Sci. for 1866, p. 18.

terms "above proof" and "below proof"; that a special form of hydrometer designed by Wm. G. Tagliabue of New York, be used instead of the ordinary Tralles instrument, and that the Government should test these hydrometers and issue them to the inspectors free of expense. The hydrometers, which were figured in the report of the committee, were to be made in series of five each, so graduated as to cover all percentages from pure alcohol to pure water. The tables which accompanied the report cover 25 pages. They give real and apparent specific gravities and percentages for all mixtures of alcohol and water at different temperatures from zero to 100° Fahrenheit, together with other data of similar character. In addition, the report has appended to it a "Manual for inspectors of spirits," consisting of tables showing the true percentage of proof spirits for and indication of the hydrometer at temperature between 0° and 100° F., and instructions for their use. This part of the report covers thirty-four pages.

The committee was not content to restrict its tables to the temperature limits of the earlier ones, but carried on an elaborate series of experiments to ascertain the proper readings of hydrometers at temperatures as low as zero Fahrenheit. This was necessitated by the fact that spirits were sometimes received at warehouses in the Northern States in winter time at temperatures far below freezing and often approaching the zero of the Fahrenheit scale. These experiments were carried on, by request of the Treasury Department, at the laboratory of the Surgeon-General's Office, and were conducted by Dr. B. F. Craig.

The committee also considered various forms of hydrometers and decided to recommend one which, in its opinion, was best adapted for the revenue service. Dr. John Torrey and Dr. F. A. P. Barnard made especially accurate mixtures of water and alcohol and prepared and marked a series of delicate floats which were afterwards used by Tagliabue in graduating the hydrometers which he manufactured for the Treasury Department.

The whole report, covering 39 printed pages, was, as already mentioned, submitted to the Secretary of the Treasury on July 21, 1866. In the Annual Report of the Academy for 1866 Joseph Henry said regarding the work of the committee:

" . . . . The duty devolved upon the members of the committee was one of much labor and responsibility. The tables accompanying the report are of much value, and will be referred to by all persons engaged in pursuits requiring a knowledge of specific gravity and volume, at various temperatures, of alcoholic spirits of different strength; they are not only indispensable to the distiller, rectifier and gauger of spirits, but will prove extremely useful in the laboratory of the chemist, and in many processes of manufacture involving the use of alcohol." [49]

At an earlier date, however, on April 19, 1866, the committee recommended to the Treasury Department the adoption of a definition of " proof spirit," and this definition was incorporated in the internal revenue law,[50] together with the provision that the Secretary of the Treasury should procure suitable hydrometers and other instruments. At the beginning of the fiscal year 1866-67, therefore, the Treasury Department was in possession of the information necessary for the establishment of a new system of proving and gauging spirits and the authority for carrying it into effect. In his report for 1867 the Commissioner of Internal Revenue remarks on this subject as follows:

" For several years there had been frequent complaints of a lack of uniformity in the inspection of distilled spirits in different sections of the country. The accounts of revenue officers were disturbed, and the interest of shippers prejudiced by difficulty in procuring their proper allowance for leakage. The Treasury, too, was frequently, it is presumed, unfavorably affected by an excess of such allowance. To secure, therefore, a uniform and correct system of inspection and gauging of spirits subject to tax throughout the United States, the Secretary of the Treasury, in February last, adopted the hydrometer of Mr. Tagliabue, of New York. This hydrometer was approved by a committee of the National Academy of Sciences, consisting of Professor Henry, General Meigs, and Professor Hilgard, and has been furnished, with an accompanying manual prepared and printed for that purpose, to collectors of the Internal Revenue for the use of duly appointed inspectors in their several districts. The caliper and head-rod system of gauging has been

[49] Rep. Nat. Acad. Sci. for 1866, p. 3.

[50] See Stat. at Large, vol. 14, 1868, p. 157, 39th Congress, 1st Session, chap. 184, sec. 33, and Rep. Nat. Acad. Sci. for 1866, p. 21.

adopted likewise, and a manual of instructions in their use furnished revenue officers. The hydrometers are furnished by the manufacturer in sets of five, at a charge of eighteen dollars per set, and in sets of three at thirteen dollars. Seven hundred and thirty-four sets have been received from the manufacturer at a cost of $11,826.50, and about five hundred sets have been distributed to officers. Inspectors supply themselves at their own charge with the necessary gauging instruments." [51]

Thus the work of the committee relative to the proving and gauging of spirits was completed, but the question of the prevention of fraud still remained for consideration.

There was a widespread belief at the time, based on the strongest evidence, that the Government was being deprived of a vast amount of its revenue through frauds practiced on an enormous scale, either by the distillers separately or in collusion with the inspectors, and many thought that these could be stopped by making the capacity of the distilleries the basis of the tax. The Commissioner of Internal Revenue, E. A. Rollins, was convinced that this idea was erroneous, but he was of the opinion that measurement of the output by means of meters attached to the stills would aid the inspectors in detecting gross misstatements of the amount of spirits manufactured, besides having incidental advantages. He remarks in his report for 1867 regarding the law as follows:

" It does not undertake to levy the tax in accordance with any real or estimated capacity, for this has always been regarded as impracticable; but it does endeavor to give to revenue officers information from which the possible product may be approximately estimated, so that fraud may well be presumed if the product returned is unreasonably small. . . . . Could the production of distilleries be ascertained for the purpose of taxation by some mechanical means, and were it impracticable for distillers to deceive officers or to collude with them, it is evident that much of the cost of supervision would be avoided, while efforts to discover illicit spirits after they have left their place of production would no longer tend to embarrass and discourage honest dealers. It was for this reason that the Department was persuaded nearly two years ago to invite the co-operation of the National Academy of Sciences, and a committee of the Academy, consisting of Professors Joseph Henry and J. E. Hilgard, gentlemen of eminent ability and wide reputation, has given the subject the full consideration which its importance deserves." [52]

[51] Rep. Comm. of Int. Rev. for 1868, p. xxxiii.

[52] Rep. Comm. Int. Rev. for 1867, pp. xxvii, xxviii.

The committee, on its part, believed that an instrument could be devised that would measure the output of the stills. In its report of July 21, 1866, the committee remarks:

"The committee confidently believe that a *spirit meter* can be constructed which will register the quantity of spirits passing from a still, and afford a reliable check on the distiller and inspector.

"They recommend that an instrument based upon the principle of Worthington's water-meter be constructed and submitted to trial.

"Of various inventions submitted for measuring and registering the quantity of spirits passing from a still, the only one which has commended itself for simplicity and certainty of action, is that of Cox & Murphy, of Montreal, which the committee likewise recommend to be submitted to actual trial in a distillery, for several months, under the supervision of an officer of the revenue." [53]

And in the report for 1867:

"The desire of the Internal Revenue Department to possess a reliable spirit-meter having become generally known through its officers and agents, a large number of inventions were brought forward, from time to time, between June, 1866, and January, 1868, and referred to this committee. The examination of the various plans and models, and the correspondence incident thereto, involved the expenditure of much time and labor, the constant aim being to develop any promising plans by pointing out defects, and making suggestions of improvement when practicable." [54]

The committee examined in all some 18 different meters and submitted written reports on most of them. This work occupied a year and a half, the last report being submitted on January 2, 1868. The meter of Cox and Murphy did not, in the end, prove satisfactory, and the committee finally turned to that of I. P. Tice, of New York, which was recommended to the Treasury Department for adoption on April 3, 1867. On August 1, 1867, Joseph Henry and J. E. Hilgard read before the Secretary of the Treasury and the Commissioner and Deputy Commissioner of Internal Revenue a statement relative to modes of defeating the operation of spirits meters.[55] On October 9, 1867, they submitted rules for the use of the Tice meter, and by the end of that year 19 such meters had been attached to distilleries in

[53] Rep. Nat. Acad. Sci. for 1866, p. 56.

[54] Rep. Nat. Acad. Sci. for 1867, p. 12.

[55] *Loc. cit.*, p. 24.

New York. Early in 1867 General Meigs was obliged to withdraw from the committee on account of ill health. He was replaced by L. M. Rutherfurd, who in turn was prevented by sickness from taking an active part in the work of the committee. The labors of 1867 fell, therefore, entirely upon Henry and Hilgard.

No sooner had the adoption of the Tice spirit meter been decided upon than difficulties began to arise regarding it. The manufacturer, through sickness and unforeseen mechanical difficulties, failed to deliver the meters as promptly as agreed upon, and he also claimed that on account of the small number ordered the cost of manufacturing them was necessarily greater. The Treasury Department thereupon increased the order to 100 meters. As already mentioned, a number of these instruments were attached to distilleries in New York late in 1867 and early in 1868. They had scarcely been put into operation than a storm of opposition arose from the distillers, and on February 3, 1868, a joint resolution of Congress was approved appointing a commission of five persons who, in connection with the committee of the Academy, should again immediately examine all meters presented to them for consideration and report to Congress in detail the results of their examination, together with such recommendations as would in their opinion promote the interests of the Government. The resolution also directed that all work on the construction of meters under direction of the Treasury Department should be suspended until the report was submitted, and that no further contract for such instruments should be made under the act of March 2, 1867.[56]

The introduction of this resolution led to an extended and acrimonius discussion in both houses of Congress, a discussion which took a wide range and even involved the question of the integrity of the highest officers of the Government. Those who opposed the measure did so on the ground that no form of meter would protect the Government from fraud, or that scientific men were not qualified to pronounce on the practical utility of

[56] See Stat. at Large, vol. 15, 1869, pp. 246, 247, 40th Congress, 2d Session, Res. no. 9.

such instruments as applied to distilleries, or that the new committee would merely renew the recommendation of the committee of the Academy, or that to enact the second section of the resolution, which prohibited the Treasury Department from attaching any more meters to distilleries until the Commission reported, would open the door to greater frauds. Those who favored the resolution pointed out that the Tice meter had proved effective as far as tried, but that other devices had been brought forward after the adoption of the former had been decided upon, which while operating on the same principle, might give more accurate results, or operating on other principles might give a better indication of the amount of spirits produced or producible. They considered that the inventors of these devices were entitled to a hearing and that the distillers should not be compelled to pay for the Tice meters while it was still uncertain whether they might not be soon discarded for more effective ones. In the end the resolution prevailed and was approved.

Upon the passage of this resolution, the manufacturer whose meters had been adopted by the Treasury Department, I. P. Tice, discharged his employees and closed his manufactory. The report of the new commission was submitted in March, 1868, and was again favorable to the Tice meter, which the committee of the Academy had already recommended. No action was taken thereon, however, until July 20, 1868, when the Commissioner of Internal Revenue was authorized to adopt and prescribe for use such meters as he should deem necessary. He once more adopted the Tice meter, and Mr. Tice was persuaded to reopen his manufactory and construct the instruments required. Though he employed some 125 workmen to construct the meters and others to attach them to the distilleries, only eleven were so equipped in November, 1868. The distillers resisted the use of the meters as far as possible, and some closed their distilleries to prevent the application of the instruments.[57]

The matter had progressed thus far when the Commissioner of Internal Revenue began to entertain suspicions as to the

[57] Rep. Comm. Int. Rev. for 1868, pp. xx, xxi.

real utility of the meter and to resolve his doubts he, accordingly, appointed an expert commission to make a series of practical tests regarding it in order to ascertain whether its use should be continued.[58]

Who these experts were, or what was the nature of their finding is not disclosed in the reports of the Commissioner of Internal Revenue, but it is evident that the latter was unfavorable to the use of the meter, for we read in the report for 1871 that "the period within which distillers were required to procure meters was extended from time to time until the 8th day of June, 1871, when Circular No. 96 was issued discontinuing their use." [59]

Thus, at the end of nearly five years' agitation of the subject the Government abandoned its project of utilizing meters to gauge the capacity of distilleries, but found itself in possession of improved instruments for proving spirits. Of the latter, which were recommended by the committee of the Academy the Commissioner of Internal Revenue said in 1871, "These instruments distributed under the present system of inspection, seem to give general satisfaction, and their accuracy and uniformity have relieved the trade of the embarrassments resulting from errors in gauging." [60]

COMMITTEE ON THE IMPROVEMENT OF GREYTOWN HARBOR, NICARAGUA. 1866

For one brief period the Academy was concerned with a question connected with the great problem of an isthmian canal which had occupied so many minds since the discovery of America. In the middle of the 19th century attention was being concentrated more and more on Nicaragua as the region which offered the greatest natural advantages for the construction of this important artificial waterway, and diplomatic contests were being waged unceasingly by capitalists and by the principal commercial nations of the world to gain or maintain control over the

[58] Rep. Comm. Int. Rev. for 1869, pp. xvi, xvii.

[59] Rep. Comm. Int. Rev. for 1871, p. vi.

[60] *Op. cit.*, p. vii.

enterprise. Companies were organized which obtained valuable concessions from the existing Nicaraguan government, only to have them withdrawn in a few months by a succeeding government; undertakings commenced with great enthusiasm and a liberal outlay soon languished for lack of financial support, or terminated abruptly in consequence of the expiration of charters; adventurers appeared who misled the Nicaraguan legislatures by claiming the support of European powers, but were soon repudiated by their governments and forced to withdraw. Such kaleidoscopic changes went on continuously down to the time when the French Panama Canal Company decided to offer its holdings to the United States at a price which the latter was willing to consider, and attention turned suddenly from Nicaragua to Panama.

Among the American companies which undertook to build the Nicaraguan canal and obtained concessions from the government was one organized in 1849 and called the "Compania de Transito de Nicaragua." This was soon merged in the larger "Atlantic and Pacific Ship-Canal Company" controlled by Cornelius Vanderbilt and other American capitalists. As the ship-canal was likely to be long in building, a subsidiary company was formed in 1851, which opened a passenger route from Greytown up the San Juan River and across Lake Nicaragua by boat, and thence down to the Pacific coast by a stage road. This route had been in operation but a few years when the American adventurer Walker appeared in Nicaragua and having been successful in overturning the existing government proceeded to have the charter of the canal company revoked and its property confiscated in retaliation for an action unfavorable to his ambitions which was taken by the United States. While the company was endeavoring to recover its rights, a French adventurer persuaded the Nicaraguan government to turn over the canal concession to him, claiming that he was supported in his enterprise by France. The French government, however, repudiated him, and the Nicaraguans being now in a friendly mood toward the United States granted the rights of the steam navigation within her territories and the construction of an interocean canal to a new American organization, known as the Central American Transit Company of which Francis Morris was the president.[61] It was this company which invoked the aid of the National Academy of Sciences in solving the problem of improving the harbor of Greytown on San Juan del Norte, that was to be the Atlantic terminus of the canal.

At the beginning of the 19th century the harbor was one of the most important on that coast. In 1832 it was reported that its width at the mouth was one and three-quarters miles, with a channel depth of 30 feet. Afterwards it became rapidly choked by sand, and in 1861 the width of the entrance was only 300 feet, while in 1865 Captain Jones of H. M. S. *Shannon* reported that it had a bar across it after a storm from the North, though in continued fine weather the river scoured out a channel of eight or ten feet. The chart made by the American engineer Preston C. F. West shows but 8 feet at the entrance at low water on February 4, 1865, while on May 25 of the same year this entrance was closed and a new one was opened through the sand spit farther to the East.

The idea that the National Academy of Sciences should investigate the condition of the harbor and if possible recommend means for improving it appears to have originated with J. E. Hilgard, who was the Acting Superintendent of the U. S. Coast Survey in 1866, and corresponded with the Nicaraguan minister on the subject. The minister, Don Luis Molina, repeated the suggestion in a letter addressed to Secretary Seward and requested that a committee of the Academy be appointed to carry it into effect. Seward in turn presented the matter to Joseph Henry, then Acting President of the Academy, with the request that he would comply with the wishes of the Nicaraguan minister, and a committee was duly appointed. The correspond-

[61] There were two of these transit companies, the relations between which are not clear. One called the "Nicaraguan Transit Company" had as its president W. H. Webb, while the other, as noted, was called the "Central American Transit Company," and had Francis Morris as president.

ence, which has been printed in the report of the Academy, is as follows:[62]

"DEPARTMENT OF STATE,

"WASHINGTON, July 12, 1866.

"SIR: The department has received a communication from the minister of the republic of Nicaragua containing a note addressed to him by Mr. J. E. Hilgard, in charge of the United States Coast Survey office, recommending the appointment of a board to consist of the members of the Academy of Sciences, of which you are the vice-president, for the purpose of investigating and reporting upon the practicability and best means of improving the navigation of the Lower San Juan river, and reclaiming the harbor of San Juan del Norte, in Nicaragua, which recommendation is fully approved by the minister in his communication to this department. He recommends in addition that Mr. Hilgard form a member of the board, whom he represents as possessing the necessary charts and reports, and as being well advised on the difficult subject to be investigated.

"It may not be unnecessary to mention the fact that by a contract entered into between the government of Nicaragua and the Central American Transit Company on the 10th of November, 1863, the latter undertakes to effect a good interoceanic transit through the republic of Nicaragua.

"I would thank you if you would act upon the suggestion of the minister of the republic of Nicaragua; and, in the event of the organization of the board, I will beg of you to instruct the same, that should a good interoceanic transit be found impracticable under the limitations contained in the contract of the Central American Transit Company, above referred to, to inquire into the expediency of effecting such transit way within the region surveyed by Captain West.

"I have the honor to be, sir, your obedient servant,

"WILLIAM H. SEWARD.

"PROFESSOR JOSEPH HENRY, &c., &c., &c., Washington."

"SMITHSONIAN INSTITUTION,

"September 20, 1866.

"SIR: I have the honor to inform you that in compliance with your request of July 12th, 1866, the subject of the improvement of the river and harbor of San Juan del Norte, in Nicaragua, was referred to a committee of the National Academy of Sciences, and that this committee has made the investigation required, and now through me presents the accompanying report.

"The committee, which was chosen with reference to special fitness from previous study and experience for the investigation, consisted of the following members of the Academy: A. A. Humphreys, major general and Chief Engineer United States Army; C. H. Davis, rear-admiral United States navy and Super-

[62] Rep. Nat. Acad. Sci. for 1866, pp. 4, 5.

intendent National Observatory; J. E. Hilgard, assistant United States Coast Survey, acting Superintendent.

" In accordance with article II, section 4, of the act of incorporation of the Academy, Mr. Henry M. Mitchell, of the United States Coast Survey, (not a member of the Academy), was appointed to assist in the investigation.

" The committee, after a careful study of all the materials furnished by Don Luis Molina, and those obtained from other sources, has arrived at conclusions and are enabled to give suggestions, which, it is hoped, may be found of value to the government of Nicaragua, and of importance in the commerce of the world. The report of the committee points out the causes and progress of the deterioration of the harbor of Greytown; considers the question of its partial restoration, and the means to be adopted to attain this end. It also considers the problem of increasing the depth and volume of water in the river as an essential condition of the improvement of the entrance of the harbor, and presents a definite opinion as to the results which may be expected when the works which are indicated have been completed. It discusses the availability of the Colorado pass, and closes with a recapitulation of all the conclusions.

" I have the honor to remain, very truly, your obedient servant,

" JOSEPH HENRY,
" *Vice-President of the National Academy.*

" HON. WILLIAM H. SEWARD,
" *Secretary of State.*"

There is little to add to Henry's summary of the report of the committee, which report was published in full in 1867 as an appendix of the Annual Report for the preceding year and gives a good general idea of the operations of the committee.[63]

The committee did not visit Nicaragua, but formed its conclusions entirely from the documents and maps laid before it by Molina. Its principal recommendation for the improvement of the San Juan River and the harbor of Greytown will be readily understood when the conformation of the lower portion of the river is explained. At a point about 15 miles from the coast it divides into two branches one of which retains the name of San Juan, while the other is known as the Colorado. The latter has by far the greater flow of water, is comparatively unobstructed, and is open to navigation by steamboats at all seasons of the year. The recommendation of the committee

[63] Rep. Nat. Acad. Sci. for 1866, pp. 4-16, with one chart.

was that a weir should be placed at the point of bifurcation of the two streams so as to direct about one-half of the water of the Colorado River to the San Juan, the idea being that the increased flow in the latter which would result would probably deepen its channel, while at the same time increasing the supply of water in the harbor.

It is obvious, however, that the committee regarded the condition of the harbor as practically hopeless, and that it was far from being convinced that the adoption of its suggestions would produce satisfactory results. This will appear from the following excerpts from the report:

"The deepening that we have advised in the lower San Juan, in the neighborhood of the weir, may prove sufficient to improve the whole stream, since the great proportion of water added at the dry season and the considerable increase of the wet season discharge must act powerfully upon the bed of the stream, and increase its depth wherever a yielding bottom is found. It may, however, well be feared that this scour, induced along the bed of the stream, will sweep into the harbor-basin masses of material not so easily removed from the deeper water of the anchorage-ground as from their present positions.

"It appears possible that the fate of Greytown harbor might have been averted by timely efforts to arrest the sand and cut off their supply. . . . . We have proposed improvements, but these must fall very short of a renovation of the noble harbor that once welcomed to an ample and secure anchorage the largest ships that crossed the Caribbean Sea. . . . . The original bight of Greytown cannot be restored. The only hope of improvement rests upon the possibility of maintaining a navigable outlet from the present lagoon by increasing the outflow of the lower San Juan and arresting the drifting sand of the coast. . . . . The basin in Greytown, where ships formerly lay at anchor, has been largely reduced in size and depth by the advance of the river delta upon one side and the drifting in of sand on the other. The time is not very distant at which the river will debouch directly upon the sea.

"It will be necessary to maintain a sufficient anchorage basin by means of dredging."[64]

It is a matter for conjecture how far the committee would have modified its recommendations if it had visited Nicaragua and made an examination into the conditions actually existing there. Commander E. P. Lull, U. S. Navy, who made a survey

[64] Rep. Nat. Acad. Sci. for 1866, pp. 14, 15.

of the San Juan River in 1873, was not at all hopeful that the suggestions of the committee could be carried into effect. He remarks in his report:

"A committee of the National Academy of Sciences in 1867 proposed, as a partial remedy for the decay of the river and harbor, the dredging out of the channel of the Lower San Juan and the construction of a weir from Leaf's Island to Concepcion Island. The latter of these is in the main river, near its right bank, and above the forks. The former has now become joined to the angle or point of the mainland between the two branches. Concepcion Island is 2,000 feet from the point. The strongest part of the current runs between the two. The island is constantly cutting away at one place and forming at another, being composed entirely of silt banked around drift-logs which have lodged in the shoal water.

"The weir, if indeed it could be constructed at all with such a combination of unfavorable conditions, viz., the depth and strength of the water, and the yielding character of the bottom, would be quite as likely to fail in as to effect, the object in view, *i. e.,* the turning of the current into the Lower San Juan, unless the latter was dredged out to a sufficient width and depth to prevent, by drawing it away, the water from cutting around the dam. This would have to be done for a distance of thirteen miles. I confess myself to have been very much discouraged when these facts and convictions impressed themselves on my mind." [65]

On account of these conditions, he proposed to eliminate the Lower San Juan and carry the traffic in a canal which should leave the river at a point about 42 miles from the coast. Recent maps indicate that this plan, with various modifications, was generally accepted down to the time when the interest in an interoceanic canal shifted from Nicaragua to Panama.

COMMITTEE ON THE PROTECTION OF COAL MINES FROM EXPLOSION BY MEANS OF ELECTRICITY. 1870

In the *Proceedings* of the Academy mention of this committee is made under date of April, 1870, in the following terms:

"Mr. Gould reported in behalf of himself and Mr. Ferrel, the Committee on the letter of Mr. Fua, of Padua, addressed to the President of the United States, in reference to the protection of Coal Mines from explosion by electricity, and referred by him to the Academy, 'That the same communication has been made to

[65] Report of Explorations and Surveys for a Ship Canal through Nicaragua, 1872-73, p. 61. Sen. Exec. Doc. no. 57, 43d Congress, 1st Session.

the academies of Paris and Berlin, by Mr. Fua, and published by them, and since the methods involve no new principle or mode of application, no action on the part of the President or Government seems to be needful.'

"The report was accepted and the Committee discharged." [66]

On turning to the *Comptes Rendus* of the Académie des Sciences, Paris, one finds this statement regarding the matter in question:

"M. Fua soumet au jugement de l'Académie quelques détails relatifs à un procédé qu'il croit propre à prévenir les accidentes causés par les explosions du grisou. Ce procédé consiste essentiellement dans l'emploi de spirals de platine rendus incandescentes, à certains intervalles, par le passage d'un courant électrique; ces spirales mettraient le feu à des méches de coton soufré, trempées dans une pâte gommée de phosphore et de chlorate de potasse." [67]

COMMITTEE ON THE EFFECT OF CHEMICALS ON INTERNAL REVENUE STAMPS. 1870

Prior to 1870 it was the practice of the Government to print internal revenue stamps on ordinary paper in ink of a single color. It resulted from this that by skilful manipulation the cancellation marks could be removed and the stamps used a second time to avoid the payment of revenue. The Government thus suffered serious loss, and was under the necessity of devising means of preventing the continuance of the nefarious practice. The Commissioner of Internal Revenue, therefore, introduced radical changes as regards the kind of paper used for the stamps and the ink with which they were printed. Instead of employing ordinary paper, a special kind of paper was adopted, which was manufactured under the supervision of the Government. At the same time it was made unlawful, as in the case of paper for bank-notes, to make any of it, to sell it or to have it in one's possession. Instead of printing with one kind and color of ink, the stamps were printed in two or more colors, and the printing was divided between private contractors and the Government, the former printing certain tints on them, and delivering them to the Bureau

[66] Proc. Nat. Acad. Sci., vol. 1, pp. 76-77.

[67] *Comptes Rendus,* vol. 68, p. 805. 1869.

of Engraving and Printing which completed them and delivered them to the office of the Commissioner of Internal Revenue to be issued.

In order to ascertain whether these changes were likely to be effective, the Acting Commissioner of Internal Revenue on April 13, 1870, sent some specimens of the stamps to the Academy with the request that they be examined by it, with regard to their sensitiveness to the action of chemicals. This request was contained in the following letter[68] addressed to Joseph Henry, President of the Academy:

"TREASURY DEPARTMENT, OFFICE OF INTERNAL REVENUE,
"WASHINGTON, April 13, 1870.

"SIR: In accordance with the third Section of the Act of Congress incorporating the National Academy of Sciences, I have the honor to submit herewith specimens of proposed Internal Revenue Stamps for examination and report with reference to their sensitiveness to chemical agencies applied for the purpose of removing ink, cancellation marks, and their durability under ordinary usage.

"Very respectfully,
"J. W. DOUGLASS,
"*Acting Commissioner.*

"PROF. JOSEPH HENRY,
"*President National Academy of Sciences, Washington, D. C.*"

A committee consisting of Wolcott Gibbs, Samuel W. Johnson and John Torrey was at once appointed to consider the subject. The records of the Academy do not contain the report of the committee but we may infer that it was to the effect that the changes introduced would prevent fraud, as the Commissioner remarked in the following year:

"It is believed that the stamps now being furnished under the contracts alluded to, cannot be tampered with. Especially is this thought to be the case with the adhesive, and tobacco, snuff, and cigar stamps printed on chameleon paper. This paper so effectually changes its color upon the application of chemical agents employed for the restoring of stamps for re-use, as to render restoration to its original state impossible."[69]

[68] Proc. Nat. Acad. Sci., vol. 1, p. 76.
[69] Rep. Comm. Int. Rev. for 1870-71, p. xiv.

COMMITTEE ON THE TRANSIT OF VENUS. 1871 AND 1881

Two transits of Venus across the sun's disc have occurred since the foundation of the Academy fifty years ago. These took place in 1874 and in 1882. No more will occur until the year 2002. As early as 1870, or even before that date, plans began to be formulated for observing these rare celestial phenomena. At the session of the Academy held in Washington in April, 1870, Simon Newcomb read a paper, " On the coming transits of Venus and the mode of observing them," in which he said:

" . . . . Although the next transit does not occur for four years, the preliminary arrangements for its observation are already being made by the governments and scientific organizations of Europe. It is not likely that our government will be backward in furnishing the means to enable its astronomers to take part in this work. The principal dangers are, I apprehend, those of setting out with insufficient preparation, with unmatured plans of observation, and without a good system of coöperation among the several parties. For this reason I beg leave to call the attention of the Academy to a discussion of the measures by which we may hope for an accurate result."

After explaining the methods which it was necessary to employ, he remarked:

" . . . . I have endeavored to show that no valuable result is to be expected from hastily-organized and hurriedly-equipped expeditions; that every step in planning the observations requires careful consideration, and that in all the preparatory arrangements we should make haste very slowly. I make this presentation with the hope that the Academy will take such action on the matter as may seem proper and desirable." [70]

At the same session a committee was appointed by the President of the Academy to secure the successful observation of the transit. It consisted of Benjamin Peirce, Superintendent of the Coast Survey, Rear-Admiral Charles H. Davis, at that time in charge of the Naval Station at Norfolk, and Commodore B. F. Sands, Superintendent of the Naval Observatory.

In his report for the year 1870, the Secretary of the Navy, George M. Robeson, remarked:

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[70] *Amer. Journ. Sci.*, ser. 2, vol. 50, 1870, pp. 74-83. On the mode of observing the coming Transits of Venus. By Simon Newcomb. Read before the National Academy of Sciences, April 13, 1870.

"The arrangements necessary to secure the successful observation of the transit of Venus, which will occur on December 8, 1874, have begun to receive the attention of the observatory.

"It is essential to the complete success of these observations that the various parties which may be sent out by the Government should make their observations on a uniform and carefully prepared plan.

"The Superintendent of the Observatory has been invited to become a member of a committee of the National Academy of Sciences, appointed to devise such a plan. The functions of the Academy being purely advisory, and it being expected that the coöperation and assistance of the ablest astronomers of the country would be secured by this committee, the invitation was accepted.

"Although this committee has not yet met, certain experiments and trials with the apparatus and instruments of observation are necessary in any case. As many experiments and many alterations of apparatus, all requiring time and careful consideration, may be necessary, the small appropriation of $3,000, for instruments and apparatus, is called for." [71]

In the Sundry Civil Act for the fiscal year 1872, approved March 3, 1871, Congress made an initial appropriation for the expenses of observing the transit, but reduced the amount proposed by the Secretary to $2,000.[72]

For some reason which is not apparent the committee of the Academy was increased in April, 1871, by the addition of five new members, namely, L. M. Rutherfurd, J. C. Watson, Simon Newcomb, J. H. C. Coffin, and F. A. P. Barnard.

The following year (1872) Rear-Admiral Sands, Superintendent of the Naval Observatory, reported thus:

"At the last session of Congress an appropriation was made for the purchase of instruments for the proper observation of the transit of Venus in 1874, to be expended under the direction of a commission, to be composed of the Superintendent and two Professors of the Naval Observatory, the President of the National Academy of Sciences, and the Superintendent of the United States Coast

[71] Rep. Secr. Navy for 1870, p. 46.

[72] The item in the Sundry Civil Act is as follows:

"For preparing instruments for observation of transit of Venus, two thousand dollars; *Provided,* That this and all other appropriations made for the observations of the transits of Venus shall be expended, subject to the approval of the Secretary of the Navy, under the direction of a commission to be composed of the superintendent and two of the professors of mathematics of the navy attached to the Naval Observatory, the president of the National Academy of Sciences, and the superintendent of the coast survey, for which services they shall not receive any compensation." Stat. at Large, vol. 16, 1871, p. 529, 41st Congress, 3d Session, chap. 117, 1871.

Survey. Professor Simon Newcomb, United States Navy, and William Harkness, United States Navy, were detailed as the two Professors of the Observatory, and, at a meeting of the commission,[73] the Naval Observatory was authorized to take charge of the details of the Transit of Venus expedition. Experiments are being made and preparations are now in hand for completing contracts for the manufacture of the necessary instruments and planning the proper temporary observatories for the several stations to be occupied. This necessarily takes much of the time of the Professors, but as legitimate work of such an institution it is cheerfully and zealously performed." [74]

In the meantime, in the Sundry Civil Act for 1873, approved June 10, 1872, Congress had made a second appropriation for the purchase and preparation of instruments, amounting to $50,000, to be expended, like the first, under the direction of the Commission.[75]

The time of the transit was now approaching and the Chief of the Bureau of Navigation, Daniel Ammen, reported at the close of that fiscal year (1873), that the preparations were practically complete.[76] Admiral Sands also remarked, "The work progresses favorably, and the expeditions are expected to leave their stations early next June." [77]

Congress made a third appropriation for the fiscal year 1874, amounting this time to $100,000, to enable the Secretary of the Navy to organize parties to observe the transit, and in conjunction therewith authorized him to detail two vessels to convey them to their several stations.[78]

Early in 1874 Admiral Charles H. Davis became Superintendent of the Naval Observatory and in that capacity took part

[73] The first meeting of the Commission was held July 22, 1872.

[74] Rep. Secr. Navy for 1872, p. 94. Prof. J. H. C. Coffin, Superintendent of the Nautical Almanac Office, reported the same year.

"As one of the preparations for the transit of Venus, in December, 1874, maps and tables to facilitate predictions of the several phases of that phenomenon have been constructed by Mr. G. W. Hill, of this Office. Their publication has been assumed by this commission on this transit appointed by Congress, as one of their series of valuable papers relating to it." *Op. cit.*, p. 96.

[75] Stat. at Large, vol. 17, 1873, p. 367, 42d Congress, 2d Session, chap. 415.

[76] Rep. Secr. Navy for 1873, p. 79.

[77] *Op. cit.*, p. 94.

[78] Stat. at Large, vol. 17, 1873, p. 514, 42d Congress, 3d Session, chap. 227, 1873. Sundry Civil Act for the fiscal year ending June 30, 1874, approved March 3, 1873.

as chairman of the Transit of Venus Commission in the operations then in progress.[79] His report and that of the Secretary of the Navy contain an admirable summary of the undertaking up to June 30, 1874. The Secretary, George M. Robeson, writes:

"It has been a part of the duty of this Department, under provisions of laws passed by Congress at its last three sessions, to organize expeditions for observing the transit of Venus, which occurs on December 8 of the present year. A plan of observation was very carefully matured by the commission created by Congress for that purpose in 1871, and the organization and arrangement of the parties were made to accord with that plan. The entire scientific corps of the expedition, numbering forty-two persons in all, spent several weeks at the Naval Observatory last spring in preliminary practice with the same instruments they were to use at the stations, thus becoming familiar with the difficult and delicate operations involved in the final observations. The five parties designed for the southern stations were embarked on the ship Swatara, Capt. Ralph Chandler, and sailed from New York June 8. So far as yet known the parties were all successfully landed at the selected stations, with the single exception of that on the Crozet Islands. Here there is no anchorage, and the constant stormy weather which prevailed during the period which it was prudent for the ship to delay, prevented a landing. The possibility of this failure had been anticipated by the commission, and the Swatara had been directed to land the party at or near Melbourne, in the event of failure to land at the station first selected.

"The three northern parties were sent by the regular course of commercial conveyance to Nagasaki, which had been selected as one of the stations. The parties designed for Wladiwostok and Peking were taken thither from Nagasaki by naval ships.

"It not being prudent to attempt the return of all the southern parties by the Swatara, the Monongahela was sent out from the Brazilian station to convey the party from Kerguelan Island to Rio de Janeiro, whence they can return by regular lines of travel." [80]

Admiral Davis adds some interesting information regarding the photographic work connected with the observations:

"Under the specific action and direction of this commission, from time to time the requisite instruments have been selected and made; the parties have been constituted, the station adopted, and the work of preparation and instruction has been carefully matured and strictly executed.

"At the meeting of the 9th of February, 1874, it was decided to invite Dr. Henry Draper, of New York, to take charge of the work of putting into suc-

[79] See Life of Charles H. Davis, p. 332.

[80] Rep. Secr. Navy for 1874, p. 16.

cessful execution the various operations necessary for photographing the transit of Venus by the methods decided upon by the commission, and of instructing the parties in those operations. Dr. Draper accepted this arduous duty, and performed it in a manner which commands the gratitude and respect of the commission. Dr. Draper declined to receive any compensation or reimbursement for his invaluable services and for his unavoidable personal expenses while traveling and residing in Washington, on the service of the commission.

"The system of practice was fully carried out, and the several parties destined for the observation of the transit of Venus in both hemispheres, left the United States fully qualified in all respects to perform their duties.

"Instructions for conducting the scientific operations of the parties were prepared by Professor Newcomb, printed, and freely distributed." [81]

The Transit of Venus Commission of 1874, which was considered as having continued in existence, took charge of the arrangements for the observations of the transit of 1882 and prepared instructions to the observers that were printed by authority of the Secretary of the Navy.[82] The Secretary remarks as follows in his report for the fiscal year ending June 30, 1882:

"TRANSIT OF VENUS

"Professor Harkness has been principally occupied in fitting out the parties for observing the approaching Transit of Venus, and in reducing the zone observations made in Chili during the years 1850, 1851, and 1852, by the astronomical expedition to the southern hemisphere, under the late Capt. James M. Gilliss. . . . .

"Everything relating to the organization of the Transit of Venus parties is confided by law to the Transit of Venus Commission; but as most of the executive work has been done at the Observatory, it may be proper to refer to it here.

"The instruments used for the last Transit have been examined and repaired; all necessary changes have been made in them, and some new instruments have been purchased.

"At a very early stage of its deliberations the Commission decided to rely mainly upon the photographic method of observing, and, to ascertain the most suitable kind of emulsion, an extensive series of experiments was made by Mr. Joseph A. Rogers, who has also prepared all the emulsion needed for the various parties.

[81] Rep. Secr. Navy for 1874, pp. 68-69.

[82] Instructions for observing the Transit of Venus, December 6, 1882, prepared by the Commission authorized by Congress, and printed for the use of the observing parties by authority of the Hon. Secretary of the Navy. Washington, 1882. 4°. Pp. 1-50, with 4 charts.

"The number of parties organized is the same as at the last Transit, namely, eight, of which four will remain in the United States, and the other four have already departed for the southern hemisphere." [83]

The following additional information also appears in the same report:

"TRANSIT OF VENUS

"The preparations for observing the coming transit of Venus have occupied the attention of the Transit of Venus Commission, of which the Superintendent of the Naval Observatory is the chairman.

"The method selected for the observation will be similar to that used in 1874, viz., by photography. A party will occupy each of the following stations: Cape of Good Hope; Santa Cruz, Patagonia; Santiago de Chile; New Zealand; San Antonio, Tex.; Cedar Keys, Fla.; Fort Selden, N. Mex.; and Washington, D. C." [84]

The results of the observations of 1882 have not been published in detail, and perhaps will not be, but a report from each station is included in Newcomb's "Astronomical Constants" in the supplement to the American Ephemeris of 1887, pages 71 to 77.

COMMITTEE ON WATER-PROOFING THE FRACTIONAL CURRENCY. 1875

In 1875 the Government was making use of a secret, patented process for water-proofing the paper on which the fractional currency and funded-loan bonds were printed. The principal feature of the process was that the paper was sized after having been printed upon. During the first session of the 44th Congress, the committee of the House of Representatives on Expenditures in the Treasury Department requested the Secretary of the Treasury to submit answers to a series of questions relating to the printing of the securities of the United States. The last two questions in the series, which numbered twenty-two in all, were as follows:

"21. Does the amount given in answer to the fifteenth question, include the expense of labor in the use of the water-proofing process, and also the amount of royalty paid for its use?

[83] Rep. Secr. Navy for 1882, vol. 1, p. 117.
[84] *Loc. cit.*, p. 110.

"22. State if any commission, and composed of what persons, by name, has examined the value of the water-proofing process, as recommended in the report of the Committee on Banking and Currency, made February 16, 1875; and, if so, please annex a copy of their report, if any has been made. If no report has been made to you in writing, has any and what oral report been made to you? And have you urged the parties having the matter in charge to make report to you." [85]

These detailed inquiries were directed primarily at a committee of the Academy. In replying to them, on March 31, 1876, the Secretary of the Treasury, B. H. Bristow, remarked that no royalty was paid on the water-proofing material, which was purchased by the gallon, and that on July 30, 1875, he had requested the President of the Academy, Professor Henry, to appoint a committee to examine into the merits of the water-proofing process. He remarked that Professors J. E. Hilgard, C. F. Chandler, Henry Morton and William Sellers had been appointed, and continued as follows:

"On the 30th of August last [1875] I requested those gentlemen to commence their investigations, and at the same time I instructed the Chief of the Bureau of Engraving and Printing to afford them every facility therefor in his power.

"I am advised that they called and examined the machinery for applying the 'water-proofing' to the paper, and the manner in which it was done, and that they were furnished with a sample of the material and with specimens of blank and printed paper, water-proofed and not water-proofed. Every facility to conduct their investigation was afforded them, and they were furnished with all the information possible upon the subject.

"During the autumn Professor Hilgard, chairman of the commission, called on me and submitted for my inspection a memorandum in writing of the principal points of his proposed report, which were deduced from his examination. He stated, as the result of his examination and tests, that he was convinced that the process in question was of great advantage and of great utility both as to durability and security, and that he would recommend that the Government should purchase the invention from the proprietor, with a view to a more economical application of the process.

"The general tenor of the report having been thus foreshadowed by the chairman of the commission, I saw no reason, at that time, and have had no cause

[85] House Misc. Doc. no. 163, 44th Congress, 1st Session, pp. 2, 3; ordered printed, April 3, 1876.

since, to question the usefulness of the process, and I therefore continued its use until the Bureau was closed and work on the fractional currency stopped. . . . .

"Professor Henry has recently procured additional sheets of water-proofed and not water-proofed paper for the purpose of further testing the matter.

"On the first instant [March 1, 1876] I requested him, by letter, to have the report of the commission made as soon as practicable, it having already been delayed a considerable time." [86]

The committee of the House of Representatives was not satisfied with these answers and on May 2, 1876, called for all the papers in the case, the real state of which then became manifest. The report of the committee of the Academy had been finished and sent to the Secretary of the Treasury on April 29, 1876, who transmitted it with the other papers.[87] Professor Hilgard's memorandum was also included.

From these papers it appears that Professor Hilgard had changed his opinion regarding the water-proofing process on account of the results of certain experiments made by Professor Morton, and had affixed his signature to a report denying the value of the process instead of affirming it, as he had done in his memorandum. In the meantime, Professor Henry had made certain experiments, as indicated above, and had reached the conclusion that the committee had not proved that the process was worthless. He therefore returned the report with the request that the committee would reconsider its decision. This the committee found itself unable to do and Professor Henry then transmitted the report to the Secretary of the Treasury, but attached a note to it expressing his own convictions in the matter.

The Secretary of the Treasury had secured an independent favorable opinion from Prof. John M. Ordway. It followed therefore, that Hilgard, Morton, Chandler, and Sellers were not in favor of the continuance of the use of the process, while Henry and Ordway regarded it as valuable, or at least were not convinced of its worthlessness.

[86] *Loc. cit.*, p. 14.

[87] It forms part of House Misc. Doc. no. 163, part 2, pp. 22-28, 44th Congress, 1st Session.

COMMITTEES ON THE ARTIFICIAL COLORING OF SUGARS, ON THE USE OF THE POLARISCOPE TO DETERMINE THE VALUE OF SUGARS, AND ON DEMARARA SUGARS. 1876–1878

These three committees were appointed in 1876, 1877, and 1878 at the request of the Treasury Department, and were concerned with the question of the valuation of sugars in connection with customs duties.[88] For many years the duties on different grades of sugars were levied in accordance with their color, or what was known as the Dutch standard. After a time, however, the Government began to suspect that certain sugars were artificially colored, whereby the higher grades were made to assume the appearance of the lower grades,[89] and were in consequence assessed at a lower rate than that which was properly chargeable. In a test case which was tried in Baltimore in 1878, the court decided that the fact of the artificial coloring of the sugars concerned for the purpose of defrauding the revenue was proven but held that no penalty could be enforced because it was not demonstrated that the importer had a guilty knowledge that the coloring was done for the purpose of escaping the higher duty.[90] Thus, while the fact that certain sugars were artificially colored was no longer in question, the position of the Government as regards the collection of duties was no better than before. Acting on the opinion of the court, however, the Treasury Department temporarily ordered that wherever the color of sugar was mentioned in the law it should be interpreted as meaning the color which it would naturally have as a result of the particular process by which it had been produced, or at the particular stage to which the process of clarification had been carried. Whenever there was reason to suspect that sugar had been artificially colored, its saccharine strength was to be determined and duty levied in accordance with the color which it would normally have when of that strength.[91] The strength was determined by the use of the polariscope, and the Customs Office had

[88] Proc. Nat. Acad. Sci., vol. 1, p. 133. Rep. Nat. Acad. Sci. for 1879, p. 11.
[89] Rep. Secr. Treas. for 1877, pp. xxvi, xxvii.
[90] Rep. Secr. Treas. for 1878, p. xxvii.
[91] Rep. Secr. Treas. for 1879, pp. xxiv, xxv.

a corps of employees, known as examiners, whose duty it was to test samples of sugar by means of the polariscope and report their findings to the chemist in charge. This system continued in practice for a few years, but always against protest of the importers, and in 1882 the Supreme Court decided that the customs officers were bound under the law to accept the color as it appeared and levy duties accordingly, although they might be entirely certain that the coloration was artificial.[92]

It is not quite clear from the records of the Academy at what point in the development of the matter its advice was sought by the Government, or what the exact relationships were between the different committees, but apparently the main questions related to the natural colors of different grades of sugar, and the use of the polariscope in determining saccharine strength.

The first committees were probably appointed in 1876 but their membership is not a matter of record. They were styled in the Annual Report of 1879 committees on " Artificial coloring of sugars designed to simulate a lower grade according to the standard on which duties are levied " and in the same place the remark is made: " This subject was repeatedly considered by committees of the academy in 1876 and 1877, and reports were made to the [Treasury] department, which for obvious reasons have not been published." [93] From various statements contained in the reports of the Secretary of the Treasury it seems allowable to suppose that the Academy suggested the use of the polariscope, or even made experiments demonstrating that certain sugars were artificially colored, and that the fact could be determined by means of that instrument. The President of the Academy, Joseph Henry, acted as a separate committee on the use of the polariscope or polarimeter, for determining the value of sugars, and reported in 1877. In the same year a third committee, Frederick A. Genth, reported to the Treasury Department on " Demarara sugars," but the nature of his report is not a matter of record.

[92] Rep. Secr. Treas. for 1882, pp. xxii, xxiii.
[93] Rep. Nat. Acad. Sci. for 1879, p. 11.

As already mentioned, the Treasury Department, about the year 1878, introduced the use of the polariscope in determining the saccharine strength of certain sugars suspected of being artificially colored, but in 1882 the Supreme Court ruled that the Department was obliged under the law to accept the color as it appeared. This unsatisfactory condition of affairs was brought to the attention of Congress the same year by the Secretary of the Treasury who remarked in his report:

"The Supreme Court, in a recent decision, has interpreted the existing law to be, that customs officers may not look beyond the apparent color, and must classify the invoices thereby, though satisfied that the color is artificial and made to get a lower rate of duty. That standard [the Dutch standard] was adopted, doubtless, believing that color showed value. The intention was to put upon sugar, duties in effect ad valorem. As it has come about, however, the grades of sugar highest in value, when thus artificially colored, come in at the lowest rate of duty. The purpose of Congress in adopting the Dutch standard is measurably defeated. Provision should be made for just classification. This may be done by putting on an ad valorem duty, by a specific duty, or by authorizing some standard other than that of apparent color. Now, domestic producers do not get the incidental protection meant to be given them. Importers, too, are subject to embarrassment in fixing the rate of duty on their goods, and otherwise," [94]

On this representation Congress, in 1883, enacted the following law, authorizing the use of the polariscope in certain instances:

"An act to reduce internal-revenue taxation, and for other purposes.

"*Be it enacted* (*etc.*), ... (p. 488).

"SEC. 6. That on and after the first day of July, eighteen hundred and eighty-three, the following sections shall constitute and be a substitute for Title thirty-three of the Revised Statutes of the United States:

"TITLE XXXIII

"DUTIES UPON IMPORTS (p. 489)

* * * *

"SCHEDULE E.—SUGAR

"All sugars not above No. 13 Dutch standard in color shall pay duty on their polariscopic test as follows, viz:

"All sugars not above No. 13 Dutch standard in color, all tank bottoms, sirups of cane juice or of beet juice, melada, concentrated melada, concrete and con-

[94] Rep. Secr. Treas. for 1882, pp. xxii, xxiii.

centrated molasses, testing by the polariscope not above seventy-five degrees, shall pay a duty of one and forty-hundredths cent per pound, and for every additional degree or fraction of a degree shown by the polariscopic test, they shall pay four-hundredths of a cent per pound additional.

"All sugars above No. 13 Dutch standard in color shall be classified by the Dutch standard of color, and pay duty as follows, namely:" . . . . (p. 502).[95]

Thus, the use of the polariscope in levying duties on certain grades of sugar, recommended, as we may believe, by the National Academy, was finally legalized, and the executive branch of the Government was aided, for a time, at least, in its efforts to collect the proper revenue from this commodity.

COMMITTEE ON PROPOSED CHANGES IN THE AMERICAN EPHEMERIS. 1877

This committee was appointed at the request of the Secretary of the Navy who, in December, 1877, expressed the desire that the Academy would advise him as to changes in the Nautical Almanac which would render that publication more useful to navigators and others. The members of the committee were J. E. Hilgard, J. H. C. Coffin, Asaph Hall, Charles A. Schott, Charles A. Young, James C. Watson and C. H. F. Peters. It reported at the end of the year 1877 or early in 1878, but the report appears not to have been published. From the report of Prof. Simon Newcomb as Superintendent of the Nautical Almanac for the fiscal year 1877-78, however, we learn the nature of the changes proposed by the Academy. Under date of October 26, 1878, he writes:[96]

" . . . . In December, 1877, on recommendation of the office, the honorable Secretary of the Navy referred to the National Academy of Sciences the question, what changes were required in the Ephemeris to make it more serviceable to those who use it. A committee of the Academy recommended several extensive changes, involving the omission of matter of which some was not regarded as necessary, and some could be readily derived from data in other parts of the work. The space thus left was filled by the addition of matter considered useful. The chiefs of several government surveys desired a large increase in the list of fixed stars contained in the Ephemeris, in order to facilitate the determination of geographical

[95] Stat. at Large, vol. 22, 1883, pp. 488, 489, 502, 47th Congress, 2d Session, 1883, chap. 121.
[96] Rep. Secr. Navy for 1878, pp. 162-164.

positions. The changes next in importance consisted in the presentation of more complete data, maps, and diagrams for the eclipses of the sun and the satellites of the planets. The changes were so adjusted that the size and cost of the work should not be materially altered. They commence with the Ephemeris of 1882, now in press."

In the preface to the Nautical Almanac for the year 1882 we find the changes adopted mentioned in the following specific terms: [97]

"The contents of the present volume of the *American Ephemeris,* though substantially unchanged in their general character, have, in some parts, undergone material alterations in their form and arrangement."

* * * * * * * * * * * *

"PART I, *Ephemeris for the Meridian of Greenwich* . . . . The principal change made in it has been the transfer of the sun's co-ordinates and of the geocentric ephemerides of Mercury, Uranus, and Neptune from Part II, and the addition of accurate heliocentric positions of all the planets.

"PART II, *Ephemeris for the Meridian of Washington* . . . . The list of mean places of fixed stars has been greatly enlarged, for the convenience of field-astronomers.

"PART III, *Phenomena* . . . . The additions comprise more complete data for eclipses of the sun, diagrams showing the configurations of the satellites of Jupiter, data respecting the disks of Mercury and Venus for the reduction of meridian and photometric observations, and diagrams, with tables, for identifying any known satellites of other planets.

"SIMON NEWCOMB,
"*Professor U. S. Navy, Superintendent.*

"WASHINGTON,
"September 3, 1879."

COMMITTEE ON A PLAN FOR SURVEYING AND MAPPING THE TERRITORIES OF THE UNITED STATES. 1878

In the decade following the close of the Civil War the recurring discussion of the relative merits of military and civil control of public enterprises centered around the management of the surveys of the public domain. We learn that as early as 1869, at the meeting of the National Academy, "one of the most eminent geologists and geographers in the country made a

[97] American Ephemeris and Nautical Almanac for 1882, 1st ed., 1879. Preface, p. iii.

sharp attack upon the system of army explorations and its fruits; and he was met by the military members of the Academy with the plea that army officers had done all that, under the circumstances, and considering their education to another business, could fairly be expected of them, and that for this they deserved gratitude rather than blame." [98]

By 1874 the discussion as regards the surveys had become more animated and more widespread. It intruded itself upon the attention of Congress and found its way into the columns of various magazines and reviews. At this time there were in existence six distinct surveys or systems of surveys of western portions of the United States. The United States Geological Exploration of the Fortieth Parallel, nominally under the direction of the Engineer Corps of the Army, but conducted by a civilian, Clarence King; the United States Geological and Geographical Survey of the Territories under the direction of the Department of the Interior and conducted by Dr. F. V. Hayden; the Geographical and Geological Explorations and Surveys West of the One Hunderdth Meridian, commonly called "Wheeler's Survey," under the Engineer Corps of the Army and conducted by Lieut. Wheeler; the U. S. Geographical and Geological Survey of the Rocky Mountain Region, under the Department of the Interior and conducted by Major J. W. Powell; the land-parcelling survey carried on by the General Land Office of the Department of the Interior; and finally, the U. S. Coast and Geodetic Survey, under the Treasury Department.

These various surveys differed in their history, their objects, and their methods. Their work was not coördinated and to a certain extent the territories in which they operated overlapped. Referring to the rivalry between civil and military directors of these surveys the *Nation,* in the article from which quotation has already been made, remarked in 1874:

"It appears that the War Department looks with something of jealousy—a natural jealousy, perhaps, at which we ought not to be surprised—at this interference of civilians with what had once been its exclusive province; and its dis-

[98] *The Nation,* May 21, 1874, p. 328.

satisfaction, long expressed freely in private, has now taken shape in a demand brought recently before Congress and strongly urged, that all national scientific surveys be placed under the control of the Engineering Bureau of that Department and directed by army officers. It is in view of this demand that we have undertaken a general review of the merits of the case, if perchance we may contribute something toward its settlement. To the educated science of the country, the movement seems a most unreasonable one. The feeling and opinion of scientific men are, we venture to say, well-nigh or altogether unanimous against it. A strong remonstrance has been sent to Washington from some of the leading educational institutions—Yale, Harvard, and others—signed by all their scientific professors; and more and stronger will be likely to follow, if there shall seem to be any danger that so invidious a selection of the graduates of one school, and that a military one, to take charge of the public scientific interests of the country, will be decreed by Congress." [99]

The subject was discussed in the first session of the 43d Congress (1874) but led to no immediate results. The House Committee on Public Lands in their report on the resolution of April 15, 1874, inquiring whether it was not practicable to consolidate the surveys under one department, remarked as follows:

"The committee believe that at present it would not be of public benefit to place the whole of the surveys under one Department.

"The time is approaching, however, when it may be proper so to consolidate them, with a view to the making of a grand geographical, geological, and topographical map of the Territories worthy of the nation because of its accuracy and minuteness of detail; and the committee believe that they would be conducted most to the public interest by being placed under the control and guidance of the Interior Department. . . . .

"In thus keeping separate, for the present, the surveys now making under the War and Interior Departments, a generous rivalry will be maintained among the good men therein, and a stimulus will be given to each to do the best work possible, and a resulting benefit will ensue in more accurate surveys and more extensive and valuable maps and reports. . . . .

"The conclusions, therefore, to which the committee have come are, that the surveys under the War Department, so far as the same are necessary for military purposes, should be continued; that all other surveys for geographical, geological, topographic, and scientific purposes should be continued under the direction of the Department of the Interior, and that suitable appropriations should be made by Congress to accomplish these results." [100]

[99] *Loc. cit.*, p. 328.

[100] House Report no. 612, 43d Congress, 1st Session, 1874, pp. 16-18.

Professor J. D. Whitney, in an article in the *North American Review,* remarked:

"The matter has already been up before a committee of Congress, and a very unpleasant altercation had between the officers and employees of the War Department on one side and of the Interior on the other. . . . . No good has been accomplished by the Congressional investigation; the work is still going on exactly as before. Instead of a careful and systematic consolidation of all the United States geographical and geological work in the Far West, under one supervision, in one department, there is just that method employed which leads to bad results and great waste of money. Congress is at this moment paying to have the same work done, on the same ground, by two, if not three, different parties, and in two different departments. . . . . Liberal appropriations were made for both classes [military and civil] by Congress, this year as well as the last, and how long this condition of things will be allowed to contiue no one can foresee." [101]

The criticisms of the various surveys contained in the article just quoted were not acceptable to the War Department, General Comstock, the director of the survey of the Great Lakes, claiming that since the question of cost had not been considered they were "worthless and misleading." [102]

The matter remained in controversy for some three years longer. Finally, in 1878, the Appropriations Committee of the House announced its determination not to recommend further appropriations for the surveys until some plan of consolidation had been determined upon. On March 8, 1878, a demand was made on the War Department and the Department of the Interior for a statement as to the cost of all the surveys carried on by those departments, and the extent to which their fields of operation overlapped.

The Sundry Civil Act for the fiscal year ending June 30, 1879,[103] contained the following provision:

"And the National Academy of Sciences is hereby required, at their next meeting, to take into consideration the methods and expenses of conducting all surveys of a scientific character under the War or Interior Department and the

[101] J. D. Whitney. Geographical and Geological Surveys, *North American Review,* vol. 121, 1875, pp. 83-84. See also House Report no. 612, and Senate Report no. 311, 43d Congress, 1st Session; and House Exec. Doc. no. 240, 43d Congress, 1st Session.

[102] Sen. Exec. Doc. no. 21, 45th Congress, 3d Session, p. 10.

[103] Approved June 20, 1878.

surveys of the Land Office, and to report to Congress, as soon thereafter as may be practicable, a plan for surveying and mapping the territories of the United States on such general system as will, in their judgment, secure the best results at the least possible cost; and also to recommend to Congress a suitable plan for the publication and distribution of the reports, maps, and documents and other results of said surveys."

When this Act was approved on June 20, 1878, the President of the Academy was in Europe. Upon his return in August and after consulting members of the Council and others, he appointed a special committee to consider the subject. This committee, as he stated in his annual report, consisted of "Professor James D. Dana, whose long experience as geologist and naturalist of the Wilkes Exploring Expedition, and subsequent residence in Washington, while preparing his reports, had especially fitted him to advise on Government work; Professor William B. Rogers, the Nestor of American geology, who had had long and varied experience with geographical and geological surveys; Professor J. S. Newberry, the State Geologist of Ohio, who had spent several years in the West on Government exploring expeditions under the War Department; Professor W. P. Trowbridge, a graduate of West Point, who, while a member of the Corps of Engineers, served for several years on the Coast Survey; Professor Simon Newcomb, whose knowledge of mathematics and astronomy rendered his advice most valuable; and Professor Alexander Agassiz, whose experience both in mining engineering and biology made him a fit representative of those departments."[104] As will be noted, no member of any of the Government surveys then existing was included in the committee, the President holding that it would be inappropriate to designate anyone representing those organizations whose contentions were reported to have caused Congress to consider their reorganization. This led to a protest by General Humphreys, Chief of Engineers, who asserted that "a properly constituted committee should have had among its members those officers in the Government service whose duties consisted in part or in whole in making geodetic, topographic, or other scientific sur-

[104] Proc. Nat. Acad. Sci., vol. 1, p. 151.

veys in the different departments of the government."[105] He considered that however proficient the members of the committee might be in their several professions, with one exception, they were not sufficiently familiar with survey work to form an opinion as to its requirements.

The committee deliberated some three months, inviting and considering the views of the directors of the surveys of the territories, the Acting Chief of Engineers and other officers of the Army, the Commissioner of the General Land Office and others interested. We learn from the documents which accompany the Academy's report that the War Department thought that its topographic and geodetic surveys should be continued and that they might advantageously be made the basis of the land-parcelling surveys of the General Land Office, and that the scale and topography of its maps might be such that they could be used for plotting the geological data collected by the geological surveys. The General Land Office was of the opinion that "combining a geological and geographical survey with the survey of the public lands might be most beneficial and economical." Dr. Hayden, representing the Geological and Geographical Survey of the Territories, questioned the practicability of a comprehensive plan of surveys which should include all the scientific organizations of the Government engaged in such work. He considered that the combination of the geological and geographical surveys with the land-parcelling surveys would be fatal to both, and that the separation of topography and geology would be unwise. Major Powell representing the Geographical and Geological Survey of the Rocky Mountain Region, reiterated the opinion expressed in an earlier report, that such surveys "should be unified and a common system adopted"; and considered that they should embrace a geographical department, including "all methods of mensuration in latitudes, longitudes and altitudes, absolute and relative"; and a geological department, including "all purely scientific subjects relating to geological structure and distribution, and practical subjects relating to mining and

[105] Sen. Exec. Doc. no. 21, 45th Congress, 3d Session, p. 3.

agricultural industries." He also advanced the view that the land-parcelling survey should be part of the same organization. He stated that the transcontinental triangulation of the Coast Survey and the barometric observations of the Signal Service could and should be made the basis of further work, but did not indicate how this was to be done.

On November 6, the committee submitted a unanimous report to the Academy. The report was considered at a special meeting held in New York and after three hours' discussion was adopted with but a single dissenting vote.[106] The President of the Academy thereupon acquainted the principal executive officers of the Government with the recommendations contained in the report, which were favorably received by the President, the General of the Army, the Secretary of the Interior, the Secretary of the Treasury and the Superintendent of the Coast Survey. The Chief of Engineers of the Army opposed the plan. On the opening of Congress in December the report was transmitted to both houses and by them ordered printed.

The committee in this report confined its attention to six scientific surveys of the public domain which were then in operation. These were the surveys west of the 100th meridian, under the War Department; the U. S. Geological and Geographical Survey of the Territories and the U. S. Geographical and Geological Survey of the Rocky Mountain Region, under the Department of the Interior; the U. S. Coast and Geodetic Survey, under the Treasury Department; and the Land Office Surveys, under the Interior Department. It pointed out that the work of these organizations could be summed up under two headings, "1. Surveys of mensuration, 2. Surveys of geology and economic resources of the soil," and its recommendation was that they be recombined to form three distinct organizations. These were to be as follows: "(1) The Coast and Interior Survey, whose function will embrace all questions of position and mensuration; (2) the United States Geological Survey, whose function will be the determination of all questions relating to

[106] Proc. Nat. Acad. Sci., vol. 1, p. 152.

the geological structure and national resources of the public domain; (3) the Land Office, controlling the disposition and sale of the public lands, including all question of title and record. The Land Office was to get its surveys and measurements from the Coast and Interior Survey, and its information regarding the value and classification of lands from the Geological Survey. The latter organization was to call on the Coast and Interior Survey for all mensuration data, but would be "authorized to execute local topographical surveys for special purposes." All three organizations were to be in the Department of the Interior.

The committee also recommended that a commission be formed to codify the laws relating to the survey and disposition of public lands and propose a classification and valuation of them and a system of surveys for land-parcelling. Other recommendations related to the form of publications and the disposition of collections of natural history and other specimens made during the prosecution of the surveys.[107]

This report, as already mentioned, was transmitted to Congress in December, 1878. It was no sooner printed than the War Department, through the Secretary of War, George W. McCrary, and the Chief of Engineers, General Humphreys, entered a protest against the adoption of its provisions. Secretary McCrary adopted the argument made before the Committee of the Academy by H. G. Wright, Acting Chief of Engineers, that in view of the fact that the War Department had been long engaged in survey work, that its experience in such work was extensive and diversified, that it had devised and perfected instruments and methods of work, and that it maintained an effective system of safeguarding expenditures, it was for the best interests of the Government that the work should continue under its direction.[108]

General Humphreys' objections to the Academy's plan were of a somewhat different character. As already mentioned, he

[107] For the full report, see Rep. Nat. Acad. Sci. for 1878, pp. 19-22. House Misc. Doc. no. 7, 46th Congress, 1st Session.

[108] Sen. Exec. Doc. no. 21, 45th Congress, 3d Session, p. 1.

first asserted that the committee was not properly constituted. He then pointed out that the committee had prescribed no methods of work and had made no estimate of expense, and claimed that it had exceeded its functions in taking the work of the Coast Survey into consideration. He argued that the geodetic work of that organization was not necessary to the proper surveying of the coasts of the United States and that it was not as well equipped as the War Department to do the work of mensuration for all the surveys, as proposed in the Academy's plan, and that, in any case, the War Department could perform the necessary work at a much smaller expense. After reviewing the history of the survey of the Great Lakes, he made the claim that the kind of land survey of the United States at large recommended by the Academy was unnecessarily refined and would entail enormous expenses, and, by a very full comparison of costs, endeavored to show that if really demanded by Congress, it would be carried out at a much less expense by the War Department than by the Coast Survey.

General Humphreys appended to his letter a communication from General Comstock, the officer in charge of the survey of the Northern and Northwestern lakes and the St. Lawrence and Mississippi rivers, dated October 25, 1875, and entitled "Considerations of the objects and methods of a natural topographical survey," in which the methods, cost and uses of different kinds of surveys are concisely summarized. General Comstock criticised Professor Whitney for omitting the question of cost from his review of the surveys, already mentioned, and remarks that on this account "his conclusions as to the value of the results derived from the funds supplied are worthless or misleading."

On the publication of General Humphreys' letter, the Superintendent of the Coast Survey, C. P. Patterson, addressed a communication on January 18, 1879, to the Secretary of the Treasury suggesting that there had been a misapprehension on the part of the former relative to the cost of the Coast Survey work. This was transmitted to General Humphreys, who thereupon prepared for the use of Congress another statement in which the estimates of cost per square mile are considerably reduced. In closing he remarked:

"To take this work from an organization like the Engineer Department, superior to all officers employed on its surveys, and exercising a careful supervision over them, and adopt the plan of the National Academy of Sciences, would, in my judgment, be in opposition to economy, and, if a general survey should be undertaken, would result in expenses amounting to scores of millions of dollars." [109]

As a reply to the contentions of the War Department, the Secretary of the Interior on February 7, 1879, sent to the House of Representatives a letter by Major J. W. Powell on the cost of the various government surveys.[110] This document is in reality a defence of the Academy's plan. It enumerates the different kinds of surveys, and explains their objects, gives the cost of different surveys per square mile, states the amount of land belonging to the public domain which is unsurveyed and the cost of surveying it, shows that different systems of geodesy and topography are employed by the several existing organizations, and finally gives the reasons why the work should be consolidated under the Interior Department.

In regard to the letters cited above, Major Powell's closing paragraph contains this reference to the Academy's report:

"The wisdom and integrity of the committee of the National Academy of Sciences needs no other vindication than that contained in its report to the honorable body that finally endorsed it and transmitted it to Congress. The report is comprehensive and explicit, and embraces both an administrative plan and a scientific system for the conduct of surveys." [111]

The report had already been commended by the *Nation,* which in an editorial published on January 9, 1879, after describing the conditions existing in the several surveys and the changes proposed by the Academy, remarked:

"No opposition prompted by good motives or supported by solid reasons can be offered to these admirable recommendations. Any objections from the

[109] Sen. Ex. Doc. no. 21, part 2, 45th Congress, 3d Session, p. 3. "Letter from the Secretary of War, communicating further information in relation to a survey of the territory west of the Mississippi River, as proposed by the National Academy of Sciences."

[110] House Exec. Doc. no. 72, 45th Congress, 3d Session. "Cost of Geographical Surveys."

[111] *Op. cit.,* p. 6.

Engineer Corps of the Army will, we are persuaded, give way on reflection to considerations of the public good. No chief of the civilian surveys will be likely to declare himself indispensable, and his pet plan the embodiment by patent right of all science." [112]

The committee on Appropriations of the House of Representatives incorporated the whole plan of the Academy in a bill (House Res. 6140) which was duly reported to Congress. When the matter came to issue, however, the portion of the plan relating to the establishment of a single geological survey under the Department of the Interior and the appointment of a commission to consider the codification of laws relating to the survey and disposition of the public domain and other matters was approved, while that providing for the consolidation of all mensuration work under the Coast Survey was not. The law, which forms part of the Sundry Civil Act for the fiscal year ending June 30, 1880, which was approved March 3, 1879, is as follows:

"For the salary of the Director of the Geological Survey, which office is hereby established, under the Interior Department, who shall be appointed by the President by and with the advice and consent of the Senate, six thousand dollars: *Provided,* That this officer shall have the direction of the Geological Survey, and the classification of the public lands and examination of the Geological Structure, mineral resources and products of the national domain. . . . . And the Geological and Geographical Survey of the Territories, and the Geographical and Geological Survey of the Rocky Mountain Region, under the Department of the Interior, and the Geographical Surveys West of the One Hundredth Meridian, under the War Department, are hereby discontinued, to take effect on the thirtieth day of June, eighteen hundred and seventy-nine. . . . .

"For the expenses of a commission on the codification of existing laws relating to the survey and disposition of the public domain, and for other purposes, twenty thousand dollars; *Provided,* That the Commission shall consist of the Commissioner of the General Land Office, the Director of the United States Geological Survey, and three civilians, to be appointed by the President." . . . . [113]

[112] *The Nation,* vol. 28, p. 29, January 9, 1879. "The proposed reforms in our land and scientific surveys" (pp. 27-29).

[113] Stat. at Large, vol. 20, p. 394, 45th Congress, 3d Session, chap. 182, 1879. See remarks on the debate in Congress, quoted from the Philadelphia *Bulletin* in *Amer. Nat.,* vol. 13, pp. 181-183.

Clarence King, the first director, was nominated by the President about March 24, 1879; was confirmed by the Senate on April 3, 1879, and took the oath of office on May 24.

Thus the earlier geological and geographical surveys were put out of existence and the new United States Geological Survey, recommended by the Academy, took their place. A provision was, however, made by Congress for the completion of the reports of the former.

Professor Dana remarked in the *American Journal of Science* in December, 1879:

"The failure of Congress to act favorably with reference to the establishment of 'Mensuration Surveys,' recommended in the Report of the Committee of the Academy, is thought to be a deferring of the subject for the time, and not a rejection of the scheme." [114]

This opinion has not been confirmed by any action of Congress up to the present time. The later history of the Geological Survey, especially, as regards the extension of its work to the States is one of much interest, but cannot be considered here.[115]

COMMITTEES ON THE RESTORATION OF THE DECLARATION OF INDEPENDENCE. 1880 AND 1903

On July 19, 1776, Congress passed the following resolution:

"*Resolved,* That the Declaration [of Independence] passed on the 4th be fairly engrossed on parchment with the title and stile [*sic*] of 'The unanimous declaration of the thirteen united states [*sic*] of America' & that the same when engrossed be signed by every member of Congress." [116]

On August 2 the Journal of Congress informs us "The Declaration of independence [*sic*] being engrossed & compared at the table was signed." [117]

While the majority of members signed on this date, the signatures of a few were not affixed until some months later.

This parchment copy of the Declaration has passed through many vicissitudes. It appears to have been in Baltimore when Congress was sitting there in 1777, but its history between that

[114] *Amer. Journ. Sci.,* ser. 3, vol. 18, p. 494.

[115] Those interested should consult the *Amer. Journ. Sci.,* ser. 3, vol. 18, 1879, pp. 492-496; vol. 19, 1880, pp. 78-81. *Amer. Naturalist,* vol. 13, 1879, pp. 343-345, 535-536; vol. 14, 1880, pp. 68-70.

[116] See Hazelton, J. H. The Declaration of Independence—Its History, 1906, p. 208.

[117] *Loc. cit.*

date and 1814 is uncertain. Hazelton is of the opinion that it was transferred to Washington in 1800 when that city became the seat of government. In 1814, during the war with the British, it appears to have been carried into Virginia for safety. In 1823, a copperplate facsimile was made by order of John Quincy Adams, then Secretary of State, from which 200 copies were struck off and distributed in accordance with a resolution of Congress. In a letter to the Senate (which received it on January 2, 1824) Secretary Adams remarked:

"An exact facsimile, engraved in copperplate, has been made by direction of this department, of the original copy of the Declaration of Independence, engrossed on parchment. . . . . Two hundred copies have been struck off from this plate, and are now at the office of this department, subject to the disposal of Congress." [118]

From 1824 to 1840 the Declaration on parchment seems to have been kept at the Department of State, but in 1841 it was transferred to the new building of the Patent Office. Here it remained until 1877 when it was returned to the Department of State and preserved in the War, State and Navy building, then just completed. It has remained there until the present time.

At the end of a century the Government and the people awoke to the fact that the precious parchment had deteriorated as a result of the vicissitudes to which it had been subjected, and was apparently in danger of destruction. In 1880 Congress passed an Act calling on the Secretary of the Interior and the National Academy of Sciences to make an examination of it, with a view to determining what steps should be taken to prevent its further deterioration, or, if possible, to restore it to its original condition. In May of that year Carl Schurz, Secretary of the Interior, requested that a committee be named by the President of the Academy. President Wm. B. Rogers thereupon appointed Wolcott Gibbs, J. E. Hilgard, C. F. Chandler, R. E. Rogers and J. Lawrence Smith. This committee submitted a brief report on January 18, 1881, as follows:

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[118] Annals of Congress. See Hazelton, *op. cit.*, p. 289.

"PROFESSOR WM. B. ROGERS,

"President of the National Academy of Sciences.

"SIR: The Committee of the National Academy of Sciences, to which was referred the question of the restoration of the faded writing of the original manuscript of the Declaration of Independence, respectfully reports:

"That, in the judgment of the Committee, it is not expedient to attempt to restore the manuscript by chemical means, partly because such methods of restoration are at best imperfect and uncertain in their results, and partly because the Committee believes that the injury to the document in question is due, not merely to the fading of the ink employed, but also and in a large measure to the fact that press copies have been taken from the original, so that a part of the ink has been removed from the parchment.

"The Committee is therefore of the opinion that it will be best, either to cover the present receptacle of the manuscript with an opaque lid or to remove the manuscript from its frame and place it in a portfolio, where it may be protected from the action of light; and, furthermore, that no press copies of any part of it should in future be permitted."[119]

As a result of this report the receptacle containing the parchment was provided with wooden doors. It was removed from exhibition in 1893, sealed between glass plates and placed in a steel safe, where it was no longer exposed to light and was secure from careless handling. It continued thus until 1903 when John Hay, Secretary of State, entertaining suspicions that the document was still deteriorating, requested that it be examined again by a committee of the Academy. Under date of April 14, 1903, he addressed the following letter[120] to President Agassiz:

"DEPARTMENT OF STATE,
"WASHINGTON, April 14, 1903.

"ALEXANDER AGASSIZ, ESQ.,

"President of the National Academy of Sciences, Cambridge, Mass.

"SIR: In accordance with the provisions of section 3 of the act of incorporating the National Academy of Sciences, I desire to invite the attention of the National Academy of Sciences to the condition of the Declaration of Independence, and to suggest that a committee be appointed to examine it in the library of this Department, and that such recommendations as may seem practicable be made to me touching its preservation. It is now kept out of the light, sealed between two

[119] Proc. Nat. Acad. Sci., vol. 1, pp. 180, 181.

[120] Rep. Nat. Acad. Sci. for 1903, p. 13.

sheets of glass, presumably proof against air, and locked in a steel safe. I am unable to say, however, that, in spite of these precautions, observed for the past ten years, the text is not continuing to fade and the parchment to wrinkle and perhaps to break.

"I am, sir, your obedient servant,

"JOHN HAY."

The President thereupon appointed C. F. Chandler, J. S. Billings and Ira Remsen to consider the question a second time. The report of this committee [121] is of such general interest that it seems desirable to quote it in full, together with the letter of acknowledgment written by the Secretary of State upon its receipt.

"NEW YORK, April 24, 1903.

"HON. JOHN HAY, *Secretary of State.*

"DEAR SIR: In response to a communication received from you, a committee was appointed by President Agassiz, of the National Academy of Sciences, to confer with you with regard to the present condition of the Declaration of Independence, and to make such recommendations as should seem desirable to insure the preservation of this precious instrument. The committee was also requested to send their report to you directly, in order to avoid the delay which might result from reporting in the usual manner to the officers of the Academy. The members of the committee are John S. Billings, Ira Remsen, and Charles F. Chandler.

"After conferring with you, the committee was given an opportunity to make a careful examination of the instrument, with the assistance of Mr. A. H. Allen, Chief of the Bureau of Rolls and Library, and with the assistance of Dr. Wilbur M. Grey, of the Army Medical Museum.

"The instrument has suffered very seriously from the very harsh treatment to which it was exposed in the earlier years of the Republic. Folding and rolling have creased and broken the parchment. The wet press-copying operation, to which it was exposed about 1820, for the purpose of producing a facsimile copy, removed a large portion of the ink. Subsequent exposure to the action of light for more than thirty years, while the instrument was placed on exhibition, has resulted in the fading of the ink, particularly in the signatures. The present method of caring for the instrument seems to be the best that can be suggested.

[121] This report was reprinted by the Department of State in the form of a circular, and the following remarks were added to it:

"The Secretary of State has directed that the recommendations of the committee as set forth in the foregoing report be observed. The Department of State has no copies of the Declaration of Independence in any form for distribution."

"The committee is pleased to find that no evidence of mold or other disintegrating agents can be discovered upon the parchment by careful microscopic examination, nor any evidence that disintegration is now in progress.

"The investigation has been facilitated by the photograph that was taken in 1883, two years after the previous examination by a committee of the Academy, and we would suggest the desirability of taking another photograph of about the same size, at the present time, and from time to time in the future, as an aid to future investigation.

"The committee does not consider it wise to apply any chemicals with a view to restoring the original color of the ink, because such application could be but partially successful, as a considerable percentage of the original ink was removed in making the copy about 1820, and also because such application might result in serious discoloration of the parchment; nor does the committee consider it necessary or advisable to apply any solution, such as collodion, paraffin, etc., with a view to strengthening the parchment or making it moisture proof.

"The committee is of the opinion that the present method of protecting the instrument should be continued; that it should be kept in the dark, and as dry as possible, and never placed on exhibition.

"Very respectfully, yours,
"CHARLES F. CHANDLER,
"Chairman of the Committee." [122]

Secretary Hay replied to this letter as follows:

"DEPARTMENT OF STATE,
"WASHINGTON, April 27, 1903.

"PROF. C. F. CHANDLER,
"Chairman Committee of the National Academy of Sciences to examine the present condition of the Declaration of Independence.

"SIR: I have received your letter of April 24 instant, conveying the report of the committee appointed by President Agassiz of the National Academy of Sciences to confer with me respecting the present condition of the Declaration of Independence, and I beg you to accept for yourself and your colleagues of the committee—President Remsen, of the Johns Hopkins University, and Dr. Billings, of the New York Public Library—my thanks for the promptness and thoroughness of the examination made by the committee, among the results of which is the gratifying assurance that no evidence of mold or other disintegrating agents were discovered upon the parchment under the microscope. I am gratified also to learn that the present method of caring for the instrument meets the concurrence of the committee.

"The suggestions and recommendations made by yourself and your colleagues will be attentively observed by the Department, and I have already caused your

[122] Rep. Nat. Acad. Sci. for 1903, pp. 13-15.

advice to be followed by securing a photograph for comparison with that of 1883, and with others to be taken hereafter, from time to time, as aids to future investigations.

"The conclusions of the committee, that the application of any chemicals with the view of restoring the original color of the ink would be unwise, and that the application of any solution, such as collodion, paraffin, etc., is neither necessary nor advisable for the purpose of strengthening the parchment or making it moisture proof, are welcome as avoiding experimental treatment of a document so precious and historic.

"Again thanking the committee for their attention and care,

"I am, sir, your obedient servant,

"JOHN HAY."[123]

It appears from the foregoing correspondence that the second committee agreed with the first as to the principal causes of the deterioration observable in the document and as to the best means of preventing further damage. The press copying mentioned is no doubt that which took place when the copperplate facsimile was made by direction of John Quincy Adams in 1824. It will be observed that a photograph of the document was made in 1883 and again in 1903, but since that latter date no more appear to have been taken. The safe containing it has been opened but once during the last decade, namely, in May, 1911.

COMMITTEE ON SORGHUM SUGAR. 1881

The varieties of sorghum which are available as sources of sugar have been cultivated for a long period in China and Africa. Seed was first imported into the United States from the former country by way of France, and from Natal about the year 1855. The sorghum plant is far more hardy than sugar-cane, and was successfully cultivated over a wide area, especially in the western and northwestern parts of the United States. The outbreak of the Civil War caused a scarcity of sugar-cane throughout the country, and the saccharine products of sorghum were greatly in demand to supply the deficiency. These products, however, did not take the form of sugar, but of syrup. In 1860, nearly 7,000,000 gallons of sorghum syrup were manu-

[123] Rep. Nat. Acad. Sci. for 1903, pp. 14, 15.

factured, and in 1870, three years after the close of the war, the production had risen to 16,000,000 gallons. It increased from year to year during the next decade, and was about at its maximum in 1880, when the output was more than 28,000,000 gallons.

Although beginning as early as 1863 some sorghum sugar was made in the United States every year, it was not until near the time when sorghum syrup production was at its height that the attention of the Government was turned toward the promotion of the manufacture of this kind of sugar. In 1878, before the agricultural bureau of the Government had developed into the Department of Agriculture, and while Dr. Peter Collier was the chemist of the bureau, experiments were commenced under his direction which were intended to test the possibility of producing sugar from sorghum on a large scale and at a low cost. The investigation was entered upon with great enthusiasm and became a matter of wide interest throughout the country. Farmers and manufacturers coöperated with the Government in promoting the undertaking and large amounts of capital were invested in machinery and appliances for the conversion of sorghum juices into sugar. The press of the country kept the subject prominently before the people and it was for some years a common topic of conversation.

The experiments of the Government were carried on for three or four years, but resulted unfavorably. The Commissioner of Agriculture remarked that "the business of manufacturing sugar from sorghum at the department failed in 1881, having furnished discouragement rather than information to those engaged in it." The same year Dr. Collier, at the invitation of the Academy, read a paper at its November session in Philadelphia on "Facts regarding Sorghum, and some conclusions as to its value as a source of sugar." Professor Silliman, who had introduced Dr. Collier, then presented the following resolution which was approved by the Council:

"*Resolved,* That the subject of sorghum sugar, the experimental results on which, obtained during the three or four years last past by Dr. Peter Collier, of the Agricultural Department, submitted in brief, by invitation, to the academy at its Philadelphia session in November, 1881, is, in the opinion of the academy, of sufficient importance to be referred to a committee of chemists, members of this academy, with the request that they give Dr. Collier's results and methods a careful consideration, and report at their early convenience the conclusions to which they come." [124]

The President, William B. Rogers, appointed as the committee Benj. Silliman, Samuel W. Johnson, Charles F. Chandler and J. Lawrence Smith. Not long after the session closed, the attention of the Commissioner of Agriculture, George B. Loring, was called by the President to the fact that the Academy had the sorghum experiments under consideration, and Mr. Loring thereupon transmitted certain documents for the use of the committee, with the remark that "if this reference involves a scientific investigation of the sorghum question he will be greatly obliged for the report." At the same time, the committee was enlarged by the appointment of Wm. H. Brewer, C. A. Goessman and Gideon E. Moore as additional members. The last two were not members of the Academy.

At the April session of the succeeding year, 1882, an abstract of the report of the committee was read before the Academy, and the first draft of the report itself was also submitted. The complete report was transmitted to the Commissioner of Agriculture in the following November. Mr. Loring refers to the document in his report for 1882 in the following terms:

"At the request of the chemist of the department, I submitted the sorghum analyses and work of his division to the National Academy of Sciences on the 30th of January last for investigation by that body. A committee appointed for that purpose entered upon their work with great zeal and energy, and their report, which was laid before me, was, on July 21, withdrawn formally by the secretary of the academy 'for such action as the academy may deem necessary.' On the 15th of November current, the president of the academy presented to me the final report of that institution, a long and elaborate document, containing a review of the history of the sorghum industry for twenty-five years, a statement of the scientific investigations made in this country and in Europe into the quality of sorghum and maize as sugar producing plants, a careful examination of

[124] Rep. Nat. Acad. Sci. for 1881, p. 19. This paper will be found on pages 64 and 65 of the report of the committee of the Academy on sorghum. For the full title of the latter see the footnote on page 287.

the chemical work of the department, a large volume of testimony received from sugar manufacturers, and certain suggestions with regard to future investigations and the work of the department. The report is evidently the result of infinite care, and has been subjected to careful revision, and I trust it will be found a valuable text-book for those engaged in the sorghum sugar industry. As a review of the successes and failures which have attended this industry, it is invaluable. As a guide to those who are engaged in it, it contains all the important results that have thus far been obtained by the chemist in his laboratory and the manufacturer in his mill. This report, together with a most voluminous appendix, making an interesting mass of matter far too large to be inclosed in the annual volume of the department for this year, will be issued at an early day as a special publication." [125]

Although it appears to have been the intention of the Department of Agriculture to publish the report, it was not issued as a departmental document. On July 6, 1882, the Senate adopted a resolution calling on the Commissioner to transmit it to Congress for the use of that body, and it was published as Senate Miscellaneous Document no. 51, 47th Congress, 2d session.[126] It did not leave the hands of the Commissioner until January 10, 1883, however, and was not published until June of that year. It was the most voluminous report prepared by any committee of the Academy and covered 152 printed pages.[127]

Though conservative in their attitude, the committee speak in favorable terms of the outlook of the sorghum sugar industry, and express their faith in its future development. "As a work of national importance," they remark, "calculated directly to benefit widely separated sections of the country, it is one that has been wisely undertaken and encouraged by the Department

[125] Rep. Comm. Agric., 1882, p. 680.

[126] The resolution was as follows:

Senate, July 6, 1882. "Mr. Windom submitted the following resolution; which was considered by unanimous consent and agreed to: *Resolved,* That the Commissioner of Agriculture be directed to furnish for the use of the Senate a copy of the report of the Committee of the National Academy of Sciences upon the subject of sorghum sugar," Congressional Record, vol. 13, part 6, p. 5669, 47th Congress, 1st Session.

[127] Forty-seventh Congress, 2d Session, Sen. Misc. Doc. no. 51. National Academy of Sciences. Investigation of the Scientific and Economic relations of the Sorghum sugar Industry, being a report made in response to a request from the Hon. George B. Loring, U. S. Commissioner of Agriculture, by a committee of the National Academy of Sciences. November, 1882. Washington: Government Printing Office. 1883. 8°. Pp. 1-152.

of Agriculture, and is deserving of every aid that Congress may be willing to grant for its encouragement and prosecution." (p. 24.) Again:

"The spirit of scientific investigation which has led the Department of Agriculture through its chemical and agronomic researches to results of such importance towards developing a new industry of national value has been liberally fostered by the General Government, and to some extent also by certain of the States. The fruits of this policy are already beginning to show themselves in the decided success which has attended the production of sugar from sorghum on a commercial scale in the few cases in which the rules of good practice, evolved especially by the researches made at the laboratory of the Department of Agriculture, have been intelligently followed. Sufficiently full returns from the crop of 1882 have already come to hand to convince us that the Industry is probably destined to be a commercial success" (p. 53).

The expectations of the committee, though doubtless justified by the knowledge available at the time at which they were formed, were not destined to be fulfilled, owing to a combination of circumstances which could not be foreseen. Congress continued to appropriate money for sorghum investigations for a number of years and the Department of Agriculture carried on experiments with great industry and earnestness, but the scope of these activities gradually narrowed as the real nature of the problem began to be perceived, and finally in 1893, they were discontinued.

In the same year in which the committee of the Academy reported (1882) the actual manufacture of sugar at the Department of Agriculture was found unprofitable and was abandoned. Attention was then concentrated on increasing the sugar-content and other desirable qualities of the sorghum plant and on finding a process for the manufacture of sugar at a low cost. It was finally determined that the only ready methods of causing the sugar to crystallize in large quantities and of freeing it from the starch and gummy substances with which it was associated involved the use of large quantities of alcohol. The high tax on alcohol made its use prohibitive and the industry thus encountered an obstacle which it has never been able to surmount. Although for many years before and after the Government entered on its investigations a million or more pounds of sugar were manufactured annually in the United States from sorghum, the industry was always a precarious one, and quite as likely to entail a loss as to yield a profit. At the critical time in its history a number of circumstances besides the difficulty regarding the use of alcohol militated against its development. Among these the most important was that the price of sugar was unusually low, a condition brought about largely by the growth of the beet-sugar industry which proved remunerative and engrossed the attention of agriculturists in those very sections of the country in which it was expected that the cultivation of sorghum sugar would prove a benefit. In 1893 Congress discontinued appropriations for sorghum investigations, the Secretary of Agriculture having remarked in his report for that year:

> "The experiments in sorghum sugar may, it is believed, be discontinued, the results of experiments already made leaving apparently nothing more for the Federal Government to undertake. A stage is now reached when individual enterprise can and should take advantage of what the Department has accomplished." [128]

Thus the activities of the Government terminated without producing the result which the committee of the Academy expected. The potentialities of sorghum as a source of sugar were demonstrated, however, and the time may yet come when new agricultural and commercial conditions and the progress of invention may bring it into actual use as one of the principal sugar-producing plants. In the meantime, the money and thought expended in investigations were not wasted, as sorghum has proved to be very valuable as a source of table syrups and as a fodder-plant for cattle.[129]

[128] Rep. Secr. Agric. for 1893, Nov. 20, 1893, pp. 33, 34 (J. Sterling Morton, Secretary). See also p. 189 of the same report.

[129] See H. W. Wiley. The relation of chemistry to the progress of agriculture. Yearbook U. S. Dep. Agric. for 1899, pp. 242, 243.

COMMITTEE ON QUESTIONS OF METEOROLOGICAL SCIENCE AND ITS APPLICATIONS. 1881

This committee was appointed in 1881 at the request of the Chief Signal Officer of the Army. The *Proceedings* of the Academy contain the following information regarding it:

"A communication was laid before the Academy from General William B. Hazen, Chief Signal Officer, United States Army, under date of April 4, 1881, asking that a permanent committee be appointed with whom the Signal Officer might confer from time to time as to the best means of advancing the science of meteorology and its applications to the benefit of agriculture and commerce.

"The following-named members were thereupon appointed by the President a Committee on Meteorology to confer and co-operate with the Chief Signal Officer: Mr. Newcomb, chairman, and Messrs. Loomis, Gibbs (W.), Newton (H. A.), Ferrel, Schott, and Langley.

"Messrs. Rood and Young were subsequently added to the Committee." [130]

In his report for 1881, General Hazen comments on the appointment of the committee in the following terms:

"The weather service of the United States has been without a rival in the practical advantages derived from its labors, but the day has now come when it should take the stand among the foremost, in the scientific study and investigation of the higher branches of theoretical meteorology, and it is upon such investigations intelligently pursued that the hope for greater benefits must mainly rest. I have endeavored to bring this service into active sympathy and co-operation with the ablest scientific intellects of the country. In this direction and in response to my request, the National Academy of Sciences has appointed an advisory committee of consulting specialists with which I may confer as occasion demands. I take pleasure in acknowledging this courtesy as showing the establishment of more intimate relations between the scientific interests of the United States and the Signal Service." [131]

The committee appears not to have presented any formal reports but was continued until 1884, when it was discharged. At this time the Academy had been requested by a Joint Commission of Congress to express its opinion as to the meteorological work carried on under the Signal Service.

[130] Proc. Nat. Acad. Sci., vol. 1, pp. 181, 182.

[131] Rep. Chief Signal Officer of the Army, p. 3 (1881) (Wm. B. Hazen).

COMMITTEE ON THE SEPARATION OF METHYL, OR WOOD SPIRITS, FROM ETHYL ALCOHOL. 1882

The reasons for which the advice of the Academy was desired on this subject are very clearly and fully stated in a letter which the Commissioner of Internal Revenue, Green B. Raum, addressed to the President on April 12, 1882. He writes:

"There is now pending before Congress a bill (H. R. 5082) 'To authorize the withdrawal from distillery warehouse, without tax, of alcohol and other spirits to be used in industrial pursuits,' which bill provides that 'such spirits shall either first have been mixed with one-ninth of their bulk of methyl, or wood alcohol, of equal proof strength, or that such spirits shall be withdrawn for use in tobacco factories, or such other industrial pursuits as shall entail their complete destruction so that they cannot be recovered by any process of distillation.'

"It is therefore deemed important to the interests of the revenue that a careful and thorough investigation be made, having for its object the determination of the fact whether the methyl, or wood spirits may be entirely, or approximately, separated by distillation, or in any other economical manner from the ethyl alcohol, or spirits of wine, upon which the tax is imposed.

"In other words, the information sought is as to whether the science of chemistry now enables the possessor of the methylated spirits to separate the ethyl alcohol from such mixture in such a state of purity, and at such a probable cost as might enable the holder to sell it in the market at a less price than those persons who withdraw spirits from bond upon payment of the tax at the rate of ninety cents per proof gallon.

"I have therefore to respectfully request that a committee of the National Academy of Sciences be appointed to undertake this investigation, and to inform this office of the result at the earliest moment practicable.

"I desire particularly to be advised as to the relative vaporizing point of purified wood-naphtha as compared with distilled spirits of the same specific gravity, and such other information on the subject as may assist this Office in reaching a conclusion as to whether or not the bill referred to would be liable to abuse if it should become a law.

"I have to ask if it is the pleasure of the academy to undertake this investigation, and if so to be informed as to the nature and quantity of alcohol, wood-naphtha, and other materials which will be needed in the prosecution of this inquiry." [132]

The Acting President, Prof. O. C. Marsh, appointed a committee consisting of Ira Remsen, G. F. Barker and C. F. Chandler which reported on September 18, 1882. The report covered

[132] Rep. Nat. Acad. Sci. for 1883, pp. 57, 58.

various aspects of the question at issue. It began by pointing out that in both England and Germany the law had for a number of years permitted the use of methylated spirits in the arts, and gave a résumé of the reports of the committees on which the legislation was based. It then defined the several liquids known as ethyl alcohol, methyl alcohol, crude wood-naphtha, and refined wood-naphtha or wood spirits, and described a number of experiments made by the committee with mixtures of ethyl alcohol and refined wood-naphtha. The committee summed up its report as follows:

" The final conclusion to which we are led is this: That by treating the mixtures of ethyl alcohol and wood spirits (in the proportion proposed in the bill now before Congress) with bone-black, filtering, adding a caustic alkali—as, for example, caustic potash—and then distilling with the aid of the Hempel tube, the principal product obtained is nearly free from methyl alcohol, and that the odor and taste of this product are not very marked. At the same time, even in the best product thus obtained, the odor and taste characteristic of wood-naphtha can be detected, though only with difficulty, by those who are unskilled in such matters. We believe that the method employed by us which gave the best product could be applied economically on the large scale, and a product fully as good as our best, if not better than it, might thus be obtained.

" As regards the question whether the product obtained could be used for drinking purposes, that is difficult for the committee to answer satisfactorily. We have submitted our best specimens to some well-known dealers in alcohol and alcoholic beverages, and we learn that the purified product might easily be used in the manufacture of low-grade whiskies and rum, though all the gentlemen whom we have consulted on this point have unhesitatingly recognized the presence of the wood-naphtha in the best specimens.

" It would appear from this that, while after the addition of the wood-naphtha to alcohol, it is extremely difficult, if not impossible, to separate the two perfectly and thus regenerate the pure alcohol, it is quite possible to get from the mixture a product which might be used in the manufacture of alcoholic beverages of lower order.

" It is plain from the foregoing that, considering our experiments as final, it is impossible to purify the mixture containing wood-naphtha to a sufficient extent to make it palatable without the aid of distillation. Hence, apparently, it would be as difficult to carry on the process of purification on the large scale as to carry on the illegitimate manufacture of alcohol. This fact, in itself, might be a sufficient protection against fraud, though the committee does not feel competent to express a decided opinion on this point." [133]

[133] Rep. Nat. Acad. Sci. for 1883, pp. 62, 63.

COMMITTEE ON GLUCOSE. 1882

The request for the appointment of a committee of the Academy on the vexed question of glucose was received from the Commissioner of Internal Revenue a few days after the request for a committee on methyl alcohol. In a letter addressed to President Rogers, dated April 27, 1882, the Commissioner remarks:

"There is now pending before Congress a bill (H. R. 3170) 'to tax and regulate the manufacture and sale of glucose,' which bill proposes to so amend the internal-revenue laws as to impose a special tax upon the manufacturers of, and dealers in, glucose, and to levy a tax on the article in its solid, liquid, and semi-liquid form.

"In view of this, I have respectfully to request the appointment of a committee of the Academy to examine as to the composition, nature, and properties of the article commercially known as glucose, or grape sugar.

"This office desires to be informed as to the saccharine quality of this product as compared with cane sugar or molasses, and also especially as to its deleterious effects when used as an article of food or drink, or as a constituent element of such articles.

"Numerous specimens of the article in question are in the possession of this, office which will be placed at the disposal of the Academy.

"Any expense necessarily incurred in conducting this inquiry will be paid upon the presentation of a properly prepared bill for that purpose." [134]

In accordance with the request contained in this letter the President, Wm. B. Rogers, appointed the following committee to consider the question at issue: Ira Remsen, C. F. Chandler, G. F. Barker. The committee reported on September 18, 1882.

The magnitude of the starch-sugar industry in the United States will be appreciated from the consideration of some statistics taken from the report of the committee of the Academy and from other sources. In 1882 there were 32 glucose and starch-sugar factories in the country with an estimated capacity of 43,000 bushels of corn a day. In 1884 there were 29 factories capable of utilizing 40,000 bushels a day. In 1902 the factories had been reduced by combination to five which, however, used 175,000 bushels of corn a day. The combined capital of four of

[134] Rep. Nat. Acad. Sci. for 1883, p. 66.

these companies amounted to $80,000,000. At the beginning of the present century the domestic consumption of corn syrup and corn sugar amounted to 1200 million pounds annually. The exports for the decade 1893-1903 amounted to more than 1700 million pounds, valued at $28,000,000.

The report of the committee was one of the most extensive made during the first half century of the Academy and covered 77 printed pages. It contained, besides a general introduction, a summary of the history of the starch-sugar industry, an account of the several varieties of glucose and starch-sugar, and of their chemical composition, an inquiry into the healthfulness of glucose as a food, analyses of commercial samples of glucose and starch-sugar with special reference to adulteration, and a list of factories. To this were added fourteen pages of extracts from literature relating to starch-sugar, a bibliography covering 28 pages, and a list of patents.

The results of the work of the committee are summarized in eight paragraphs referring to the following subjects: The history of starch-sugar, the process of manufacture, the extent of the industry, the utilization of the products, the relation of starch-sugar to other sugars, the organic constitutents, the healthfulness of glucose as a food.

The conclusions were as follows:

"In conclusion, then, the following facts appear as the result of the present investigation: 1st. That the manufacture of sugar from starch is a long-established industry, scientifically valuable and commercially important. 2d. That the processes which it employs at the present time are unobjectionable in their character, and leave the product uncontaminated. 3d. That the starch sugar thus made and sent into commerce is of exceptional purity and uniformity of composition, and contains no injurious substances. And, 4th, that though having at best only about three-fifths the sweetening power of cane sugar, yet starch sugar is in no way inferior to cane sugar in healthfulness, there being no evidence before the committee that maize starch sugar, either in its normal condition or fermented, has any deleterious effect upon the system, even when taken in large quantities." [135]

[135] Rep. Nat. Acad. Sci. for 1883, p. 88.

COMMITTEE ON THE SIGNAL SERVICE OF THE ARMY, THE GEOLOGICAL SURVEY, THE COAST AND GEODETIC SURVEY, AND THE HYDROGRAPHIC OFFICE OF THE NAVY DEPARTMENT. 1884

In the Sundry Civil Act approved July 7, 1884, Congress directed the appointment of a joint commission of the Senate and House to consider and report on the organization of the Signal Service of the Army, the Geological Survey, the Coast and Geodetic Survey, and the Hydrographic Office of the Navy Department "with the view to secure greater efficiency and economy of administration of the public service in said bureaus." It would appear that the demand for this inquiry had a double origin. In Congress and in the country generally it was thought that the weather service, which was organized under the Signal Service of the Army, would be improved and extended if it were taken out from under the control of the War Department and placed in charge of civilians. A separate inquiry into this matter was at first proposed, but subsequently it was merged with an inquiry into the relationships of the several national surveys. Regarding the latter the Joint Commission remarked in its report:

"It has been frequently stated in the course of debates in Congress that the several scientific Bureaus named were engaged in unnecessary work, so far as practical results were concerned, and also that there was a duplication of work, two or more Bureaus being engaged in substantially the same character of investigation and in the execution of the same work. It was claimed, especially, that the Geological Survey and the Coast and Geodetic Survey were duplicating their work; and it was also claimed that the work of the Coast Survey proper could be more economically performed under the direction of the Navy Department by use of the force and the organization in that Department known as the Hydrographic Office, and that that work should be transferred from the Treasury to the Navy."[136]

As originally organized, the Joint Commission consisted of Senators Wm. B. Allison (chairman), Eugene Hale, and Geo. H. Pendleton, and Representatives Robert Lowry, Hilary A. Herbert and Theodore Lyman (secretary). The Commission

[136] House Reports, 49th Congress, 1st Session, Rep. no. 2740, pp. 1-2.

was unable to report in December, 1884, as the law demanded, and the time was extended to December, 1885, "or as soon thereafter as may be." In the meanwhile Senator Pendleton and Representative Lyman had retired from Congress, and were replaced on the Commission by Senator John T. Morgan and Representative John T. Wait. The report was finally submitted on June 10, 1886.[137] The testimony taken before the Commission had already been published. It forms a thick volume of more than a thousand pages.[138]

Feeling that it should receive the advice of the National Academy of Sciences, the Commission, through its secretary, Hon. Theodore Lyman, requested that a committee of the Academy be appointed to consider the subject in question. The committee appointed by President Marsh consisted of M. C. Meigs, Wm. H. Brewer, Cyrus B. Comstock, S. P. Langley, Simon Newcomb, E. C. Pickering, W. P. Trowbridge, F. A. Walker, and C. A. Young. All accepted appointment, but subsequently Prof. Newcomb and Gen. Comstock resigned by order of the Secretary of the Navy and the Secretary of War, respectively. These orders were issued on the ground that it was not proper for the two members who were active officers of the Departments mentioned to be concerned in giving advice to Congress, which might result in action which would embarrass the heads of those Departments in carrying out their policies.[139]

On the other hand, President Marsh held that the Academy should not be deprived of the services of the two members in formulating advice asked for by the legislative branch of the Government. He declined, therefore, to accept their resignations, and laid the matter before the Academy. The Academy appears, however, to have taken no action regarding it.

[137] House Rep. no. 2740, 49th Congress, 1st Session.

[138] Senate Misc. Doc. no. 82, 49th Congress, 1st Session, 1886.

[139] This view did not affect the appointment of General Meigs, apparently for the reason that he was a retired officer. He was requested by the Secretary of War to withdraw, but upon his submitting a protest the matter was dropped.

The questions which the committee was requested to consider were as follows:

"*First.* What is the organization of the government surveys, and of the signal service, in the chief countries of Europe, and could any part of this organization be advantageously adopted in this country?

"*Secondly.* In what way can the scientific branches above referred to be best co-ordinated?

"*Thirdly.* What changes in, or additions to, these branches are desirable?" [140]

The report of the committee was submitted on September 24, 1884, and with the appendices, covers 30 pages. To the first inquiry propounded by the Joint Commission the committee replied that in its opinion the efficiency of the surveys of the United States would not be increased by adopting any form of organization existing in Europe, but that a more extended use of photography and zincography might prove economical in the production of maps and charts. It then called attention to a previous recommendation of the Academy that the Coast Survey be transferred to the Department of the Interior and that its work be extended to include topographic land surveys. The committee recommended that the Weather Bureau be separated from the Signal Service of the War Department and placed under the control of a scientific commission. No immediate change in the scope of the Hydrographic Office was recommended, but it was suggested that when the original survey of the coast should be finished, the work of re-sounding, re-examining, etc., might perhaps be advantageously committed to the Navy Department. Having given attention to these particulars, the committee then pronounced its conviction that a proper coördination of the scientific work of the Government would be most satisfactorily effected by the establishment of a Department of Science. It was proposed that this Department should include the Coast and Geodetic Survey under the name of the Coast and Interior Survey; the Geological Survey, unchanged; a Meteorological Bureau, to which should be transferred the main portion of the meteorological work of the Signal Service; and a physical

[140] Rep. Nat. Acad. Sci. for 1884, p. 35.

observatory, "to investigate the laws of solar and terrestrial radiation and their application to meteorology, with such other investigations in exact science as the Government might assign to it." Attention was also called to the desirability of having in this department a bureau of standards, which might include the Bureau of Weights and Measures.

Should Congress consider it inadvisable to establish a new Department of Science, the committee suggested that all the scientific bureaus be assembled under some one of the Departments then existing. In case either action was taken, the Committee recommended that a permanent scientific commission be created to direct the policy of the several bureaus, this commission to consist of the Secretary of the Department of Science, or other Department to which the bureaus should be assigned (who should be president *ex officio*), the President of the National Academy of Sciences, the Secretary of the Smithsonian Institution, "two civilians of high scientific reputation," an officer of the Engineer Corps of the Army, a professor of mathematics in the Navy, the Superintendent of the Coast and Geodetic Survey, the Director of the Geological Survey, the head of the meteorological bureau.

This report was sent to the Government Commission on October 16, 1884, together with certain letters of the heads of the several scientific bureaus concerned.

The more comprehensive recommendations of the committee of the Academy have not been adopted by Congress up to the present time. Neither a Department of Science nor a general scientific commission has been established, but several of the changes proposed have been made. The meteorological service, formerly combined with the Signal Service of the Army, has become a separate bureau under the Department of Agriculture.[141] A Bureau of Standards has been established in the Department of Commerce and Labor to which has been transferred the work of the former Bureau of Weights and Measures.

[141] The Department of Agriculture became an executive department on February 9, 1889, and the Weather Service was transferred to it on October 1, 1890.

An Astrophysical Observatory has been organized under the Smithsonian Institution corresponding to the observatory proposed by the committee of the Academy. To this extent, the views of the committee have found favor with Congress. Whether the larger plans will eventually be adopted time alone will reveal.

The report of the committee of the Academy was printed in the introduction to the volume of testimony given before the Joint Commission. Many high officials were called upon by the Commission to express their views or to make statistical or other statements relative to the matter under investigation, including the Lieutenant-General of the Army, the Secretaries of War and of the Navy, the heads of the several scientific bureaus concerned and many subordinate officers. The discussion took a wide range but returned repeatedly to the recommendations of the committee of the Academy which formed the text for many remarks.

The report of the Joint Commission in reality comprises three separate reports. Allison, Hale and Lowry agreed as to the various questions at issue, and Wait also sided with them, except in so far as the Signal Service was concerned. Morgan, Herbert and Wait submitted a separate series of recommendations regarding the latter, while Herbert and Morgan presented a minority report relative to the Coast and Geodetic Survey and the Geological Survey.

The conclusion of the majority of the Commission regarding the Coast and Geodetic Survey was as follows:

" . . . . A majority of the commission concur with the view expressed by the Academy of Sciences, that when the original survey shall have been completed it will be time enough to raise the question whether or not the hydrographic work involved in these resurveys may not then be transferred to the Navy Department; but until that time the undersigned believe that question should not be seriously considered. . . . ." [142]

" There is nothing in the testimony to indicate that the work now performed by the Survey can be more efficiently performed if transfer is made, nor is it shown

[142] House Report no. 2740, 49th Congress, 1st Session, p. 6.

that the Navy can more economically execute the work, so there is no reason either on the score of efficiency or economy for making the change. It is suggested that a new method might be adopted, which would result in a considerable saving of expenditure, but the commission does not regard itself competent to decide upon the methods to be adopted in a survey so highly scientific in its character and objects, much less does it feel competent to recommend a change of method which has received the sanction of the scientists of our country, and has the sanction of more than two generations of experience and criticism. . . . ." [143]

Regarding the Weather Service, the report remarked:

" A proposition made to establish a weather service as a civilian organization failed in the commission, three of the commission favoring such transfer, and three opposing it. Those favoring the transfer submit separately their views on the subject, which are appended hereto. . . . ." [144]

The conclusion regarding the Hydrographic Office was as follows:

" The commission unanimously recommend that this office be maintained by appropriations from year to year in its present state of efficiency." [145]

Concerning the suggestions of the Academy that a commission be established to direct the work of the scientific bureaus, or that a department of science be created, the report remarks:

" . . . . The commission considered with care the many suggestions respecting a change of existing law looking to the selection of a supervisory commission, which should from time to time, and at least once in each year, consider what work should properly be done by the several bureaus under examination, and supervise the methods of executing the work committed to them severally. They regard this as impracticable as long as these bureaus are distributed as now among several Departments of the Government. They believe it wiser to leave this general direction and control to each head of Department for the bureau under his supervision. It would be impracticable to give such Commission power to overrule the head of a Department, and if this were not done its powers would only be advisory.

" Nor is the Commission prepared to recommend the establishment of a scientific department of the Government to take charge of all these bureaus. There is no such duplication of work or necessary connection of these bureaus with each other as make such establishment essential to their efficiency, as in cases where one bureau finds it necessary to utilize the work of another, a request for information and data is always complied with." [146]

[143] *Op. cit.*, p. 13.
[144] *Op. cit.*, p. 26.
[145] *Op. cit.*, p. 28.
[146] *Op. cit.*, pp. 53, 54.

Messrs. Morgan, Herbert and Wait, reported on the Weather Service as follows: [147]

"As the result of their investigation of the Signal Service Bureau, the undersigned respectfully submit to Congress the following bill, and recommend its passage:

"'A bill to establish a Weather Bureau in the War Department, and for other purposes.

"'*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That on the first day of July, eighteen hundred and eighty-six, the Signal Service Bureau shall be abolished, and a Bureau to be styled the Weather Bureau shall be established, to which shall be transferred the records and property of every kind now in charge of the Signal Service, except arms and other military equipments and stores, all of which shall be turned over to the proper officers of the Army.

"'SEC. 2. That the Weather Bureau shall be organized as a civil establishment to promote meteorological investigations, and shall be under the direction of the Secretary of War.'

"JOHN T. MORGAN,
"HILARY A. HERBERT,
"JOHN T. WAIT."

Regarding the Coast and Geodetic Survey, Messrs. Herbert and Morgan made the following minority report:

"The undersigned favor the transfer of the Coast Survey proper to the Hydrographic Office of the Navy Department. We mean to include not only the hydrography, that is, soundings, etc., now done by naval officers under the direction of the civilian head of the Coast Survey, but all topography upon nautical charts, including such triangulation as is incident thereto. We believe the Navy would execute this work more economically and speedily, and therefore more effectively, than it is now being done." [148]

"So far as a further survey of our coast is concerned, there seems to be a propriety in transferring that work to the Navy Department. The other duties now in charge of this establishment, if they cannot be profitably attached to some existing Department or other Bureau, should be prosecuted under a law exactly defining their scope and purpose, and with a careful discrimination between the scientific inquiries which may properly be assumed by the Government and those which should be undertaken by State authority or by individual enterprise." [149]

[147] *Op. cit.*, pp. 63-64.
[148] *Op. cit.*, p. 66.
[149] Report, p. 80.

COMMITTEE ON PHILOSOPHICAL AND SCIENTIFIC APPARATUS. 1884

The tariff act approved March 3, 1883, contained the expression "philosophical and scientific apparatus, instruments, and preparations," and upon the claim being put forward by some importers that certain articles which they wished to bring in were "philosophical" instruments the Treasury Department found itself unable to decide whether they were really such, or how they differed from "scientific" instruments. The Acting Secretary of the Treasury, H. F. French, thereupon addressed a letter to Prof. Spencer F. Baird, Secretary of the Smithsonian Institution, asking that the Institution prepare a list of philosophical instruments for the use of the collectors of customs. Professor Baird having suggested that the Academy might prepare such a list, Secretary French wrote to the President under date of September 13, 1884, stating that the Department would be obliged if he would furnish the list. The President, O. C. Marsh, thereupon appointed a committee consisting of George J. Brush, Wolcott Gibbs, S. H. Scudder, Simon Newcomb and George F. Barker, to report on the subject in question. The committee reported later in the year, explaining the reasons which made it impracticable to prepare a list of instruments, and explaining the meaning of the expression "philosophical instruments" as follows:[150]

"Although the term 'philosophical' as applied to instruments has long ceased to be employed in scientific language, it has a well defined signification in ordinary use. It has come down from a time when nearly all our knowledge of inanimate nature was comprehended under the general term 'natural philosophy,' and the instruments and apparatus necessary for acquiring and illustrating that knowledge were termed 'philosophical.' The obvious intent of Congress in specially designating philosophical instruments was to cover the case of institutions and individuals who might import the instruments and apparatus for the purpose of improving natural knowledge. It therefore appears to us that the terms 'philosophical apparatus and instruments' in both clauses quoted should be held to cover all such instruments and apparatus imported for this purpose.

[150] The correspondence and the report of the committee are in the Annual Report of the Academy for 1884, pp. 65-67.

"It does not appear to your committee that the addition of the word 'scientific' in the last clause of the law quoted comprehends any objects other than those which may be included under the term 'philosophical' as hereinbefore defined. We regard the addition of this word as merely intended to render the meaning of Congress more explicit."[151]

COMMITTEE ON THE ASTRONOMICAL DAY, THE SOLAR ECLIPSE OF AUGUST, 1886, AND THE ERECTION OF A NEW NAVAL OBSERVATORY. 1885

As indicated by the heading, this committee was concerned with three different matters of astronomical importance. It was appointed at the request of the Secretary of the Navy, W. C. Whitney, who, on April 22, 1885, addressed the following letter to the President of the Academy:[152]

"NAVY DEPARTMENT,
"WASHINGTON, D. C., April 22, 1885.

"PROFESSOR O. C. MARSH,
"President of the National Academy of Sciences.

"SIR: I have the honor to submit enclosed a copy of Senate Executive Document No. 78, 48th Congress, 2nd Session, containing a letter from the Secretary of the Navy, dated February 17th, 1885, transmitting communications concerning the proposed change in the time for beginning the astronomical day, as recommended by the recent Meridian Conference.

"I would respectfully request that the National Academy of Sciences take into consideration the question of adopting the proposed change in the American Ephemeris and Nautical Almanac, and other astronomical publications, and advise this Department of its views and recommendations on the subject.

"I have also the honor to submit for your consideration and recommendation the following questions:

"1st. As to the advisability of asking Congress to make an appropriation for the observation of the eclipse of the sun in August, 1886, to be expended by the Superintendent of the Naval Observatory under direction of the Navy Department.

"2nd. As to the advisability of proceeding promptly with the erection of a new Naval Observatory upon the site purchased in 1880.

"Very respectfully,
"W. C. WHITNEY,
"Secretary of the Navy."

[151] Rep. Nat. Acad. Sci. for 1884, p. 67.
[152] Rep. Nat. Acad. Sci. for 1885, pp. 35-36.

The committee consisted of F. A. P. Barnard (chairman), A. Graham Bell, J. D. Dana, S. P. Langley, Theodore Lyman, E. C. Pickering, and C. A. Young.

Of the three subjects presented for its consideration, the committee gave its attention principally to the question of the erection of a new observatory building.

The Astronomical Day

As regards the change in the astronomical day proposed by the International Meridian Conference, to make it conform to the civil day, the committee recommended that it be carried into effect as soon as there should be a general agreement among astronomers and astronomical establishments to adopt it, and preferably in 1890 or in 1900. It is well known that from the earliest times astronomers have been accustomed to reckon the day as beginning when the sun is on the meridian, or in other words, at noon; while for ordinary purposes among modern nations the day begins at midnight. In the case of a phenomenon reported as occurring on a certain day between noon and midnight there is, therefore, room for uncertainty as to the real date, unless the kind of day be specified. If the astronomical day should be made to conform to the civil day, this uncertainty would disappear but, on the other hand, there would be a lack of uniformity between ancient and recent astronomical records. The committee considered these difficulties and decided that the advantage of having a single system of reckoning time overbalanced the inconvenience of a discrepancy among astronomical records. This view has not, however, prevailed up to the present time, and, with few exceptions, astronomers have continued to regard the day as beginning at noon.

The Solar Eclipse of August 29, 1886

This eclipse was visible in the tropics and the committee, after looking into the matter, concluded that it would be observed to the best advantage in Benguela, West Africa, but as a considerable time would be required for making the necessary preparations, and it was improbable that any money that might be appropriated would be available until late in the spring of 1886, the committee did not recommend that Congress be asked to take action regarding it.

The eclipse was, however, observed in the West Indies by astronomers from private American observatories.

THE U. S. NAVAL OBSERVATORY

An act of Congress approved February 4, 1880, provided for the purchase of a new site for the Naval Observatory in Washington,[153] which since 1844 had been located on a low eminence near the Potomac River, known as "observatory hill," situated between 23d and 25th streets. The affairs of the observatory form the main theme of the committee's report. For some years the old site had been generally regarded as very unhealthy, the building was somewhat dilapidated and had become inadequate for the needs of the observatory, the equipment had become more or less antiquated, and the grounds were regarded as too limited. The committee invited expressions of opinion as to the advisability of moving from astronomers who had been attached to the observatory for a long term of years, including Professor Holden and Professor Newcomb, and also from various physicians of Washington as to the wholesomeness of the old site. While opinions differed widely as to the effects of the malarial surroundings of the observatory caused by river-fogs, the committee reached the conclusion that a change of location was desirable. Accordingly, an item was included by the Secretary of the Navy in the estimates for 1887, for beginning the erection of a new building on the site on the heights back of Georgetown, and in the act making appropriations for the naval service for the fiscal year ending June 30, 1887, approved July 26, 1886, Congress gave the necessary authorization, in the following terms:

"For commencing the erection of the new Naval Observatory on the site purchased under the act of Congress approved February fourth, eighteen hundred

[153] Stat. at Large, vol. 21, p. 64, 46th Congress, 2d Session, chap. 19.

and eighty, fifty thousand dollars: *Provided,* That the construction of no building shall be commenced except an observatory proper, with necessary offices for observers and computers." [154]

The new observatory was completed in 1893.

While the committee recognized the importance of a suitable site, and adequate equipment and buildings, it was far more concerned regarding the organization of the observatory. The main body of its report relates to this subject. It argued that while astronomers who were naval officers, and especially James M. Gilliss and Charles H. Davis (both members of the Academy) had contributed to the reputation of the Observatory, as an important scientific establishment, that reputation was derived mainly from the labors of its civilian professors, Walker, Ferguson, Hall, Holden, Newcomb and others. It, therefore, recommended that the Observatory be reorganized under a civilian administration, and that its name be changed from United States Naval Observatory to the National Observatory of the United States, which latter designation it bore at a certain early period in its history.[155]

COMMITTEE ON THE TARIFF CLASSIFICATION OF WOOLS. 1885

In the various tariff laws enacted by Congress in the course of the last forty years, different rates of duties are imposed for wool in the natural condition of the fleece, and for wool that has been washed or scoured. Washing is defined as cleansing the fleece while still on the sheep's back by washing it in cold water, while scouring is defined as a more effective cleansing of the wool by means of hot water, or alkalies and other chemicals. The rate for washed wool is twice, and that for scoured wool three times the rate for wool in the natural condition. For some time the appraisers appear to have overlooked the distinction and much wool was admitted at a less rate than it should

[154] Stat. at Large, vol. 24, p. 156, 49th Congress, 1st Session, chap. 781, 1886.

[155] The report of the committee constitutes Sen. Exec. Doc., no. 67, 49th Congr., 1st Sess. Ordered printed Feb. 10, 1886. See also Sen. Exec. Doc. no. 78, 48th Congr. 2d Sess. 1885.

have paid under the law. In the report of H. Wheeler Combs, general appraiser at the port of New York, dated October 30, 1885, we read:

"We had also made inquiry into the discrepancies between the large ports in the matter of the value and classification of foreign wools—particularly those known as 'Donskoi wools'—and were in communication with the officials and reputable importers at the large ports on this subject. We have learned enough to convince us that gross undervaluations at all the ports have existed for years, through a misapprehension on the part of the customs officials of the true value of the currency on which the traffic is actually based.

"These wools are entered as 'washed wools,' valued at less than 12 cents per pound. A chemical analysis was made at the laboratory connected with the appraiser's office, and the chemist reports that they are '*scoured* wools.' This subject is now being carefully investigated by the appraiser of this port." [156]

On December 3, 1885, the Secretary of the Treasury, Daniel Manning, addressed a letter to the President of the Academy, in which he stated that an appeal had been taken from the decision of the Collector of Customs at the port of New York in a case involving the classification of a certain consignment of wool for tariff purposes, and requested that the Academy would advise him as to its proper classification. The President appointed a committee to examine the sample of wool which accompanied the letter and determine its real character. This committee, which consisted of C. F. Chandler, W. H. Brewer and Henry Morton, reported on January 16, 1886, giving its opinion as to the character of the wool and at the same time offering some detailed information of a very interesting character as to the qualities of different kinds of wool. This included a translation of Chindsinsky's article on the composition of the fleece of merino and coarse-wooled breeds of sheep. To this were added analyses of various samples of wools procured by the committee, including the one received from the Treasury Department, and a summary of analyses made by other investigations. The committee then presented the following conclusions:

"From the preceding facts, we see that wool comes into the trade in a very great variety of purity, some with not over 10 or 15 per cent. of actual wool

[156] Report of H. Wheeler Combs, General Appraiser, B. H. Hinds, C. H. Lapp, Special Agents, New York, October 30, 1885. Rep. Secr. Treas., 1885, p. 126.

fiber, others with 80 or 85 per cent., and that some of the contaminations are soluble in cold water, others requiring hot water and soap, or other chemicals, and still others, mechanical, and requiring special machinery for their removal.

" From all this it will be seen that any classification of wools for tariff, founded on any of the physical characters named, or on the alleged treatment, as 'unwashed,' 'washed,' or 'scoured,' must of necessity be entirely arbitrary, and in very many cases uncertain and unsatisfactory, since each character is variable in itself, and by its combinations allows of an infinite number of gradings and sorts, so that, however classified, according to these characters there will be many samples which will lie so near the assumed border lines that their actual place will be a matter of opinion rather than of demonstration.

" A classification may, however, be founded on chemical characters determined by the amount of actual wool fiber, which may be used as the fixed quantity for rating a specific tariff. The actual wool fiber may be readily and accurately determined by chemical methods, beyond any reasonable question.

" Inasmuch as the commercial values depend greatly on the fineness of the wools, and any tariff classification founded on the weight of actual wool substance would bear most heavily on the coarser and cheaper sorts, the ad valorem element may be combined with the fixed element suggested, in order to meet any special ends other than that of mere revenue." [157]

Up to the present time, Congress has not adopted the suggestion of the committee in regard to the classification of wools, but has continued to impose special rates on " washed " wool and " scoured " wool.

COMMITTEE ON QUARTZ PLATES USED IN SACCHARIMETERS FOR SUGAR DETERMINATIONS. 1887

After the polariscope method had been used for some years by the Government in determining the saccharine strength of sugars on which customs duties were levied, the Treasury Department appealed to the Academy to test certain quartz plates used in the saccharimeters. The following letter was addressed to the Academy by the Secretary of the Treasury, C. S. Fairchild:

" TREASURY DEPARTMENT,

" WASHINGTON, D. C., June 17, 1887.

" GENTLEMEN: Certain questions connected with the classification of imported sugars are now under consideration by this Department. It becomes necessary that three standard quartz plates used by appraisers in determining the saccharine

[157] Rep. Nat. Acad. Sci. for 1885, p. 99.

strength of sugars whereby its classification for duty is made, be tested with a view to ascertain their exact measurement, angle, and ray. I will thank you to inform me if the necessary test can be made by your Academy, and, if so, upon receipt of your reply, the plates will be forwarded to such address as you may indicate.

" Respectfully, yours,

" C. S. FAIRCHILD,

" *Secretary*.[158]

" The National Academy of Sciences, Washington, D. C."

The President appointed as a committee, Arthur W. Wright, Edward S. Dana and Charles S. Hastings, requesting them not only to examine the plates but " to bring out the scientific principles involved, as a basis for future work." Three plates were received for examination from the Treasury Department in June, 1887, and three more in September of the same year. The report of the committee, which was submitted on December 29, 1887, contains, in addition to a technical statement regarding the methods pursued, and the quality and value of each plate examined, a brief summary of the principles on which the saccharimeter is based.[159]

COMMITTEES ON THE MORPHINE CONTENT OF OPIUM. 1886 AND 1887

It seems rather singular that the Treasury Department should have thought it fitting to send samples of opium to the Academy for the simple purpose of ascertaining what percentage of morphine they contained. Nevertheless, this was done on two occasions; first in 1886 and again in 1887. The Acting Secretary, C. S. Fairchild, seems to have given a literal interpretation to the section of the charter of the Academy which provides that it shall examine or investigate any subject of science or art when called upon by the Government to do so.

The opium in question was part of two lots seized on account of having been smuggled into the country. The first request for an analysis was received from the Acting Secretary of the

[158] Rep. Nat. Acad. Sci. for 1887, p. 37.

[159] For the full report and correspondence, see Rep. Nat. Acad. Sci. for 1887, pp. 37-45.

Treasury under date of April 7, 1886. The President of the Academy, Professor Marsh, appointed a committee, consisting of Ira Remsen and George F. Barker who reported on June 14, 1886. As various methods had been employed for determining the percentage of morphine in opium, the committee at first proposed to ascertain which of them was calculated to give the most accurate results, but having learned that the Treasury Department would be satisfied with a less thorough investigation, it confined itself to a single method.

By employing Flückiger's process, as modified by Squibb, it was determined that the percentage of morphine in the syrupy liquid opium was 19.53, and in the same when reduced to a dry powder, 25.28 per cent.[160]

A year later, in 1887, a second request was received from the Acting Secretary of the Treasury for the same information regarding another sample of smuggled opium. The President seems not to have been entirely satisfied to have the Academy called upon to answer these comparatively unimportant inquiries. Notwithstanding, he requested the same two chemists to serve a second time, and appointed Professor Charles F. Chandler as the third member of the committee. In a letter addressed to the chairman of the committee, however, under date of May 4, 1887, he remarked: "The province of the Academy is not to conduct a technical examination merely, but especially to bring out the scientific principles involved in the investigation, and in this spirit I wish the work to be undertaken." [161]

Having in view this injunction of the President, the committee returned to its original plan of first testing the various methods of analysis to ascertain which of them gave the most uniform results, and then applying this particular method to the problem at issue. Accordingly, the committee engaged the services of Mr. I. H. Kastle of Johns Hopkins University to make the necessary experiments. Five methods were investigated, namely, that of the United States Pharmacopœia, Flückiger's method,

[160] Rep. Nat. Acad. Sci. for 1886, p. 40.

[161] Rep. Nat. Acad. Sci. for 1887, p. 32.

the same as modified by Squibb, Stillwell's modification of the Flückiger-Squibb method, and the so-called "Helfenberg Method" devised by Dietrich. Each of these methods is described in the report of the committee, and afterwards the results obtained from two or more analyses of the sample of opium received from the Treasury Department by the use of each method. The conclusion reached was that the Pharmacopœia method was far from accurate, while Stillwell's method was in every way the most satisfactory. A modification of the latter was devised which shortened the time required for making the estimations. The opium, which was a thick, black, semi-liquid mass was found to contain an average amount of 12.16 per cent of morphine. The report was submitted on August 16, 1887, and was transmitted to the Secretary of the Treasury two days later.[162]

COMMITTEE TO FORMULATE A PLAN FOR A SYSTEMATIC SEARCH FOR THE MAGNETIC NORTH POLE. 1890

The idea of organizing an expedition to search for the Magnetic North Pole originated with Colonel W. H. Gilder, United States Army. Col. Gilder was a member of the expedition sent out by the American Geographical Society in 1879 to search for the papers of Sir John Franklin. In 1881 he was a volunteer on the ship *Rodgers,* which was sent out by the Government to search for the *Jeannette.*

His suggestion of the desirability of sending out an expedition for the purpose of locating the Magnetic North Pole was made in 1890 to Professor T. C. Mendenhall, then Superintendent of the United States Coast and Geodetic Survey, who put him into communication with Professor C. A. Schott.[163] On May 28 of the same year Professor Mendenhall addressed a letter to the Secretary of the Treasury in which he expressed the opinion that any properly-organized expedition for the purpose ought to receive the encouragement of the Government, and suggested

[162] Rep. Nat. Acad. Sci. for 1887, pp. 31-35.
[163] See Jour. Amer. Geogr. Soc., vol. 24, pp. 215-261.

that the National Academy of Sciences be asked to formulate a plan.

On May 22, 1890, the Acting Secretary of the Treasury, Geo. S. Batcheller, requested the President of the Academy to appoint a committee to report on the subject. The President, Professor Marsh, appointed S. P. Langley (chairman), Henry L. Abbot, W. P. Trowbridge, A. M. Mayer, Chas. A. Schott, John Trowbridge and Charles Carpmael. This committee submitted a preliminary report on November 12, 1890, in which it stated that in its opinion a knowledge of the exact position of the Magnetic North Pole was not so important " as a study of the changes in the magnetic elements to be obtained from a cordon of stations, stretching from Alaska to Newfoundland, supplemented also by stations in Siberia." It suggested that a cordon of stations should be established near the line of dip of 89°, and that the observations should be taken simultaneously at all the stations.[164]

Here the matter seems to have rested until May 2, 1892, when a general discussion took place before the American Geographical Society, Chief Justice Daly of New York presiding. The preliminary report of the Academy was read, together with letters from Professor Mendenhall and Professor Marsh, after which addresses were delivered by Professor Wm. P. Trowbridge, Professor Mayer, General Greeley and Colonel Gilder. Professor Trowbridge read a letter from Professor Schott containing a detailed plan for a survey of the region immediately surrounding the pole.

Although the meeting was an enthusiastic one, the expedition was never organized. It seems to have been intended that Col. Gilder should be the leader, and that Lieut. Schwatka should accompany him. Lieut. Schwatka died on November 2, 1892,[165] and this circumstance appears to have interfered with the success of the enterprise.

[164] Rep. Nat. Acad. Sci. for 1890, p. 35.

[165] *Journ. Amer. Geogr. Soc.*, vol. 24, p. 618.

COMMITTEE TO PRESCRIBE AND PUBLISH SPECIFICATIONS FOR THE PRACTICAL APPLICATION OF THE DEFINITIONS OF THE AMPERE AND VOLT. 1894

It will be recalled that the Academy sent delegates in 1884 to the International Congress of Electricians at Paris. At this congress the "legal ohm" or "congress ohm" was established, having for its determination the resistance of a column of mercury 106 centimeters long. It was considered both at that time and subsequently that this length was not the proper one and for the further consideration of this and other matters connected with electrical units an international electrical congress was held in Chicago in 1893. On this occasion the ohm known as the "international ohm" was determined upon, having as its basis the resistance of a column of mercury 106.3 centimeters long. The "volt," "ampere," "henry" and other units were also fixed.

In the year following an act was passed by the Congress of the United States, defining the various units in accordance with the decisions of the electrical congress. These comprised the ohm, the ampere, the volt, the coulomb, the farad, the joule, the watt and the henry; the last, as is well known, named in honor of Joseph Henry, the first Secretary of the Smithsonian Institution and second President of the National Academy of Sciences.

The act referred to, which was approved on July 12, 1894,[166] contained the following provision:

> "Sec. 2. That it shall be the duty of the National Academy of Sciences to prescribe and publish, as soon as possible after the passage of this Act, such specifications of details as shall be necessary for the practical application of the definitions of the ampere and volt hereinbefore given, and such specifications shall be the standard specifications herein mentioned."

For some reason which is not apparent, the Act did not come to the attention of the President until the last day of October.[167] On November 6, he applied to the Secretary of State for an authentic copy, and received the same on November 9.

[166] Stat. at Large, vol. 28, p. 101, 53d Congress, 2d Session, chap. 131. See also Rep. Nat. Acad. Sci. for 1894, p. 39; also for 1895, p. 7.

[167] See Rep. Nat. Acad. Sci. for 1894, p. 40.

The same day he appointed the following committee to investigate and report upon the matter: H. A. Rowland (chairman), T. C. Mendenhall, H. L. Abbot, G. F. Barker, J. Trowbridge, C. S. Hastings, and C. Barus. Professor Mendenhall declined appointment and was replaced by Professor A. A. Michelson. A special meeting was held in New York on February 9, 1895, to consider the report of the committee, in which detailed specifications were given for the practical application of the ampere and volt, which were prepared to meet the requirements of the law and were also in accordance with the international agreement. The specifications are quoted in full in the report of the Academy for 1895 (pp. 9-13), with notes and illustrations. The Academy then by a unanimous vote adopted the specifications and prescribed them in accordance with the Act of Congress. " It was also voted unanimously that these specifications be published by the sending, by the president, of a copy of the same to each House of Congress and to the Secretary of State, with the request to the latter that they be issued by the State Department; and, further, by the printing by the home secretary of the Academy of a suitable number of copies for public distribution." [168]

COMMITTEE ON THE INAUGURATION OF A RATIONAL FOREST POLICY FOR THE FORESTED LANDS OF THE UNITED STATES. 1896

At an early date, the Government of the United States adopted the policy of purchasing or setting aside from the public domain certain limited areas of forested land from which to obtain timber for the use of the Navy, but it was not until the repeal of the so-called timber-culture laws in 1891 that the President was authorized to make extensive forest reservations without reference to any special economic value which they might possess. As a result of executive action in accordance with

[168] See Rep. Nat. Acad. Sci. for 1894, pp. 17, 39-42; for 1895, pp. 7-13. The report of the committee constitutes Sen. Misc. Doc. no. 115, 53d Congr. 3d Sess. Order printed Feb. 19, 1895.

this provision of law, the reserved forest lands in 1896 comprised no less than eighteen million acres, for which there was no definite system of management. Moved apparently by this circumstance,[169] under date of February 15, 1896, the Secretary of the Interior, Hoke Smith, addressed the following letter to the President of the Academy: [170]

"DEPARTMENT OF THE INTERIOR,
"WASHINGTON, February 15, 1896.

"SIR: I have the honor, as the head of the Department charged with the administration of the public domain, to request an investigation and report of your honorable body, as is provided in the act incorporating the National Academy, and by article 5, section 5, of its constitution, upon the inauguration of a rational forest policy for the forested lands of the United States.

"Being convinced of the necessity for a radical change in the existing policy with reference to the disposal and preservation of the forests upon the public domain, I particularly desire an official expression from your body upon the following points:

"1. Is it desirable and practicable to preserve from fire and to maintain permanently as forested lands those portions of the public domain now bearing wood growth for the supply of timber?

"2. How far does the influence of forest upon climate, soil, and water conditions make desirable a policy of forest conservation in regions where the public domain is principally situated?

"3. What specific legislation should be enacted to remedy the evils now confessedly existing?

"My predecessors in office for the last twenty years have vainly called attention to the inadequacy and confusion of existing laws relating to the public timber lands, and consequent absence of an intelligent policy in their administration, resulting in such conditions as may, if not speedily stopped, prevent a proper development of a large portion of our country; and because the evil grows more and more as the years go by, I am impelled to emphasize the importance of the question by calling upon you for the opinion and advice of that body of scientists which is officially empowered to act in such cases as this.

"I also beg to refer you to the proposed legislation which has been introduced into Congress for several years past at the instance of the American Forestry Association, supported by memorials of private citizens and scientific bodies, and more especially the memorials presented by the American Association for the Advancement of Science in 1873, which led to desirable legislation, and again in 1890, 1892, and in 1894.

[169] See Yearbook U. S. Dep. Agric., 1899, p. 13.
[170] Rep. Nat. Acad. Sci. for 1896, p. 13.

"As I believe that a speedy change in the existing policy is urgent, I request that you will give an early consideration to this matter, and favor me with such statements and recommendations as may be laid before Congress for action during this session.

"I have the honor to be, your obedient servant,

"HOKE SMITH,

"*Secretary.*"

The President of the Academy at once appointed the following committee to consider and report on the subject in question: Charles S. Sargent (chairman), Henry L. Abbot, Alexander Agassiz, Wm. H. Brewer, Arnold Hague, and Gifford Pinchot. The President was also, *ex officio,* a member of the committee.

It was obvious at the outset that no report of value could be made without a personal inspection by the committee of the forested areas of the public domain and the forest reservations, and on the representations of President Wolcott Gibbs, the sum of $25,000 was appropriated by Congress in the Sundry Civil Act, approved June 11, 1896, to enable the Secretary of the Interior to meet the expenses of an investigation and report by the Academy. The committee already mentioned being acceptable to the Secretary of the Interior, was authorized to visit the various forested areas and reservations at the expense of the Government. The members of the committee, with the exception of the President, Wolcott Gibbs (whose condition of health forbade his going into the field) and Professor Agassiz, travelled westward on July 2, 1896, and spent three months in laborious study and inspection of the forests. They traversed large areas of unreserved forest, and visited all the reservations established prior to 1897, except six, which were either of limited extent or well-known to the members of the committee.

The conditions which they found were truly lamentable. Except in the national parks, which were effectively guarded by detachments of the Army, vast sections of the forest reserves were being destroyed annually by fires started by careless or ignorant campers and hunters, or by sparks from locomotives. In some instances they were started by shepherds or by mining prospectors for the purpose of clearing the ground. "Nearly every summer their smoke obscured for months the sight of the sun over hundreds of square miles." To this destruction by fire was added a widespread devastation caused by wandering herds of sheep, which ranged about the borders of the forests, stripping the ground bare of seedling trees and growing shrubs, trampling the tender plants, and dislodging the soil on steep mountain slopes. On the unreserved lands, the theft of timber by settlers, mining prospectors, railroad contractors and others had assumed enormous proportions. The Department of the Interior which was charged with the custody of these lands was powerless to stop this plunder of the public domain, owing mainly to defective and conflicting laws and the sentiment of the people in the States and Territories in which the forests are located that they belonged to them and not to the people of the United States as a whole.

Upon its return from the West, the committee on February 1, 1897, presented a preliminary report to the Secretary of the Interior, in which it recommended the establishment of thirteen new forest reservations, covering somewhat more than twenty-one million acres, to be added to the seventeen reserves already existing, which comprised seventeen and one-half million acres. This report was forwarded to the President on February 6, 1897, by the Secretary of the Interior, David R. Francis, with a favorable recommendation, and on February 22, the 165th anniversary of the birth of Washington, President Cleveland promulgated proclamations establishing the reserves.

About two months later, on May 1, 1897, the committee submitted its complete report on the inauguration of a forest policy, which was transmitted on the same date by President Wolcott Gibbs to the Secretary of the Interior and printed at the Government Printing Office.[171] This report, which covers 45 printed pages, is comprehensive in scope and contains definite recommendations for the establishment of a national forestry service.

[171] See p. 383; also Rep. Nat. Acad. Sci. for 1897, pp. 29-73, where the report is printed in full.

It begins with a review of Gustav Wex's researches on the relation of stream-flow to forests in Central Europe, and sets forth the reasons why attention should be given to the preservation of the forests of the United States. It then gives a brief account of the history of forest administration in Europe and of the organization of the forestry service in France, Germany, India, and Canada. This is followed by a chapter on the destructive effects of fires, sheep husbandry and illegal timber cutting in the forest reserves of the United States, and on the condition of the several reserves. The committee then proceeds to outline a definite system of national forest administration, including both temporary measures and a permanent organization. The disastrous results of defective and conflicting forest laws are then commented upon, and attention called to the desirability of establishing additional national parks. A summary of the conclusions and recommendations closes the report.

The form of organization for the national forestry service recommended by the committee was patterned after that of Germany. It contemplated the formation of a separate forest bureau in the Department of the Interior, the principal officers of which were to be a director, an assistant director, and four inspectors. These officers were to form an advisory board which would pass on general matters relating to the forests. The actual care of the forests was to be intrusted to a corps of foresters, assistants, and rangers. The forest areas of the West were to be grouped in four departments, each to be in charge of an inspector.

All the officers above the grade of rangers were to be appointed by the President and confirmed by the Senate, were to hold office during good behavior, but to be subject to retirement at the age of 64 years.

Until a permanent corps could be organized, it was proposed to form a temporary corps recruited mainly from graduates from West Point. A portion of these officers were to be sent to Europe to study in the forestry schools of France and Germany, and it should be their duty on returning to America to organize a forestry school in the United States for the instruction of the forest corps. This part of the program was not regarded by the committee, or at least by some of its members, as of primary importance. Stress was, however, laid on the desirability of offering relatively high rates of compensation and providing for retirement, in order to attract men of integrity who would render intelligent and conscientious service.

To provide for the proper establishment of new forest reserves, the committee recommended that a board of forest lands should be created, composed of an officer of the Engineer Corps of the Army, an officer of the Geological Survey, an officer of the Coast Survey and two persons not connected with the Government service, whose duty should be to fix the boundaries of such reserves.

These and other recommendations were summarized by the committee in its report which closes as follows:[172]

"1. That the Secretary of War, upon the request of the Secretary of the Interior, shall be authorized and directed to make the necessary details of troops to protect the forests, timber, and undergrowth on the public reservations, and in the national parks not otherwise protected under existing laws, until a permanent forest bureau in the Department of the Interior has been authorized and thoroughly organized. (See bill No. 1.)

"2. That the Secretary of the Interior shall be authorized and directed to issue the necessary rules and regulations for the protection, growth, and improvement of the forests on the forest reserves of the United States; for the sale from them of timber, firewood, and fencing of actual settlers on and adjacent to such reserves, and to the owners of mines legally located in them for use in such mines; for allowing actual settlers who have no timber on their own claims to take from the reserves firewood, posts, poles, and fencing material necessary for their immediate personal use; for allowing the public to enter and cross the reserves; for granting to county commissioners rights of way for wagon roads in and across the reserves; for granting rights of way for irrigating ditches, flumes, and pipes, and for reservoir sites; and for permitting prospectors to enter the reserves in search of valuable minerals; for opening the reserves to the location of mining claims under the general mineral laws; and for allowing the owners of unperfected claims or patents, and the land-grant railroads with lands located in the reserves, to exchange them under equitable conditions for unreserved lands. (See bill No. 2, secs. 2-4.)

[172] Rep. Nat. Acad. Sci. for 1897, pp. 64, 65.

"3. That a bureau of public forests shall be established in the Department of the Interior, composed of officers specially selected with reference to their character and attainments, holding office during efficiency and good behavior and liberally paid and pensioned. (See bill No. 2, secs. 5-11.)

"4. That a board of forest lands shall be appointed by the President to determine from actual topographical surveys to be made by the Director of the Geological Survey what portions of the public domain should be reserved permanently as forest lands and what portions, being more valuable for agriculture or mining, should be open to sale and settlement. (See bill No. 2, sec. 15, and bill No. 3, sec. 6.)

"5. That all public lands of the United States more valuable for the production of timber than for agriculture or mining shall be withdrawn from sale, settlement, and other disposition and held for the growth and sale of timber. (See bill No. 3.)

"6. That certain portions of the Rainier Forest Reserve in Washington and of the Grand Canyon Forest Reserve in Arizona shall be set aside and governed as national parks. (See bills, Nos. 4 and 5.)

"Yours, respectfully,

"CHARLES S. SARGENT,
"HENRY L. ABBOT,
"A. AGASSIZ,
"WM. H. BREWER,
"ARNOLD HAGUE,
"GIFFORD PINCHOT,
"WOLCOTT GIBBS.

"To the President of the National Academy of Sciences."

To aid Congress in enacting laws in accordance with its recommendations, the committee drafted five bills, which are given in full in the appendix to its report.

The work of the committee has had far-reaching consequences, although the Government did not adopt the system of forest administration proposed. The proclamation of new forest reserves, in accordance with the recommendations contained in the preliminary report of the committee, led to an animated discussion in Congress, in the course of which the views and action of President Cleveland and of the committee of the Academy were vigorously attacked. It resulted therefrom that the reservations were ordered suspended for a year. They were subsequently reaffirmed and made effective, however, by President McKinley.

The final report of the committee was to a certain extent forestalled by the action of Congress which in the Sundry Civil Act for 1898, passed June 4, 1897, made the following provision:

"The Secretary of the Interior shall make provisions for the protection against destruction by fire and depredations upon the public forests and forest reservations which may have been set aside or which may be hereafter set aside under the said Act of March third, eighteen hundred and ninety-one, and which may be continued; and he may make such rules and regulations and establish such service as will insure the objects of such reservations, namely, to regulate their occupancy and use and to preserve the forests thereon from destruction, etc."[173]

In the Sundry Civil Act for 1899, $110,000 was appropriated "to meet the expenses of protecting timber on the public lands," and for other similar purposes, and $75,000 "for the care and administration of the forest reserves, to meet the expenses of forest inspectors and assistants, and for the employment of foresters and other emergency help in the prevention and extinguishment of forest fires, and for advertising dead and matured trees for sale within such reservations."[174] These amounts were to be expended under the Department of the Interior. The control of the public forests thus remained with the Interior Department without the formation of a separate bureau, as recommended by the committee of the Academy.

In the meantime the Government had in the Division of Forestry in the Department of Agriculture another organization concerned with questions of forest management and preservation. The activities of this division increased rapidly year by year, and finally on February 1, 1905, the management of the public forests was transferred to it from the Department of the Interior. A special Act of Congress, approved on that date, provides "that the Secretary of the Department of Agriculture shall, from and after the passage of this Act, execute or cause to be executed all laws affecting public lands heretofore or hereafter reserved under the provisions of section twenty-four of the

[173] Stat. at Large, vol. 30, p. 35, 55th Congress, 1st Session, chap. 2, 1897.
[174] *Op. cit.*, p. 618, 55th Congress, 2d Session, chap. 546, 1898.

Act entitled 'An Act to repeal the timber-culture laws, and for other purposes,' approved March third, eighteen hundred and ninety-one, and Acts supplemental to and amendatory thereof, after such lands have been so reserved, excepting such laws as affect the surveying, prospecting, locating, appropriating, entering, relinquishing, reconveying, certifying, or patenting of any of such lands." [175]

At the beginning of the fiscal year this bureau, known as the Forest Service, had in its employ 821 persons, of whom 153 were professionally trained foresters. In 1908 the force comprised 1779 persons, consisting of 29 inspectors, 98 forest supervisors, 61 deputies, 33 forest assistants, 8 planting assistants, 941 rangers, 521 guards and 88 clerks.[176] The scope and magnitude of the activities of the Service have increased year by year since that date.

Thus, after the lapse of fifteen years since the committee of the Academy made its recommendations, the Government has provided an effective organization for the protection of the public forests—one which may be fairly said to possess the principal features, though not the exact form, which the committee considered desirable. Instead of a bureau of forests in the Department of the Interior we have the Forest Service in the Department of Agriculture. Instead of a "director" and "assistant director," we have a "chief forester" and "associate forester"; instead of "head foresters" and "foresters" we have "forest supervisors" and "deputies." The division into departments has been adopted. The formation of a special "board of forest lands" has not been carried into effect, the locating and surveying of forest lands and kindred duties remaining in charge of the General Land Office of the Department of the Interior.

The plan of recruiting officers from West Point and providing for retirement for age has not been adopted, while the forest schools connected with universities and colleges have supplied the means of educating young men in the principles of forestry

[175] Stat. at Large, vol. 33, part 1, p. 628, 58th Congress, 3d Session, chap. 288, sec. 1, 1905.
[176] Rep. Dep. Agric. for 1908, p. 417.

and the organization of a forestry school by the Government has not been necessary. Regarding the importance of the work of the committee of the Academy in the promotion of the forestry interests of the United States, Mr. Gifford Pinchot, who was a member of the committee, and has also been the most conspicuous advocate of scientific forestry in America, wrote in 1905:

"The work of the committee of the National Academy of Sciences, while it failed of much that it might have accomplished, nevertheless was the spring from which the present activity in forest matters was derived. The proclamation of the reserves which it recommended drew the attention of the country as nothing else had ever done to the question of forestry. Vigorous discussion of forest matters by the public press led to a widespread interest, and that in turn to a keen appreciation of the value of forests in the economy of each State, and to a willingness to take measures to protect them. It may fairly be assumed that, as one of the results of this awakened interest, the policy of making Government forest reserves is now established beyond the reach of further question." [177]

The following data were culled from the report of Secretary Wilson for 1912:

In the midsummer of 1912 the Forest Service employed a total of 4097 persons and had an appropriation of over $5,000,000 for the current year. This bureau employed only thirteen persons sixteen years ago. Its administrative and protective duties alone are discharged in thirty-four States and in Alaska. Besides having charge of the national forests, this bureau offers to provide owners of woodlands an opportunity to obtain practical advice and assistance looking toward the introduction of forest management on their holdings.

Grazing of the forest lands, which was formerly done destructively, is now permitted under control of this Department. Grazing permits are issued, and in 1912 over 26,000 permits were issued for the grazing of 1,400,000 cattle, 95,000 horses, and nearly 7,500,000 sheep.

In the care of the national forests much timber is sold, and in 1912 the timber sales numbered nearly 5800 and embraced 800,000,000 board feet, from which the receipts were over $1,000,000. The area of the national forests, June 30, 1912, was over 187,000,000 acres.

COMMITTEE ON THE ESTABLISHMENT OF A NATIONAL RESERVE IN THE SOUTHERN APPALACHIANS. 1902

In 1902 the Academy received a letter from the chairman of the Senate Committee on Forest Reservations and the Protection of Game relative to the establishment of a reservation in the

[177] Yearbook of the Dep. Agric., 1899, p. 297.

Appalachian Mountains. This letter and the report of the committee of the Academy appointed to consider the matter are given in full in the Report for the year mentioned. As they are self-explanatory, they are quoted in full in this place.

"UNITED STATES SENATE

"COMMITTEE ON FOREST RESERVATIONS AND THE PROTECTION OF GAME,

"April 16, 1902.

"PROF. ALEX. AGASSIZ,

"President National Academy of Sciences, Washington, D. C.

"DEAR SIR: There is now before Congress a bill looking to the establishment of a national forest reserve to include the higher and larger masses of mountains in the Southern Appalachian region.

"This measure is to be considered at an early date by the Senate Committee on Forest Reservations, and in order that the best interests of the country may be served in this connection I will be greatly pleased if the Committee on Forest Reservations may have the benefit of the Academy's advice.

"Yours very truly,

"J. R. BURTON."

"BOSTON, April 30, 1902.

"ALEXANDER AGASSIZ, ESQ.,

"President National Academy of Sciences.

"SIR: The committee of the Academy to whom you have referred the request of the chairman of the Committee on Forestry of the Senate of the United States for an opinion on the advisability of establishing an Appalachian forest reserve, have examined Senate Document No. 84, Fifty-seventh Congress, first session, being the message from the President of the United States transmitting a report of the Secretary of Agriculture in relation to the forests, rivers, and mountains of the Southern Appalachian region (without the accompanying illustrations), and a copy of Senate bill 5228, for the purchase of a national forest reserve in the Southern Appalachian Mountain region, to be known as the 'National Appalachian Forest Reserve,' and beg to state that they are in full sympathy with the principle of forest reservations intended to preserve the gradual distribution of rainfall in the flow of rivers heading therein.

"They do not feel, however, without a personal examination of the region in question, qualified to give an opinion as to whether the recent disastrous floods in various rivers flowing from the Appalachian Mountains, recounted in the reports transmitted by the Bureau of Forestry and by the Geological Survey and contained in Document No. 84, resulted from the actual destruction of the forests, and as to whether their repetition could be prevented by a restoration of the forest growth. No data or records are presented to show that floods equally large did not occur in older times.

"To make a proper report would require a certain time, as well as an appropriation to meet the expenses incurred by the committee of the academy.

"As regards the provisions of the bill, it appears to the committee to be absolutely essential that the Government shall have full ownership and control of all reserved lands, and that these shall be in large continuous blocks. To limit such ownership to detached lots, surrounded by areas held by private parties upon whose concurrence success must depend, would seem to be entering on a dangerous copartnership likely to result in large expenditures and litigation.

"C. S. SARGENT,
"HENRY L. ABBOT,
"WM. H. BREWER,
"Committee."

COMMITTEE ON SCIENTIFIC EXPLORATIONS OF THE PHILIPPINE ISLANDS. 1902

Near the close of the year 1902, President Roosevelt sent the following letter to Professor Alexander Agassiz.[178]

"WHITE HOUSE,
"WASHINGTON, December 26, 1902.

"MY DEAR MR. AGASSIZ: I should like much a report from the National Academy of Sciences on the desirability of instituting scientific explorations of the Philippine Islands and on the scope proper to such an undertaking. The National Academy is the official scientific adviser of the Government, and I would like its coöperation in planning a comprehensive investigation of the natural resources and natural history of the islands. It will of course rest with Congress to decide the extent to which such a plan can be carried through; but I should like, at any rate, to have a plan formulated and to do what I can to have it adopted.

"Sincerely yours,
"THEODORE ROOSEVELT.

"PROF. ALEXANDER AGASSIZ,
"President of the National Academy, Cambridge, Mass."

Professor Agassiz was absent in Europe when this letter reached Cambridge, and it was placed in the hands of the Vice-President, Asaph Hall, who, after consulting with members of

[178] Rep. Nat. Acad. Sci. for 1904, p. 22.

the council residing in Baltimore and Washington, appointed the following committee to formulate a plan of explorations in accordance with the President's wishes: William H. Brewer (chairman), George F. Becker, C. Hart Merriam, F. W. Putman, and R. S. Woodward. The committee completed and adopted its report on February 7, 1903. The plan proposed covered the following subjects which the committee recommended should receive attention in the order here given provided they could not all be taken up at the same time: Coast and geodetic surveying and marine hydrography, land topography, including surveys and classification of public lands, geology and mineral resources, botany, systematic forestry (or forestry problems), zoölogy, anthropology.

In order to properly coördinate the work, the committee proposed that it should be in charge of a board of scientific experts, to be selected from the various scientific bureaus of the Government. The board was to be assisted by a scientific council, to consist of the chief field officers of the several bureaus engaged in the work and presided over by a member of the Philippine Commission. The council was to have an officer of the Engineer Corps of the Army and a naval officer associated with it.

This report was transmitted to President Roosevelt on February 12, 1903.

On March 9, 1903, about a month after the committee of the Academy had presented its report, President Roosevelt appointed a board, called the Board of Scientific Surveys of the Philippine Islands, for the purpose of developing the plans outlined by the Academy.

"White House,

"Washington, March 9, 1903.

"My dear Sir: At my request, the National Academy of Sciences has outlined a comprehensive plan for scientific explorations of the Philippine Islands in a report, a copy of which I transmit herewith for your information.

"A plan of exploration so broad and systematic has never hitherto been prepared for any region, and if it can be carried into effect, it will add to human knowledge a contribution of great importance, highly commendable to the United States.

" Before taking any further steps in this matter, I desire to have estimates of the cost of such explorations prepared, assuming that the work is to be completed in ten years, and that the various branches of the scientific surveys coöperate with one another systematically and heartily.

" I therefore appoint the following Board of Scientific Surveys to prepare such estimates and to make such suggestions as may appear to it pertinent in the circumstances, viz:

" MR. CHARLES D. WALCOTT, *Chairman.*
" MR. FREDERICK C. COVILLE
" MR. BARTON W. EVERMANN
" MR. W. H. HOLMES
" MR. C. HART MERRIAM
" MR. GIFFORD PINCHOT
" MR. OTTO H. TITTMANN.

" Sincerely yours,
" THEODORE ROOSEVELT."

The board held five meetings in March, May and June, 1903, appointed a committee on plans and organization, prepared estimates of expenditures, drafted a bill for the consideration of Congress, drew up various memoranda, and transacted other business. After that the matter was held in abeyance for two years, but on February 7, 1905, President Roosevelt sent the report of the committee of the Academy to Congress, with the following message:

" WHITE HOUSE,
" February 7, 1905.

" *To the Senate and House of Representatives:*

" Circumstances have placed under the control of this Government the Philippine Archipelago. The islands of that group present as many interesting and novel questions with respect to their ethnology, their fauna and flora, and their geology and mineral resources as any region of the world. At my request the National Academy of Sciences appointed a committee to consider and report upon the desirability of instituting scientific explorations of the Philippine Islands. The report of this committee, together with the report of the Board of Scientific Surveys of the Philippine Islands, including draft of a bill providing for surveys of the Philippine Islands, which board was appointed by me, after receiving the report of the committee appointed by the National Academy of Sciences, with instructions to prepare such estimates and make such suggestions as might appear to it pertinent in the circumstances, accompanies this message.

"The scientific surveys which should be undertaken go far beyond any surveys or explorations which the government of the Philippine Islands, however completely self-supporting, could be expected to make. The surveys, while of course beneficial to the people of the Philippine Islands, should be undertaken as a national work for the information not merely of the people of the Philippine Islands, but of the people of this country and of the world. Only preliminary explorations have yet been made in the archipelago, and it should be a matter of pride to the Government of the United States fully to investigate and to describe the entire region. So far as may be convenient and practical, the work of this survey should be conducted in harmony with that of the proper bureaus of the government of the Philippines; but it should not be under the control of the authorities of the Philippine Islands, for it should be undertaken as a national work and subject to a board appointed by Congress or the President. The plan transmitted recommends simultaneous surveys in different branches of research, organized on a co-operative system. This would tend to completeness, avoid duplication, and render work more economical than if the exploration were undertaken piecemeal. No such organized surveys have ever yet been attempted anywhere; but the idea is in harmony with modern, scientific, and industrial methods.

"I recommend, therefore, that provision be made for the appointment of a board of surveys to superintend the national surveys and explorations to be made in the Philippine Islands, and that appropriations be made from time to time to meet the necessary expenses of such investigation. It is not probable that the survey would be completed in a less period than that of eight or ten years, but it is well that it should be begun in the near future. The Philippine Commission, and those responsible for the Philippine government are properly anxious that this survey should not be considered as an expense of that government, but should be carried on and treated as a national duty in the interests of science.

"THEODORE ROOSEVELT."[179]

The papers of the President's board were transmitted to Congress with the report of the committee of the Academy, and printed in the same document. The plan proposed by the board conforms in all its essential features to that recommended by the Academy, except that no provision is made for an advisory council consisting of the heads, or chief field agents, of the various surveys.

The message, with the accompanying documents, was referred to the Committee on the Philippines and ordered to be printed,[180]

[179] Congr. Record, vol. 39, part 2, pp. 2052, 2057.

[180] It forms Sen. Doc. no. 145, 58th Congress, 3d Session, February 7, 1905.

but was not reported back, and the projected surveys were, therefore, never undertaken. They appear to have failed to obtain support mainly on account of the opposition of the late Dr. Paul C. Freer, who thought that they would interfere with the scientific work in the Philippines which was under his jurisdiction as head of the Government laboratories in Manila. Senator Lodge gave notice on February 10, 1905, of an amendment which he intended to propose to the Sundry Civil bill for the fiscal year 1906, consisting of an item for the expenses of the board (58th Congress, 3d session), but on March 2 he wrote: "I went before the Committee on Appropriations in regard to the amendment and said all I could for it, but, I am sorry to say, they refused to put it in."

Scientific explorations and investigations were, however, carried on under the Philippine Commission. Nearly three years before President Roosevelt addressed his letter to the Academy, the Philippine Commission had already begun to establish scientific bureaus to investigate the natural resources of the islands, and for other similar purposes. A Bureau of Forestry and a Bureau of Mines were established in 1900. The following year a Health Bureau, an Agricultural Bureau, a Bureau of Government Laboratories, an Ethnological Survey (first called a bureau of Non-Christian Tribes), a Weather Bureau, and a Bureau of Coast and Geodetic Surveys were established. These have all continued to the present time, but in 1906 the Bureau of Government Laboratories and the Bureau of Mines were combined under the designation of the Bureau of Sciences, while the Ethnological Survey was incorporated in the Bureau of Education in 1905, and also the Agricultural Bureau in 1910. The Bureau of Education had in the meantime become the Department of Public Instruction. The coast survey and geodetic work has been carried on jointly by the Philippine government and the United States Coast and Geodetic Survey. All these organizations have issued numerous reports, scientific papers and other publications relating to the Islands.

COMMITTEE ON THE METHODS AND EXPENSES OF CONDUCTING SCIENTIFIC WORK UNDER THE GOVERNMENT. 1908

The Sundry Civil Act for 1908-1909, approved May 27, 1908, contained the following section:

"SECT. 8. The National Academy of Sciences is required, at their next meeting, to take into consideration the methods and expenses of conducting all surveys of a scientific character, and all chemical, testing, and experimental laboratories and to report to Congress as soon thereafter as may be practicable a plan for consolidating such surveys, chemical, testing, and experimental laboratories so as to effectually prevent duplication of work and reduce expenditures without detriment to the public service.

"It is the judgment of Congress that any person who holds employment under the United States or who is employed by or receives a regular salary from any scientific bureau or institution that is required to report to Congress should refrain from participation in the deliberations of said National Academy of Science on this subject and from voting on or joining in any recommendation hereunder."[181]

Immediately upon the passage of this Act, President Remsen appointed a committee consisting of R. S. Woodward, W. W. Campbell, Edward L. Nichols, Arthur A. Noyes, and Charles R. Van Hise to consider and report on the subject in question. The committee submitted its report to the Council on January 9, 1909, and President Remsen on January 16, addressed it to the Speaker of the House of Representatives. It was transmitted to Congress by President Roosevelt on January 18 and referred to the Committee on Appropriations of the House and ordered to be printed.[182]

The principal conclusions of the committee are embodied in the following paragraphs:

"From a general survey of the field of work under consideration three facts appear to be clearly established, namely:

"*First.* That the amount of actual duplication of work now carried on by the government bureaus is relatively unimportant; but that the duplication of organizations and of plants for the conduct of such work is so considerable as to need careful attention from Congress in the future.

[181] Stat. at Large, vol. 35, part 1, p. 387, 60th Congress, 1st Session, chap. 200.

[182] It constitutes House Doc. no. 1337, 60th Congress, 2d Session.

"*Second.* That while the consolidation of some of the branches of work now carried on in several organizations is probably advisable, specific recommendations in reference to such consolidation can be made wisely only after a careful consideration of all the facts by the board hereinafter suggested or by some similarly competent body.

"*Third.* That there has never been hitherto and there is not at present anything like a rational correlation of allied branches of scientific work carried on by the Government.

"This last fact appears to your committee by far the most important one presented for consideration." [183]

It was suggested by the committee that the permanent board referred to above should consist of the heads of the various scientific bureaus, two delegates from each house of Congress, and "five to seven eminent men of science not connected with the government service."

The recommendations of the Academy have not as yet been adopted by Congress.[184]

[183] *Op. cit.*, pp. 3, 4.

[184] In the foregoing account of the committees appointed by the Academy at the request of the several branches of the Government, no mention is made of the following, whose work was either of minor importance, or of such a character that its history is not accessible:

On National currency, 1863 (Confidential).

On prevention of counterfeiting, 1865 (Confidential).

On the preservation of army knapsacks, 1868. (Correspondence in the files of the Academy indicates that this committee never reported. The question was one of restoring knapsacks valued at a million dollars, the paint on which had become soft and sticky.)

On silk culture in the United States, 1870. (See Proc., vol. 1, pp. 75, 77, Rep. for 1879, p. 11.)

On the exploration of the Yellowstone region by General Stanley, 1873.

On distinguishing calf's hair goods from woolen goods, 1875 (Confidential).

On building stone for the custom house at Chicago, 1878.

On triangulation connecting the Atlantic and Pacific coasts, 1882.

The Academy had some correspondence with the Department of the Interior in 1893 relative to the appointment of a committee on a conventional standard of color. The committee, however, was not appointed. (See Rep. Nat. Acad. Sci. for 1893, pp. 43-46; also for 1894, p. 7.)

APPENDICES

APPENDIX I

LIST OF OFFICERS

PRESIDENT

	From	To
ALEXANDER DALLAS BACHE	1863	February 14, 1867 [1]
JOSEPH HENRY (acting)	January 25, 1866	January 26, 1868
JOSEPH HENRY	January 26, 1868	May 13, 1878 [1]
O. C. MARSH (acting)	May 13, 1878	April 16, 1879
WILLIAM B. ROGERS	April 16, 1879	May 30, 1882 [1]
O. C. MARSH (acting)	May 30, 1882	April 20, 1883
O. C. MARSH	April 20, 1883	April 19, 1895
WOLCOTT GIBBS	April 19, 1895	April 19, 1900 [2]
ASAPH HALL (acting)	April 19, 1900	April 18, 1901
ALEXANDER AGASSIZ	April 18, 1901	April 18, 1907
IRA REMSEN	April 18, 1907	———

VICE-PRESIDENT

	From	To
JAMES D. DANA	1863	August 23, 1865 [2]
JOSEPH HENRY	January 25, 1866	January 26, 1868
WILLIAM CHAUVENET	January 26, 1868	December 13, 1870 [1]
WOLCOTT GIBBS	April 19, 1872	April 16, 1878
O. C. MARSH	April 16, 1878	April 20, 1883
SIMON NEWCOMB	April 20, 1883	April 17, 1889
S. P. LANGLEY	April 17, 1889	April 24, 1891 [2]
F. A. WALKER	April 24, 1891	January 5, 1897 [1]
ASAPH HALL	April 22, 1897	April 23, 1903
IRA REMSEN	April 23, 1903	April 18, 1907
CHARLES D. WALCOTT	April 18, 1907	———

[1] Date of death.

[2] Date of resignation.

HOME SECRETARY

	From		To	
Wolcott Gibbs		1863	April	19, 1872 [2]
J. E. Hilgard	April	19, 1872	April	16, 1878
J. H. C. Coffin	April	16, 1878	April	22, 1881 [2]
Simon Newcomb	April	22, 1881	April	20, 1883
Asaph Hall	April	20, 1883	April	22, 1897
Ira Remsen	April	22, 1897	April	18, 1901
Arnold Hague	April	18, 1901	———	

FOREIGN SECRETARY

	From		To	
Louis Agassiz		1863	December	14, 1873 [1]
F. A. P. Barnard	April	25, 1874	April	16, 1880
Alexander Agassiz	April	16, 1880	April	23, 1886
Wolcott Gibbs	April	23, 1886	April	19, 1895
Alexander Agassiz	April	19, 1895	April	18, 1901
Ira Remsen	April	18, 1901	April	23, 1903
Simon Newcomb	April	23, 1903	April	22, 1909
Alexander Agassiz	April	22, 1909	March	27, 1910 [1]
George E. Hale	April	21, 1910	———	

TREASURER

	From		To	
Fairman Rogers		1863	April	22, 1881 [2]
J. H. C. Coffin	April	22, 1881	April	22, 1887
J. S. Billings	April	22, 1887	April	22, 1898
Charles D. Walcott	April	22, 1898	April	17, 1902 [2]
S. F. Emmons	April	17, 1902	March	28, 1911 [1]
Whitman Cross (acting)	March	28, 1911	April	20, 1911
Whitman Cross	April	20, 1911	———	

[1] Date of death.
[2] Date of resignation.

APPENDIX II

LIST OF MEMBERS AND FOREIGN ASSOCIATES

MEMBERS

Name	Address	Date of Election
ABBE, CLEVELAND	U. S. Weather Bureau, Washington, D. C.	1879
ABBOT, HENRY L., U. S. A.	23 Berkeley St., Cambridge, Mass.	1872
ABEL, JOHN JACOB	Johns Hopkins University, Baltimore, Md.	1912
ALLEN, J. ASAPH	American Museum of Natural History, N. Y. City.	1876
AMES, JOSEPH S.	Johns Hopkins University, Baltimore, Md.	1909
BARNARD, E. E.	Yerkes Observatory, Williams Bay, Wis.	1911
BARUS, CARL	Brown University, Providence, R. I.	1892
BECKER, GEORGE F.	U. S. Geological Survey, Washington, D. C.	1901
BELL, A. GRAHAM	1331 Connecticut Ave., Washington, D. C.	1883
BILLINGS, JOHN S., U. S. A.[1]	32 E. Thirty-first St., New York City.	1883
BOAS, FRANZ	Franklin Ave., Grantwood, N. J.	1900
BÔCHER, MAXIME	Harvard University, Cambridge, Mass.	1909
BOLTWOOD, B. B.	Yale University, New Haven, Conn.	1911
BOLZA, OSKAR	Marienstrasse 7, Freiburg, Germany.	1909
BRANNER, JOHN C.	Stanford University, California.	1905
CAMPBELL, D. H.	Stanford University, California.	1910
CAMPBELL, WILLIAM W.	Lick Observatory, Mount Hamilton, Calif.	1902
CATTELL, JAMES McK.	Garrison, N. Y.	1901
CHAMBERLIN, THOMAS C.	University of Chicago, Chicago, Ill.	1903
CHANDLER, CHARLES F.	Columbia University, New York City.	1874
CHANDLER, SETH C.	Box 216, Wellesley Hills, Mass.	1888
CHITTENDEN, RUSSELL H.	Sheffield Scientific School, New Haven, Conn.	1890
CLARK, W. B.	Johns Hopkins University, Baltimore, Md.	1908
CLARKE, F. W.	U. S. Geological Survey, Washington, D. C.	1909
CLARKE, J. M.	State Hall, Albany, N. Y.	1909
COMSTOCK, GEORGE C.	Washburn Observatory, Madison, Wis.	1899
CONKLIN, E. G.	Princeton, N. J.	1908
COULTER, J. M.	University of Chicago, Chicago, Ill.	1909
COUNCILMAN, WM. T.	Harvard Medical School, Boston, Mass.	1904
CRAFTS, JAMES M.	59 Marlborough St., Boston, Mass.	1872
CREW, HENRY	Northwestern University, Evanston, Ill.	1909
CROSS, WHITMAN	U. S. Geological Survey, Washington, D. C.	1908

[1] Died March 10, 1913.

		Date of Election
DALL, WILLIAM H.	Smithsonian Institution, Washington, D. C.	1897
DANA, EDWARD S.	Yale University, New Haven, Conn.	1884
DAVENPORT, CHARLES B.	Cold Spring Harbor, N. Y.	1912
DAVIS, WILLIAM MORRIS	17 Francis Ave., Cambridge, Mass.	1904
DAY, ARTHUR L.	Geophysical Laboratory, Washington, D. C.	1911
DEWEY, JOHN	Columbia University, New York City.	1910
ELKIN, WILLIAM L.	Yale University Observatory, New Haven, Conn.	1895
FARLOW, W. G.	Harvard University, Cambridge, Mass.	1879
FLEXNER, SIMON	Rockefeller Institute, New York City.	1908
FROST, EDWIN B.	Yerkes Observatory, Williams Bay, Wis.	1908
GILBERT, GROVE K.	U. S. Geological Survey, Washington, D. C.	1883
GILL, THEODORE N.	Smithsonian Institution, Washington, D. C.	1873
GOOCH, FRANK A.	Yale University, New Haven, Conn.	1897
GOODALE, GEORGE L.	Harvard University, Cambridge, Mass.	1890
HAGUE, ARNOLD	U. S. Geological Survey, Washington, D. C.	1885
HALE, GEORGE E.	Solar Observatory Office, Pasadena, Calif.	1902
HALL, EDWIN H.	Harvard University, Cambridge, Mass.	1911
HARPER, R. A.	Columbia University, New York City.	1911
HASTINGS, CHARLES S.	Yale University, New Haven, Conn.	1889
HAYFORD, JOHN F.	Northwestern University, Evanston, Ill.	1911
HILGARD, EUGENE W.	University of California, Berkeley, Calif.	1872
HILL, GEORGE W.	West Nyack, N. Y.	1874
HILLEBRAND, WILLIAM F.	Bureau of Standards, Washington, D. C.	1908
HOLDEN, EDWARD S.	U. S. Military Academy, West Point, N. Y.	1885
HOLMES, WILLIAM H.	U. S. National Museum, Washington, D. C.	1905
HOWELL, WILLIAM H.	Johns Hopkins University, Baltimore, Md.	1905
IDDINGS, JOSEPH P.	Brinklow, Md.	1907
JACKSON, CHARLES L.	6 Boylston Hall, Cambridge, Mass.	1883
KEMP, JAMES F.	Columbia University, New York City.	1911
LINDGREN, WALDEMAR	U. S. Geological Survey, Washington, D. C.	1909
LOEB, JACQUES	Rockefeller Institute, New York City.	1910
MALL, FRANKLIN P.	Johns Hopkins University, Baltimore, Md.	1907
MARK, EDWARD L.	109 Irving St., Cambridge, Mass.	1903
MELTZER, SAMUEL JAMES	Rockefeller Institute, New York City.	1912
MENDENHALL, THOMAS C.	329 North Chestnut St., Ravenna, Ohio.	1887
MERRIAM, C. HART	1919 Sixteenth St., Washington, D. C.	1902
MICHAEL, ARTHUR	219 Parker St., Newton Center, Mass.	1889
MICHELSON, ALBERT A.	University of Chicago, Chicago, Ill.	1888
MINOT, CHARLES S.	Harvard Medical School, Boston, Mass.	1897
MITCHELL, S. WEIR	1524 Walnut St., Philadelphia, Pa.	1865
MOORE, ELIAKIM H.	University of Chicago, Chicago, Ill.	1901

Name	Address	Date of Election
MORGAN, T. H.	Columbia University, New York City.	1909
MORLEY, EDWARD W.	West Hartford, Conn.	1897
MORSE, EDWARD S.	Salem, Mass.	1876
MORSE, HARMON N.	Johns Hopkins University, Baltimore, Md.	1907
MOULTON, F. R.	University of Chicago, Chicago, Ill.	1910
NEF, JOHN ULRIC	University of Chicago, Chicago, Ill.	1904
NICHOLS, EDWARD L.	Cornell University, Ithaca, N. Y.	1901
NICHOLS, ERNEST F.	Dartmouth College, Hanover, N. H.	1908
NOYES, ARTHUR A.	Massachusetts Institute of Technology, Boston, Mass.	1905
NOYES, WILLIAM A.	University of Illinois, Urbana, Ill.	1910
OSBORN, H. F.	American Museum of Natural History, New York City.	1900
OSBORNE, T. B.	Agr. Exp. Station, New Haven, Conn.	1910
OSGOOD, WILLIAM FOGG	Harvard University, Cambridge, Mass.	1904
PEIRCE, BENJAMIN O.	Harvard University, Cambridge, Mass.	1906
PEIRCE, CHARLES S.	Milford, Pa.	1876
PICKERING, EDWARD C.	Harvard College Observatory, Cambridge, Mass.	1873
PRUDDEN, T. MITCHELL	Columbia University, New York City.	1901
PUMPELLY, RAPHAEL	Gibbs Ave., Newport, R. I.	1872
PUPIN, MICHAEL I.	Columbia University, New York City.	1905
PUTNAM, FREDERICK W.	Peabody Museum, Cambridge, Mass.	1885
REID, H. FIELDING	Johns Hopkins University, Baltimore, Md.	1912
REMSEN, IRA	Johns Hopkins University, Baltimore, Md.	1882
RICHARDS, THEODORE W.	Harvard University, Cambridge, Mass.	1899
ROYCE, JOSIAH	Harvard University, Cambridge, Mass.	1906
SARGENT, CHARLES S.	Arnold Arboretum, Jamaica Plain, Mass.	1895
SCHUCHERT, CHARLES	Yale University, New Haven, Conn.	1910
SCOTT, WILLIAM B.	Princeton University, Princeton, N. J.	1906
SMITH, EDGAR F.	University of Pennsylvania, Philadelphia, Pa.	1899
SMITH, THEOBALD	Harvard Medical School, Boston, Mass.	1908
STIEGLITZ, J. O.	University of Chicago, Chicago, Ill.	1911
STORY, WILLIAM E.	Clark University, Worcester, Mass.	1908
THAXTER, ROLAND	Harvard University, Cambridge, Mass.	1912
THOMSON, ELIHU	Swampscott, Mass.	1907
TRELEASE, WM.	Missouri Botanical Garden, St. Louis, Mo.	1902
TROWBRIDGE, JOHN	Harvard University, Cambridge, Mass.	1878
VAN HISE, C. R.	University of Wisconsin, Madison, Wis.	1902
VAN VLECK, E. B.	University of Wisconsin, Madison, Wis.	1911
VERRILL, A. E.	Yale University, New Haven, Conn.	1872
WALCOTT, CHARLES D.	Smithsonian Institution, Washington, D. C.	1896
WEBSTER, ARTHUR G.	Clark University, Worcester, Mass.	1903
WELCH, WILLIAM H.	807 St. Paul St., Baltimore, Md.	1895

		Date of Election
Wells, Horace L.	Yale University, New Haven, Conn.	1903
Wheeler, Henry L.	Sheffield Scientific School, New Haven, Conn.	1909
Wheeler, William M.	Harvard University, Cambridge, Mass.	1912
White, David	U. S. Geological Survey, Washington, D. C.	1912
Wilson, Edmund B.	Columbia University, New York City.	1899
Wood, Horatio C.	4107 Chester Ave., Philadelphia, Pa.	1879
Wood, Robert W.	Johns Hopkins University, Baltimore, Md.	1912
Woodward, Robert S.	Carnegie Institution, Washington, D. C.	1896
Wright, Arthur W.	Yale University, New Haven, Conn.	1881

HONORARY MEMBER

Smith, Sidney I.	Yale University, New Haven, Conn.	1884

FOREIGN ASSOCIATES

Arrhenius, S. A.	Nobel Institute, Stockholm.	1908
Auwers, G. F. J. Arthur	Königl. Akad. der Wissenschaften, Berlin.	1883
Backlund, Oskar	Astron. Sternwarte, Pulkowa.	1903
Baeyer, Adolph Ritter von	University of Munich.	1898
Barrois, Charles	University of Lille.	1908
Brøgger, W. C.	University of Christiania.	1903
Dewar, Sir James	University of Cambridge.	1907
Ehrlich, Paul	Königl. Inst. für Exper. Therapie, Frankfurt a. Main.	1904
Fischer, Emil	Chem. Inst., University of Berlin.	1904
Forsyth, A. R.	Trinity College, Cambridge.	1907
Geikie, Sir Archibald	Haslemere, Surrey.	1901
Gill, Sir David	Royal Observatory, Cape Town.	1898
Groth, Paul von	University of Munich.	1905
Hilbert, David	University of Göttingen.	1907
Kapteyn, John C.	University of Groningen.	1907
Klein, Felix	University of Göttingen.	1898
Kronecker, Hugo	University of Berne.	1901
Lankester, Sir E. Ray	South Kensington, London.	1903
Larmor, Sir Joseph	St. Johns College, Cambridge.	1908
Lorentz, Hendrik Anton	University of Leyden.	1906
Murray, Sir John	Edinburgh.	1912
Ostwald, Wilhelm	Grossbothen, bei Leipsic.	1906
Pavlov, Ivan Petrovitch	Imp. Inst. for Exper. Med., St. Petersburg.	1908
Penck, Albrecht	University of Berlin.	1909
Pfeffer, Wilhelm	Botanical Institute of the University of Leipsic.	1903
Picard, Charles Émile	University of Paris.	1903

		Date of Election
RAMSAY, SIR WILLIAM	University College, London.	1904
RAYLEIGH, LORD	University of Cambridge.	1898
RETZIUS, GUSTAV	University, Stockholm.	1909
ROSENBUSCH, H.	University of Heidelberg.	1904
RUTHERFORD, ERNEST	University of Manchester.	1911
SEELIGER, HUGO RITTER VON	University of Munich.	1908
SUESS, EDOUARD	University of Vienna.	1898
THOMSON, SIR JOSEPH J.	University of Cambridge.	1903
VOLTERRA, VITO	University of Rome.	1911
VRIES, HUGO DE	University of Amsterdam.	1904
WALDEYER, WILHELM	University of Berlin.	1909
WUNDT, WILHELM	University of Leipsic.	1909

DECEASED MEMBERS

	Date of Election	Date of Death
AGASSIZ, ALEXANDER	1866	Mar. 27, 1910
AGASSIZ, LOUIS	(2)	Dec. 14, 1873
ALEXANDER, J. H.	(2)	Mar. 2, 1867
ALEXANDER, STEPHEN	(2)	June 25, 1883
BACHE, ALEXANDER DALLAS	(2)	Feb. 17, 1867
BAIRD, SPENCER F.	1864	Aug. 19, 1887
BARKER, GEORGE F.	1876	May 24, 1910
BARNARD, F. A. P.	(2)	Apr. 27, 1889
BARNARD, J. G.	(2)	May 14, 1882
BARTLETT, W. H. C.	(2)	Feb. 11, 1893
BEECHER, CHARLES EMERSON	1899	Feb. 14, 1904
BOSS, LEWIS	1889	Oct. 5, 1912
BOWDITCH, HENRY P.	1887	Mar. 13, 1911
BREWER, WILLIAM H.	1880	Nov. 2, 1910
BROOKS, WILLIAM KEITH	1884	Nov. 12, 1908
BROWN-SÉQUARD, CHARLES E.	1868	Apr. 2, 1894
CASEY, THOMAS L.	1890	Mar. 25, 1896
CASWELL, ALEXIS	(2)	Jan. 8, 1877
CHAUVENET, WILLIAM	(2)	Dec. 13, 1870
CLARKE, HENRY JAMES	1872	July 1, 1873
COFFIN, JAMES	1869	Jan. 6, 1873
COFFIN, J. H. C.	(2)	Jan. 8, 1890
COMSTOCK, CYRUS B.	1884	May 29, 1910
COOK, GEORGE H.	1887	Sept. 22, 1889
COOKE, JOSIAH P.	1872	Sept. 3, 1894

[2] Incorporators.

	Date of Election	Date of Death
COPE, EDWARD D.	1872	Apr. 12, 1897
COUES, ELLIOTT	1877	Dec. 25, 1899
DAHLGREN, J. A. B.	(2)	Resigned
DALTON, J. C.	1864	Feb. 2, 1889
DANA, JAMES D.	(2)	Apr. 14, 1895
DAVIDSON, GEORGE	1874	Dec. 2, 1911
DAVIS, CHARLES H.	(2)	Feb. 18, 1877
DRAPER, HENRY	1877	Nov. 20, 1882
DRAPER, JOHN W.	1877	Jan. 4, 1882
DUTTON, C. E.	1884	Jan. 4, 1912
EADS, JAMES B.	1872	Mar. 8, 1887
EMMONS, SAMUEL F.	1892	Mar. 28, 1911
ENGELMANN, GEORGE	(2)	Feb. 4, 1884
FERREL, WILLIAM	1868	Sept. 18, 1891
FRAZER, JOHN FRIES	(2)	Oct. 12, 1872
GABB, WILLIAM M.	1876	May 30, 1878
GENTH, F. A.	1872	Feb. 2, 1893
GIBBS, JOSIAH WILLARD	1879	Apr. 28, 1903
GIBBS, WOLCOTT	(2)	Dec. 9, 1908
GILLISS, JAMES MELVILLE	(2)	Feb. 9, 1865
GOODE, G. BROWN	1888	Sept. 6, 1896
GOULD, AUGUSTUS A.	(2)	Sept. 15, 1866
GOULD, BENJAMIN A.	(2)	Nov. 26, 1896
GRAY, ASA	(2)	Jan. 30, 1888
GUYOT, ARNOLD	(2)	Feb. 8, 1884
HADLEY, JAMES	1864	Aug. 1, 1872
HALDEMAN, S. S.	1876	Sept. 20, 1880
HALL, ASAPH	1875	Nov. 22, 1907
HALL, JAMES	(2)	Aug. 7, 1898
HAYDEN, F. V.	1873	Dec. 22, 1887
HENRY, JOSEPH	(2)	May 13, 1878
HILGARD, JULIUS E.	(2)	May 8, 1890
HILL, HENRY B.	1883	Apr. 6, 1903
HITCHCOCK, EDWARD	(2)	Feb. 27, 1864
HOLBROOK, J. E.	1868	Sept. 8, 1871
HUBBARD, J. S.	(2)	Aug. 16, 1863
HUMPHREYS, A. A.	(2)	Dec. 27, 1883
HUNT, T. STERRY	1873	Feb. 12, 1892
HYATT, ALPHEUS	1875	Jan. 16, 1902
JAMES, WILLIAM	1903	Resigned

[2] Incorporators.

	Date of Election	Date of Death
Johnson, S. W.	1866	July 21, 1909
Keeler, J. E.	1900	Aug. 12, 1900
King, Clarence	1876	Dec. 24, 1901
Kirkland, Jared P.	1865	Dec. 10, 1877
Lane, J. Homer	1872	May 3, 1880
Langley, Samuel P.	1876	Feb. 27, 1906
Lea, Matthew Carey	1892	Mar. 15, 1897
Le Conte, John	1878	Apr. 29, 1891
Le Conte, John L.	([2])	Nov. 15, 1883
Le Conte, Joseph	1875	July 6, 1901
Leidy, Joseph	([2])	Apr. 30, 1891
Lesley, J. Peter	([2])	June 1, 1903
Lesquereux, Leo	1864	Oct. 25, 1889
Longstreth, Miers F.	([2])	Dec. 27, 1891
Loomis, Elias	1873	Aug. 16, 1889
Lovering, Joseph	1873	Jan. 18, 1892
Lyman, Theodore	1872	Sept. 10, 1897
Mahan, D. H.	([2])	Sept. 16, 1871
Marsh, G. P.	1866	July 23, 1882
Marsh, O. C.	1874	Mar. 18, 1899
Mayer, Alfred M.	1872	July 13, 1897
Mayo-Smith, Richmond	1890	Nov. 11, 1901
Meek, F. B.	1869	Dec. 21, 1877
Meigs, M. C.	1865	Jan. 2, 1892
Mitchell, Henry	1885	Dec. 1, 1902
Morgan, Lewis H.	1875	Dec. 14, 1881
Morton, Henry	1874	May 9, 1902
Newberry, J. S.	([2])	Dec. 7, 1892
Newcomb, Simon	1869	July 11, 1909
Newton, H. A.	([2])	Aug. 12, 1896
Newton, John	1876	May 1, 1895
Norton, William A.	1873	Sept. 21, 1883
Oliver, James E.	1872	Mar. 27, 1895
Packard, A. S.	1872	Feb. 14, 1905
Peirce, Benjamin	([2])	Resigned
Penfield, Samuel L.	1900	Aug. 13, 1906
Peters, C. H. F.	1876	July 18, 1890
Pourtalès, L. F.	1873	July 19, 1880
Powell, John W.	1880	Sept. 23, 1902
Rodgers, John	([2])	May 5, 1882

[2] Incorporators.

	Date of Election	Date of Death
Rogers, Fairman	(2)	Aug. 22, 1900
Rogers, Robert E.	(2)	Sept. 6, 1884
Rogers, Wm. A.	1885	Mar. 1, 1898
Rogers, Wm. B.	(2)	May 30, 1882
Rood, Ogden N.	1885	Nov. 12, 1902
Rowland, Henry A.	1881	Apr. 16, 1901
Rutherfurd, Lewis M.	(2)	May 30, 1892
Saxton, Joseph	(2)	Oct. 26, 1873
Schott, Charles A.	1872	July 31, 1901
Scudder, Samuel H.	1877	May 17, 1911
Sellers, William	1873	Jan. 24, 1905
Silliman, Benj., Sr.	(2)	Nov. 24, 1864
Silliman, Benj., Jr.	(2)	Jan. 14, 1885
Smith, J. Lawrence	1872	Oct. 12, 1883
Stimpson, William	1868	May 26, 1873
Strong, Theodore	(2)	Feb. 1, 1869
Sullivant, W. S.	1873	Apr. 30, 1882
Torrey, John	(2)	Mar. 10, 1873
Totten, J. G.	(2)	Apr. 22, 1864
Trowbridge, William P.	1872	Aug. 12, 1892
Trumbull, James H.	1872	Aug. 5, 1897
Tuckerman, Edward	1868	Mar. 15, 1886
Walker, Francis A.	1878	Jan. 5, 1897
Warren, G. K.	1876	Aug. 8, 1882
Watson, James C.	1868	Nov. 23, 1880
Watson, Sereno	1889	Mar. 9, 1892
White, Charles A.	1889	June 29, 1910
Whitman, C. O.	1895	Dec. 6, 1910
Whitney, Josiah D.	(2)	Resigned
Whitney, William Dwight	1866	Resigned
Winlock, Joseph	(2)	June 11, 1875
Woodward, J. J.	1873	Aug. 17, 1884
Worthen, A. H.	1872	May 6, 1888
Wyman, Jeffries	(2)	Sept. 4, 1874
Young, Charles A.	1872	Jan. 3, 1908

2 Incorporators.

DECEASED FOREIGN ASSOCIATES

Adams, J. C.
Airy, Sir George B.
Argelander, F. W. A.
Baer, Karl Ernest von.
Barrande, Joachim.
Beaumont, L. Élie de.
Becquerel, Henri.
Berthelot, M. P. E.
Bertrand, J. L. F.
Boltzmann, Ludwig.
Bornet, Edouard.
Boussingault, J. B. J. D.
Braun, Alexander.
Brewster, Sir David.
Bunsen, Robert W.
Burmeister, C. H. C.
Candolle, Alphonse de.
Cayley, Arthur.
Chasles, Michel.
Chevreul, M. E.
Clausius, Rudolph.
Cornu, Alfred.
Darwin, Sir George Howard.
Dove, H. W.
Dumas, J. B.
Faraday, Michael.
Gegenbaur, Karl.
Gyldén, Hugo.
Hamilton, Sir William Rowan.
Helmholtz, Baron H. von.
Hoff, J. H. van't.
Hofmann, A. W.
Hooker, Sir Joseph D.
Huggins, Sir William.
Huxley, T. H.
Ibañez, Carlos.
Janssen, J.
Joule, James P.
Kekulé, August.
Kelvin, Lord.
Kirchoff, G. R.
Koch, Robert.
Kohlrausch, Friedrich.
Kölliker, Albert von.
Lacaze-Duthiers, Henri de.
Leuckart, Rudolph.
Lie, Sophus.
Liebig, Justus von.
Lister, Lord.
Loewy, Maurice.
Ludwig, K. F. W.
Marey, E. J.
Mendeléeff, D. I.
Milne-Edwards, Henri.
Moissan, Henri.
Murchison, Sir Roderick I.
Oppolzer, Theodore von.
Owen, Sir Richard.
Pasteur, Louis.
Peters, C. A. F.
Plana, G. A. A.
Poincaré, Jules Henri.
Rammelsberg, C. F.
Regnault, Victor.
Reymond, Emil Du Bois.
Richthofen, F. von.
Sachs, Julius von.
Schiaparelli, Giovanni.
Stas, Jean Servais.
Stokes, Sir George G.
Strasburger, Edouard.
Struve, Otto von.
Sylvester, J. J.
Tisserand, F. F.
Virchow, Rudolph von.
Vogel, H. C.
Weierstrass, Karl.
Wöhler, Friedrich.
Würtz, Adolph.
Zirkel, Ferdinand.
Zittel, K. A. R. von.

APPENDIX III

LIST OF MEDALISTS

ALEXANDER AGASSIZ MEDAL

[Founded in 1911, by Sir John Murray, for original contributions to the science of oceanography.]

HENRY DRAPER MEDAL

[Founded in 1885, by Mrs. Henry Draper, for investigations in astronomical physics.]

1886. SAMUEL PIERPONT LANGLEY.
For researches and discoveries in relation to solar radiation.

1888. EDWARD CHARLES PICKERING.
For recent work in astronomical photometry and photography.

1890. HENRY AUGUSTUS ROWLAND.
For researches on the solar spectrum.

1893. HERMAN KARL VOGEL.
For spectroscopic observations upon the motion of stars in the line of sight.

1899. JAMES EDWARD KEELER.
For researches in spectroscopic astronomy.

1901. SIR WILLIAM HUGGINS.
For investigations in astronomical physics.

1904. GEORGE ELLERY HALE.
For investigations in astronomical physics.

1911. CHARLES GREELEY ABBOT.
For his researches on the infra-red region of the solar spectrum and his accurate measurements, by improved devices of the solar "constant" of radiation.

J. LAWRENCE SMITH MEDAL

[Founded in 1885 for the investigation of meteoric bodies.]

1888. H. A. NEWTON.
For investigation of the orbits of meteors.

WATSON MEDAL

[Founded in 1883, by James C. Watson, for the promotion of astronomical research.]

1887. BENJAMIN APTHORP GOULD.
For valuable labors in promoting the progress in astronomical science, and especially for his establishment of the National Observatory of the Argentine Republic.

1889. ED. SCHÖNFELD.
For services in cataloguing and mapping the stars visible in our latitudes, and especially for his [then] recently published southern "Durchmusterung." (The medal and gold were forwarded through the German embassy at Washington.)

1891. ARTHUR AUWERS.
For his contributions to stellar astronomy. (The medal and gold were forwarded through the German embassy at Washington.)

1894. SETH CARLO CHANDLER.
For researches on the variation of latitude.

1899. SIR DAVID GILL.
For work in perfecting the application of the heliometer to astronomical measurements.

APPENDIX IV

LIST OF REPORTS OF COMMITTEES APPOINTED ON BEHALF OF THE GOVERNMENT

Report of the committee on weights, measures, and coinage.*

Ann. Rep. for 1863, pp. 11-21.

Report on the protection of bottoms of iron vessels from corrosion, etc.

Ann. Rep. for 1863, pp. 21-23.

Report of the chairman of the compass committee to the National Academy of Sciences, January, 1864.

Ann. Rep. for 1863, pp. 23-96, 7 pls.

Report of the committee on Saxton's alcoholometer.

Ann. Rep. for 1863, pp. 96-97.

Report of the committee of the National Academy of Sciences appointed to examine the "Wind and Current Charts" and "Sailing Directions" issued from the Naval Observatory.

Ann. Rep. for 1863, pp. 98-112.

Report of the committee on tests for purity of whiskey.

Ann. Rep. for 1864, p. 5.

Report on the operations of the joint commission on the expansion of steam.

Ann. Rep. for 1864, pp. 5-7.

Report of the committee appointed to test the suitableness of aluminum bronze for coinage and other purposes.

Ann. Rep. for 1864, pp. 7-10.

Report on the explosion of a boiler on the United States gunboat *Chenango*.

Ann. Rep. for 1864, pp. 10-14.

Report of the committee on Greytown Harbor, Nicaragua.

Ann. Rep. for 1866, pp. 4-16, 1 chart.

[Report on coating iron head-blocks with zinc.]

Ann. Rep. for 1866, pp. 17-18.

Report of the committee on methods of inspecting and assessing tax on distilled spirits.

Ann. Rep. for 1866, pp. 18-38.

* For convenience of reference, the wording of the titles follows as closely as practicable that given in the reports cited.

Report of the committee on methods of inspecting distilled spirits subject to duty.

Ann. Rep. for 1867, pp. 12-44.

[Report on the question of the value of the water-proofing process employed in the manufacture of the fractional currency.]

In House Misc. Doc. no. 163, part 2, 44th Congress, 1st Session, pp. 22-28, Apr. 3, 1876.

Report on surveys of the Territories.

Ann. Rep. for 1878, pp. 19-22; also House Misc. Doc. no. 5, 45th Congress, 3d Session, pp. 1-27, Dec. 3, 1878.

Report on the sorghum sugar industry.

Sen. Misc. Doc. no. 51, 47th Congress, 2d Session. 8°, pp. 1-152. Washington, 1883.

Report on methylated spirits.

Ann. Rep. for 1883, pp. 57-63.

Report on glucose.

Ann. Rep. for 1883, pp. 65-143; also separate.

Report on the national surveys and signal service.

Ann. Rep. for 1884, pp. 33-63; also in Sen. Misc. Doc. no. 82, 49th Congress, 1st Session, pp. 1*-37*. 1886.

Report on customs duty on philosophical and scientific apparatus.

Ann. Rep. for 1884, pp. 65-67.

Report on the astronomical day, the eclipse of the sun in 1886, and the erection of a new Naval Observatory.

Ann. Rep. for 1885, pp. 35-79; also Sen. Exec. Doc. no. 67, 49th Congress, 1st Session, February 10, 1886.

Report on tariff classification of wool.

Ann. Rep. for 1885, pp. 81-99; also Treas. Dep. Doc. 805, 1886.

Report on opium.

Ann. Rep. for 1886, pp. 39-40.

Report on opium, 1887.

Ann. Rep. for 1887, pp. 31-35.

Report on sugar determinations.

Ann. Rep. for 1887, pp. 37-45.

Preliminary report on the investigation of the north magnetic pole.

Ann. Rep. for 1890, pp. 33-35.

A conventional standard of color. (Preliminary correspondence.)

Ann. Rep. for 1893, pp. 43-46.

[Report on specifications for the practical application of the definitions of the ampere and volt.]

Ann. Rep. for 1895, pp. 9-13; also Sen. Misc. Doc. no. 115, 53d Congress, 3d Session, February 19, 1895; see also Ann. Rep. for 1894, pp. 39-42.

Report of the commission appointed by the National Academy of Sciences upon a forest policy for the forested lands of the United States.

Ann. Rep. for 1897, pp. 29-73; also, separate, Washington, Government Printing Office, 1897. 8°, pp. 1-47.

[Report on the question of establishing a forest reserve on the Southern Appalachian region.]

Ann. Rep. for 1902, p. 16.

[Report on the Declaration of Independence.]

Ann. Rep. for 1903, pp. 13-15.

Report on scientific surveys of the Philippine Islands.

Ann. Rep. for 1904, pp. 21-33; also Sen. Doc. no. 145, 58th Congress, 3d Session, February 7, 1905. 8°, pp. 1-22.

Report on the conduct of scientific work under the United States Government.

Ann. Rep. for 1908, pp. 27-31; also House Doc. no. 1337, 60th Congress, 2d Session, January 18, 1909. 8°, pp. 1-5.

APPENDIX V

ACT OF INCORPORATION, CONSTITUTION, AMENDMENTS AND RULES

ACT OF INCORPORATION

AN ACT To incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That Louis Agassiz, Massachusetts; J. H. Alexander, Maryland; S. Alexander, New Jersey; A. D. Bache, at large; F. A. P. Barnard, at large; J. G. Barnard, United States Army, Massachusetts; W. H. C. Bartlett, United States Military Academy, Missouri; U. A. Boyden, Massachusetts; Alexis Caswell, Rhode Island; William Chauvenet, Missouri; J. H. C. Coffin, United States Naval Academy, Maine; J. A. Dahlgren, United States Navy, Pennsylvania; J. D. Dana, Connecticut; Charles H. Davis, United States Navy, Massachusetts; George Engelmann, Saint Louis, Mo.; J. F. Frazer, Pennsylvania; Wolcott Gibbs, New York; J. M. Gilliss, United States Navy, District of Columbia; A. A. Gould, Massachusetts; B. A. Gould, Massachusetts; Asa Gray, Massachusetts; A. Guyot, New Jersey; James Hall, New York; Joseph Henry, at large; J. E. Hilgard, at large, Illinois; Edward Hitchcock, Massachusetts; J. S. Hubbard, United States Naval Observatory, Connecticut; A. A. Humphreys, United States Army, Pennsylvania; J. L. Le Conte, United States Army, Pennsylvania; J. Leidy, Pennsylvania; J. P. Lesley, Pennsylvania; M. F. Longstreth, Pennsylvania; D. H. Mahan, United States Military Academy, Virginia; J. S. Newberry, Ohio; H. A. Newton, Connecticut; Benjamin Peirce, Massachusetts; John Rodgers, United States Navy, Indiana; Fairman Rogers, Pennsylvania; R. E. Rogers, Pennsylvania; W. B. Rogers, Massachusetts; L. M. Rutherfurd, New York; Joseph Saxton, at large; Benjamin Silliman, Connecticut; Benjamin Silliman, junior, Connecticut; Theodore Strong, New Jersey; John Torrey, New York; J. G. Totten, United States Army, Connecticut; Joseph Winlock, United States Nautical Almanac, Kentucky; Jeffries Wyman, Massachusetts; J. D. Whitney, California; their associates and successors duly chosen, are hereby incorporated, constituted, and declared to be a body corporate, by the name of the National Academy of Sciences.

SEC. 2. *And be it further enacted,* That the National Academy of Sciences shall consist of not more than fifty ordinary members, and the said corporation hereby constituted shall have power to make its own organization, including its constitution, by-laws, and rules and regulations; to fill all vacancies created by death, resignation, or otherwise; to provide for the election of foreign and domestic members, the division into classes, and all other matters needful or usual in such institution, and to report the same to Congress.

SEC. 3. *And be it further enacted,* That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the Academy shall, whenever called upon by any Department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports to be paid from appropriations which may be made for the purpose, but the Academy shall receive no compensation whatever for any services to the Government of the United States.

Approved, March 3, 1863.

AMENDMENTS

AN ACT To amend the act to incorporate the National Academy of Sciences.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act to incorporate the National Academy of Sciences, approved March third, eighteen hundred and sixty-three, be, and the same is hereby, so amended as to remove the limitation of the number of ordinary members of said academy as provided in said act.

Approved, July 14, 1870.

AN ACT To authorize the National Academy of Sciences to receive and hold trust funds

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the National Academy of Sciences, incorporated by the act of Congress approved March third, eighteen hundred and sixty-three, and its several supplements, be, and the same is hereby, authorized and empowered to receive bequests and donations and hold the same in trust, to be applied by the said academy in aid of scientific investigations according to the will of the donors.

Approved, June 20, 1884.

CONSTITUTION OF THE NATIONAL ACADEMY

As amended and adopted April 17, 1872, and further amended April 20, 1875; April 21, 1881; April 19, 1882; April 18, 1883; April 19, 1888; April 18, 1895; April 20, 1899; April 17, 1902; April 18, 1906; November 20, 1906; April 17, 1907; November 20, 1907; April 20, 1911; April 16, 1912.

PREAMBLE

Empowered by the act of incorporation enacted by Congress, and approved by the President of the United States on the 3d day of March, A. D. 1863, and in conformity with the amendment to said act, approved July 14, 1870, the National Academy of Sciences adopts the following amended constitution and rules:

ARTICLE I.—OF MEMBERS

SEC. 1. The academy shall consist of members, honorary members, and foreign associates. Members must be citizens of the United States.

SEC. 2. Members who, from age or inability to attend the meetings of the academy, wish to resign the duties of active membership, may, at their own request, be transferred to the roll of honorary members by a vote of the academy.

SEC. 3. The academy may elect 50 foreign associates.

SEC. 4. Honorary members and foreign associates shall have the privilege of attending the meetings and of reading and communicating papers to the academy, but shall take no part in its business, shall not be subject to its assessments, and shall be entitled to a copy of the publications of the academy.

ARTICLE II.—OF THE OFFICERS

SEC. 1. The officers of the academy shall be a president, a vice president, a foreign secretary, a home secretary, and a treasurer, all of whom shall be elected for a term of six years, by a majority of votes present, at the first stated meeting after the expiration of the current terms, provided that existing officers retain their places until their successors are elected. In case of a vacancy, the election for six years shall be held in the same manner at the meeting when such vacancy occurs, or at the next stated meeting thereafter, as the academy may direct. A vacancy in the office of treasurer or home secretary may, however, be filled by appointment of the president of the academy until the next stated meeting of the academy.

SEC. 2. The officers of the academy, together with six members to be elected by the academy, shall constitute a council for the transaction of such business as may be assigned to them by the constitution or the academy.

SEC. 3. The president of the academy, or, in case of his absence or inability to act, the vice president, shall preside at the meetings of the academy and of the council; shall name all committees except such as are otherwise especially provided for; shall refer investigations required by the Government of the United States to members especially conversant with the subjects and report thereon to the academy at its meeting next ensuing; and, with the council, shall direct the general business of the academy.

It shall be competent for the president, in special cases, to call in the aid, upon committees, of experts or men of special attainments not members of the academy.

SEC. 4. The foreign and home secretaries shall conduct the correspondence proper to their respective departments, advising with the president and council in cases of doubt, and reporting their action to the academy at one of the stated meetings in each year.

It shall be the duty of the home secretary to give notice to the members of the place and time of all meetings, of all nominations for membership, and of all proposed amendments to the constitution.

The minutes of each meeting shall be duly engrossed before the next stated meeting under the direction of the home secretary.

Sec. 5. The treasurer shall attend to all receipts and disbursements of the academy, giving such bond and furnishing such vouchers as the council may require. He shall collect all dues from members, and keep a set of books showing a full account of receipts and disbursements. He shall present a general report at the annual meeting. He shall be the custodian of the corporate seal of the academy.

ARTICLE III.—OF THE MEETINGS

Sec. 1. The academy shall hold one stated meeting in each year, called the annual meeting, in the city of Washington, beginning on the third Tuesday in April, and another, called the autumn meeting, may be held at such place and time as the council shall determine.

Special business meetings of the academy may be called, by order of eight members of the council, at such place and time as may be designated in the call.

Special scientific meetings of the academy may be held at times and places to be designated by a majority of the council.

Sec. 2. The names of the members present at each session of a meeting shall be recorded in the minutes, and the members present at any session shall constitute a quorum for the transaction of business.

Sec. 3. Scientific sessions of the academy, unless otherwise ordered by a majority of the members present, shall be open to the public; sessions for the transaction of business shall be closed.

Sec. 4. Stated meetings of the council shall be held during the stated or special meetings of the academy. Special meetings of the council may be convened at the call of the president and two members of the council, or of four members of the council.

Sec. 5. No member who has not paid his dues shall take part in the business of the academy.

ARTICLE IV.—OF ELECTIONS AND RESIGNATIONS

Sec. 1. All elections shall be by ballot, and each election shall be held separately unless otherwise ordered by this constitution.

Sec. 2. The time for holding an election of officers shall be fixed by the academy at least one day before the election is held.

Sec. 3. The election of the six members of the council shall be as follows:

At the annual meeting in April, 1907, six members of the council to be elected, of whom two shall serve for three years, two for two years, and two for one year, their respective terms to be determined by lot. Each year thereafter the terms of two members shall expire, and their successors, to serve for three years, shall be elected at the annual meeting in each year.

SEC. 4. The academy shall be divided by the council into standing committees representing the principal branches of scientific research. A member may be assigned to more than one of these committees. The president of the academy shall appoint, subject to the approval of the council, a member of each committee as its chairman, who shall be responsible for the work of the committee.

Nominations to membership in the academy shall be made in writing, approved by a majority of the members of the committee on the branch of research in which the person nominated is eminent, or by a majority of the council in case there is no committee on the subject. The nominations shall be sent to the home secretary by the chairman of the committee before January 1 of the year in which the election is to be held, and each nomination shall be accompanied by a list of the principal contributions of the nominee to science. This list shall be printed by the home secretary for distribution among the members of the academy.

SEC. 5. Election of members shall be held at the annual meeting in Washington in the following manner: There shall be two ballots—a preference ballot, which may be prepared either before or at the annual meeting and must be transmitted to the home secretary, and a final ballot to be taken at the meeting.

Preference ballot.—Each member may inscribe on a ballot not more than 10 names of nominees selected from the submitted list. A list of the nominees shall then be prepared, on which the names shall be entered in the order of the number of votes received by each. In case two or more nominees should have the same number of votes on this preference list, the order in which they shall be placed on the list shall be determined by a majority vote of those present.

Final ballot.—A vote shall first be taken on the nominee who appears first on the preference list, and he shall be declared elected if he receive two-thirds of the votes cast and not less than 20 votes in all, provided that the number of members of the academy be not 150 or over, in which case to be declared elected he must receive four-fifths of the votes cast and not less than 25 votes in all. A vote shall then be taken in similar manner on the nominee standing second on the preference list, and so on until all the nominees on the preference list shall have been acted on, or until 10 nominees shall have been elected.

Not more than 10 members shall be elected at one annual meeting.

Before and during elections a discussion of the merits of nominees will be in order.

The election of members may be suspended at any time by a majority vote of the members present.

SEC. 6. Every member elect shall accept his membership, personally or in writing, before the close of the next stated meeting after the date of his election. Otherwise, on proof that the secretary has formally notified him of his election, his name shall not be entered on the roll of members.

SEC. 7. The election of foreign associates shall be in the following manner:

Foreign associates may be nominated by the council and may be elected at the annual meeting by a two-thirds vote of the members present. Each member shall indicate on a ballot those names for which he votes, and those nominees whose names appear on two-thirds of the votes cast shall be declared elected. A list of those nominated shall be sent to all members of the academy with the notice of the meeting at which the election is to be held.

SEC. 8. A diploma, with the corporate seal of the academy and the signatures of the officers, shall be sent by the appropriate secretary to each member on his acceptance of his membership and to foreign associates on their election.

SEC. 9. Resignations shall be addressed to the president and acted on by the academy.

SEC. 10. Whenever a member has not paid his dues for four successive years, the treasurer shall report the fact to the council, which may report the case to the academy with the recommendation that the person thus in arrears be declared to have forfeited his membership. If this recommendation be approved by two-thirds of the members present, the said person shall no longer be a member of the academy and his name shall be dropped from the roll.

ARTICLE V.—OF SCIENTIFIC COMMUNICATIONS, PUBLICATIONS, AND REPORTS

SEC. 1. Communications on scientific subjects shall be read at scientific sessions of the academy, and papers by any member may be read by the author or by any other member, notice of the same having been previously given to the secretary.

SEC. 2. Any member of the academy may read a paper from a person who is not a member, and shall not be considered responsible for the facts or opinions expressed by the author, but shall be held responsible for the propriety of the paper.

Persons who are not members may read papers on invitation of the council or of the committee of arrangements.

SEC. 3. The academy may provide for the publication, under the direction of the council, of proceedings, memoirs, and reports.

SEC. 4. Propositions for investigations or reports by the academy shall be submitted to the council for approval, except those requested by the Government of the United States, which shall be acted on by the president, who will in such cases report their results to the Government as soon as obtained and to the academy at its next following stated meeting.

SEC. 5. The advice of the academy shall be at all times at the disposition of the Government upon any matter of science or art within its scope.

SEC. 6. An annual report to be presented to Congress shall be prepared by the president, and before its presentation submitted by him, first to the council and afterwards to the academy, at one of the stated meetings.

SEC. 7. Medals and prizes may be established, and the means of bestowing them accepted by the academy upon the recommendation of the council, by whom all the necessary arrangements for their establishment and award shall be made.

Bequests and trusts having for their object the advancement of science may also be accepted and administered by the academy.

ARTICLE VI.—OF THE PROPERTY OF THE ACADEMY

SEC. 1. All investments shall be made by the treasurer in the corporate name of the academy with the approval of a finance committee of three members, to be appointed annually by the president, of which the treasurer shall be one. Investments shall be made in bonds of the United States, in state bonds, or bonds or notes secured by first mortgages on real estate, in investments legal for savings banks under the laws of Massachusetts or New York, or in other bonds recommended to the treasurer by the fiscal advisers of the academy.

The council shall, at its annual meeting in each year, designate one bank or trust company in Washington, D. C., and one in New York city, to act, when requested by the treasurer, as the fiscal advisers of the academy.

The treasurer shall have the authority, with the approval of the finance committee, to change any investment held by him in the corporate name of the academy.

SEC. 2. No contract shall be binding upon the academy which has not been first approved by the council.

SEC. 3. The assessments required for the support of the academy shall be fixed by the academy on the recommendation of the council.

ARTICLE VII.—OF ADDITIONS AND AMENDMENTS

Additions and amendments to the constitution shall be made only at a stated meeting of the academy. Notice of a proposition for such a change must be given at a stated meeting, and shall be referred to the council, which may amend the proposition, and shall report thereon to the academy. Its report shall be considered by the academy in committee of the whole for amendment.

The proposition as amended, if adopted in committee of the whole, shall be voted on at the next stated meeting, and if it receives two-thirds of the votes cast it shall be declared adopted.

Absent members may send their votes on pending changes in the constitution to the home secretary in writing, and such votes shall be counted as if the members were present.

RULES

I. In the absence of any officer a member shall be chosen to perform his duties temporarily, by a plurality of viva voce votes, upon open nominations.

II. On the first day of each stated session, immediately after calling the roll of members, a recording secretary shall be elected, by a plurality of members present, to assist the home secretary in keeping the records of the session.

III. The accounts of the treasurer shall, between January 1 and January 15 of each year, be audited by a committee of three members to be appointed by the president at the autumn meeting of the academy. The auditing committee may employ an expert accountant to examine the books of the treasurer. This committee shall inspect and verify the bonds, securities, and other property in the custody of the treasurer and shall compare the expenditures with the vouchers therefor. The annual report of the treasurer shall be published with that of the president to Congress. The reports of the treasurer and auditing committee shall be presented to the academy at the annual meeting.

IV. A committee of arrangements, consisting of five members shall be appointed by the president for each stated session of the academy. This committee shall meet not less than two weeks previous to each session. It shall be in session during the meetings to make arrangements for the reception of the members, to arrange the business of each day, and, in general, to attend to all business and scientific arrangements.

It shall be the duty of the committee of arrangements to ascertain the length of time required for reading the several memoirs presented, and, when it appears advisable, to recommend a limit of time to be occupied in their discussion.

V. At the meetings the order of business shall be as follows:

1. Chair taken by the president, or, in his absence, by the vice president.
2. Roll of members called by home secretary.
3. Minutes of the preceding meeting read and approved.
4. Stated business.
5. Reports of president, secretaries, treasurer, and committees.
6. Business from council.
7. Other business.
8. On the last day of the session the rough minutes of that day's proceedings are to be read for correction.

VI. The rules of order of the academy shall be those of the Senate of the United States, unless suspended by unanimous consent.

VII. Unless otherwise ordered by the academy, the scientific meetings at the April session shall be held in the afternoon, the mornings being reserved for business.

VIII. At each meeting the president shall announce the death of any members who may have died since the preceding meeting. As soon as practicable thereafter he shall designate a member to write—or with the approval of the president to secure from some other source—a biographical notice of each deceased member.

IX. The secretaries will receive memoirs at any time, and report the date of their reception at the next session; but no memoir shall be published unless it has been read or presented by title before the academy.

Before publication all memoirs must be referred to the committee on publication, who may, if they deem best, refer any memoir to a special committee appointed by the president to determine whether the same should be published by the academy.

X. Memoirs shall date, in the records of the academy, from the date of their presentation to the academy, and the order of their presentation shall be so arranged by the secretary that, so far as may be convenient, those upon kindred topics shall follow one another.

XI. Papers from persons not members read before the academy and intended for publication shall be referred at the meeting at which they are read to a committee of members competent to judge whether the paper is worthy of publication. Such committee shall report to the academy as early as practicable, and not later than the next stated session.

XII. The annual report of the academy may be accompanied by a memorial to Congress in regard to such investigations and other subjects as may be deemed advisable, recommending appropriations therefor when necessary.

XIII. The proper secretary shall acknowledge all donations made to the academy, and shall report them at the next stated session.

XIV. The books, apparatus, archives, and other collections of the academy shall be deposited in some safe place in the city of Washington. A list of the articles so deposited shall be kept by the home secretary, who is authorized to employ a clerk to take charge of them.

XV. A stamp corresponding to the corporate seal of the academy shall be kept by the secretaries, who shall be responsible for the due marking of all books and other objects to which it is applicable.

Labels or other proper marks of similar device shall be placed upon objects not admitting of the stamp.

XVI. The treasurer is authorized to defray, when approved by the president, all the proper expenses of committees appointed to make scientific investigations at the request of departments of the Government, and in each case to look to the department requesting the investigation for reimbursement to the academy.

XVII. Nominations for membership should state the full name, residence, the official position, and the special scientific studies of the candidate. A form of nomination shall be prepared by the home secretary.

XVIII. Ballots for election of members may be sent by sealing them up in a blank envelope, and inclosing this in another, across the back of which is written the name of the sender, and which is addressed to the home secretary; such envelopes will be opened only by the tellers.

XIX. All discussions as to the claims and qualifications of nominees at meetings of the academy will be held strictly confidential, and remarks and criticisms then made may be communicated to no person who was not a member of the academy at the time of the discussion.

XX. Any rule of the academy may be amended, suspended, or repealed on the written motion of any two members, signed by them, and presented at a stated session of the academy, provided the same shall be approved by a majority of the members present.

XXI. The fiscal year of the academy shall end on December 31 of each year.

XXII. The annual reports of the committees on research funds shall, so far as the academy has authority to determine their form, give a current number to each award, stating the name, position, and address of the recipient, the subject of research for which the award is made, and the sum awarded; and in later annual reports the status of the work accomplished under each award previously made shall be announced, until the research is completed, when announcement of its completion and, if published, the title and place of publication shall be stated, and the record of the award shall be reported as closed.

By a resolution adopted January 12, 1864, the president is ex officio a member of all government committees of the academy.

APPENDIX VI

TEXT OF BEQUESTS AND TRUSTS

THE ALEXANDER AGASSIZ FUND

The will of Professor Agassiz contains the following clause:

I give to the National Academy of Sciences at Washington the sum of Fifty Thousand Dollars ($50,000) for the general use of the said Academy.

THE A. D. BACHE FUND

The will of Alexander Dallas Bache, dated March 18, 1862, contains the following provisions:

Item.—As to all the rest and residue of my Estate, including the sum of Five thousand dollars placed at the disposal of my wife in case she should not desire to make any disposition of the same, I direct my executors hereinafter named to apply the income thereof after the death of my wife according to and under the directions of Joseph Henry of Washington, Louis Agassiz and Benjamin Peirce of Harvard College, Massachusetts, to the prosecution of researches in Physical and Natural Science by assisting experimentalists and observers in such manner and in such sums as shall be agreed upon by the three abovenamed gentlemen, or any two of them, whom I constitute a Board of Direction for the application of the income of my residuary estate for the above objects, after the death of my said wife. The class of subjects to be selected by this Board, and the results of such observations and experiments, to be published at the expense of my Trust Estate under their direction out of the income thereof but without encroaching on the principal.

In case of the death or inability to act of all or any of the three gentlemen I have named in my wife's lifetime, My will is that she shall supply their places in the Board of Direction by an Instrument of writing either testamentary or otherwise, desiring that in the selection of the persons, to administer the income of the trust funds hereby created, she will have regard to the selection of persons whose attention has been directed to the same branches of science as those I have named and so that each of the Departments of Physics, Mathematics, and Natural History shall be represented in the Board. In case of any vacancy occurring in the Board of Direction after its organization and after the death of my wife, by reason of the death inability or refusal to act or resignation of any of its members, my will is that the surviving or remaining member or members for the time being shall have power to fill vacancies so occurring in the Board by the selection of other person or persons to fill such vacancies and so on from time to time as vacancies shall occur. My intention being that the Board of Direction shall have power to continue its existence and to filling all vacancies occurring in their body from time to time I direct that a minute of their proceedings be kept, and that the appointment of any member by the Board shall be notified in writing to the trustees for the time being of my residuary estate. In the event of any failure of the Board for the time being to direct the application of the income of my said residuary estate, or to continue its existence by filling vacancies occurring in their body, my will is that the application of the income thereof for the purposes and objects declared in this clause of my Will, shall be made by the Trustees, under the direction of The American Philosophical Society of Philadelphia.

* * * * * * * * * * * * *

Item.—I hereby nominate and appoint my friends, Peter McCall, Esq., and Morton P. Henry, Esq., of the City of Philadelphia, and the survivor of them, to be the executors of and trustees under this my last will and Testament.

CODICIL, JULY 15, 1863.

Item.—I give and devise to my sister Sally Franklin Wainwright the house purchased by me situated No. 396 West Twentieth Street, in the City of Washington, between G and H Streets to be held and enjoyed by her during the term of her natural life. After her death I direct the said house shall pass with the residue of my Estate (subject to a life estate of my wife Nancy Clarke Bache therein in case she should survive my sister) to The National Academy of Sciences, upon the Trusts set forth as to the said residue of my estate.

* * * * * * * * * * * * *

Item.—My will is that upon the death of my wife all the rest and residue of my Estate shall be paid over to and vest in the corporation of The National Academy of Sciences incorporated by Act of Congress, passed the Third day of March, A. D. 1863, whom I hereby appoint Trustees in the place of my said Executors under the Fourth clause of my said will to apply the income according to the directions in the said clause contained to the prosecution of researches in Physical and Natural Science by assisting experimentalists and observers in such manner and in such sums as shall be agreed upon by the Board of Direction in the said clause named. My will further is that in case of any failure of the Board for the time being to direct the application of the income of my residuary estate or to continue its existence by filling vacancies occurring in their body, the application of the income thereof for the purposes and objects declared in the said clause shall be made under the Direction of The National Academy of Sciences instead of The American Philosophical Society of Philadelphia. In all other respects the said application of the income to the purposes aforesaid to be made by the same persons and under the same rules as I have prescribed in the said clause of my will.

Duly sworn to before Saml. Lloyd, February 27, 1867, in the city and county of Philadelphia.

The last will and testament of Nancy Clarke Bache is as follows:

I hereby, in pursuance and exercise of the power of appointment contained in the last will and testament of my husband, Alexander Dallas Bache, devise, bequeath, and appoint the sum of five thousand dollars of the principal of the estate of my said husband, over which I have a power of appointment by his will, to be paid by his executors, or by such person or persons as shall hold the principal of the estate at my death, to my nephew, Henry Wood Bache, absolutely; and I hereby request my nephew, in case he should die unmarried and without issue, to make such a disposition of this amount by will as will secure it to be paid at his death to the National Academy of Sciences, at Washington, to be held by that corporation upon the same trusts and for the same purposes as are declared by my husband in his will as to the residue of his estate after my death. I expressly desire, however, that it shall be understood that this request shall not be construed into any direction which would interfere with his full control of the principal, which is to be paid into his hands directly.

Second. I hereby direct the house, No. 1624 Chestnut street, in which I now reside, to be sold by my executor, hereinafter named, within a reasonable time after my death, either at public or private sale, and after deducting from the purchase money any debts or expenses connected with the sale and the administration of my estate, which, with the cash on hand or other property which I may own or possess at my death, shall be sufficient to satisfy, I direct my executor to pay over the net proceeds to the National Academy of Sciences, at Washington, to be held by that corporation as trustees in trust to apply the income thereof to the prosecution of researches in physical and natural science, according to the directions contained in the last will and testament of my husband as to the residue of his estate after my death in the same manner as if all the directions contained in the last will and testament of my husband and in the codicil thereto were herein repeated at length; my object being to make precisely the same disposition of the proceeds of this house as was made by my husband of his residuary estate after my death.

Third. I direct all the medals and diplomas of my husband, and the large photograph of him now in my possession, to be deposited and remain with the National Academy of Sciences. I have made a memorandum of the disposition of certain other articles, which I desire shall be carried into effect as if contained in this will. I appoint Morton P. Henry, of Philadelphia, executor of this my last will and testament.

CODICIL, APRIL 19, 1869.

Item.—I hereby direct my executor to pay out of the proceeds of the sale of my said house, No. 1624 Chestnut street, Philadelphia, which I have directed to be sold, the sum of five hundred dollars to my nephew, Henry Wood Bache, for his own use and benefit. I further direct my executor to invest five thousand dollars of the proceeds of sale of said house in his own name as trustee in such securities as he may think proper, and to pay the income thereof to my nephew, Henry Wood Bache, during his natural life. After the death of my nephew, I direct that the principal of the said sum of five thousand dollars shall go to the National Academy of Sciences, at Washington, in trust for the same uses and purposes as are declared as to the proceeds of sale of said house by my said will. I expressly declare that the above bequests to Henry Wood Bache are in addition to the five thousand dollars I have appointed to him out of my husband's estate.

Item.—I hereby declare that the balance of the proceeds of the sale of my said house shall go, after paying and providing for the above legacies, as is set forth and declared in my said will, which in all other respects I hereby republish and declare as my last will and testament.

Sworn and subscribed before John Campbell, deputy register, in the city and county of Philadelphia, January 20, 1870.

THE CYRUS B. COMSTOCK FUND

Know all men by these presents, that I, Cyrus B. Comstock, of the City of New York, to advance knowledge in electricity, magnetism and radiant energy, by the giving of money prizes for important investigations or discoveries in those subjects, have given, assigned, transferred and set over, and do by these presents give, assign, transfer and set over unto the National Academy of Sciences, incorporated by the Act of Congress approved March 3rd, 1863, and its several supplements, and hereinafter designated as the Trustee, and unto its successor or successors, ten (10) Union Pacific Railroad Company Registered First Mortgage and Land Grant Four Per Cent Gold Bonds, Numbers B 588, B 663, B 993, B 994, B 1106, B 1204, B 1282, B 1290, B 1309, B 1369, each for $1,000, and my check for Four hundred Dollars ($400.00), bearing even date herewith and payable to the order of the National Academy of Sciences.

To have and to hold the same unto the said National Academy of Sciences, its successor or successors in trust and upon the following conditions, to wit:

First. The Trustee shall keep said sum of Four hundred Dollars ($400.00), and said bonds, or the proceeds thereof and all additions thereto, as a separate fund, to be known as the "Cyrus B. Comstock Fund."

Second. The Trustee shall have power at any time in its discretion to sell said bonds or any of them and execute a proper assignment thereof to the purchaser or purchasers, and shall invest the proceeds thereof and all moneys forming a part of said fund, and keep the same invested in such securities and in such manner as its constitution shall provide for the investment of its property or as shall be authorized by law for the investment of trust funds.

Third. The Trustee shall collect the income arising from said fund and apply the same as follows:

(1) The market value of the fund shall be maintained at not less than Ten thousand Dollars ($10,000), and any and all depreciation therein shall be made up out of the income of the fund before any part of such income shall be applied as hereinafter provided. But when, by the additions hereinafter authorized and directed, the principal of the fund shall have been increased in the amount of Five thousand Dollars ($5,000.), then and thereafter the market value of the fund shall be maintained in the manner aforesaid at not less than Fifteen thousand Dollars ($15,000.).

(2) The balance of the income of said fund shall be set aside and accumulated, and out of such accumulations the Trustee shall award once for every five years a prize in money to the bona fide resident of North America, who, not less than one year nor more than six years before the awarding of the prize, shall have made in the judgment of the Trustee the most important discovery or investigation in electricity or magnetism or radiant energy.

Such prize shall be known and designated as the "Comstock Prize," and shall be in an amount equal to about two-thirds of said balance of the income of said fund for the five years for which the award shall be made, and shall be paid to the person to whom the prize shall have been awarded at such time as may be convenient to the Trustee, but the awarding thereof shall be entirely and in all respects in the discretion of the Trustee. If no such discovery or investigation shall be deemed by the Trustee to be worthy of the prize, or if for any other reason the prize shall not be awarded for any period of five years, then and in that event the money which might have been awarded shall be added to the principal of the fund and become a part thereof; but the Trustee may in its discretion use the whole or any part of the amount unawarded for any five years in aiding such investigation or investigations as the Trustee shall deem worthy in electricity, magnetism or radiant energy to be made by a bona fide resident or residents of North America; Provided, however, that the prize shall not be diverted to give such aid oftener than once in fifteen years.

(3) The balance of the income so accumulated, less the amount to be awarded as a prize, as provided in the preceding section, shall be added to the principal of the fund and become a part thereof and subject to the terms and conditions herein contained, as though such additions had been part of the original donation; Provided, however, that when the market value of said fund shall have been increased to Fifteen thousand Dollars ($15,000.), the amount of the prize may be increased in the discretion of the Trustee to more than two-thirds of the net income as above provided.

Fourth. Upon the failure or inability of the Trustee, its successor or successors, to carry out the said trust upon the terms and conditions above set forth, said fund together with all accumulations and unexpended income shall revert to me, the said Cyrus B. Comstock, if then living; if dead, to my heirs-at-law who shall then be living, per stirpes and not per capita.

In witness whereof, I, the said Cyrus B. Comstock, have hereunto and unto a duplicate hereof, set my hand and seal this twenty-seventh day of November, one thousand nine hundred and seven.

CYRUS B. COMSTOCK.

Sworn and subscribed before Monchure March, notary public, in the city and county of New York, November 27, 1907.

Know all men by these presents that the National Academy of Sciences, the Trustee named in the foregoing instrument, hereby acknowledges the receipt from the said Cyrus B. Comstock of said ten (10) Union Pacific Railroad Company Registered First Mortgage Railroad and Land Grant Four Per Cent Gold Bonds, Numbers B 588, B 663, B 993, B 994, B 1106, B 1204, B 1282, B 1290, B 1309, B 1369 each for $1,000, duly assigned to the said National Academy of Sciences as Trustee under the foregoing instrument, and his check for Four hundred Dollars ($400.00), payable to the order of the National Academy of Sciences; and that, by authority of its Council, the said Trustee hereby accepts and agrees to hold the same in trust and upon the terms and conditions above set forth.

And the said National Academy of Sciences hereby constitutes and appoints Ira Remsen its true and lawful attorney, for it and in its name to acknowledge this instrument, and a duplicate hereof, to be its act before any person having authority to take such acknowledgment.

In witness whereof, the said the National Academy of Sciences has caused its corporate seal to be hereunto and unto a duplicate hereof affixed, and these presents, and a duplicate hereof, to be signed in its name by its President and Treasurer this thirtieth day of November, one thousand nine hundred and seven.

NATIONAL ACADEMY OF SCIENCES.
By IRA REMSEN, *President.*
S. F. EMMONS, *Treasurer.*

Sworn and subscribed before John R. Hooper, notary public, in the city of Baltimore, State of Maryland, December 4, 1907.

THE HENRY DRAPER FUND

The text of the deed of gift is as follows:

Know all men by these presents that I, Mary Anna Palmer Draper of the City, County and State of New York, in consideration of the premises, and of the acceptance of the within trust by the National Academy of Sciences and also in consideration of divers other good and valuable considerations, we, the said Mary Anna Palmer Draper hereto moving, have given, granted, assigned, transferred and set over and by these presents do give, grant, assign, transfer and set over unto the said National Academy of Sciences and to their successors forever, a certain fund or sum of Six thousand dollars with the interest and income thereof To have and to hold the same in trust nevertheless upon the special trusts and for the uses and purposes following, to wit:

First. In trust to invest and to reinvest the said sum of Six thousand dollars and to keep the same invested in good and safe securities, or in such other manner as shall be, in their opinion, best for the preservation and maintenance of said fund.

Second. In trust to use the interest, and income thereof for the purpose of striking a gold medal which shall be called the "Henry Draper Medal," shall be of the value of Two hundred dollars, and shall be struck in a die to be selected and presented to said National Academy of Sciences by me, the said Mary Anna Palmer Draper. And the said medal shall be awarded and presented, from time to time, by the said National Academy of Sciences, to any person in the United States of America or elsewhere who shall make an original investigation in astronomical physics the results of which shall be made known to the public, such results being in the opinion of the said National Academy of Sciences of sufficient importance and benefit to science to merit such recognition, provided however that said medal shall not be presented or awarded more frequently than once in two years, and provided also that the investigation for which it is awarded or the completed publication thereof shall have been made since the time of the last preceding award and presentation of said medal.

Third. In trust that if discoveries of equal importance shall be made in astronomical physics at or about the same time in the United States of America and also in some other part of the world, each of which discoveries might in the opinion of said Academy entitle the discoverer to be considered as a competitor for said medal, preference shall be given in the awarding thereof to discoveries made by a citizen of the said United States of America.

Fourth. In trust that if the said die shall at any time be lost, destroyed, broken, or in any manner rendered unfit for the purpose of striking the said medal, a new die shall be procured exactly similar to the one so selected and presented as aforesaid, and shall be paid for out of the interest and income of said fund; and such sum or sums of money as shall at any time or times be necessary for the proper care, custody and protection of the said die or of the said fund hereby given, shall also be taken from and out of the interest and income of the said fund whenever the same shall be deemed necessary by the said National Academy of Sciences.

Fifth. In trust that, if at any time or times the interest or income of the said trust fund of Six thousand dollars shall exceed the amount necessary for the striking of said medal, and the care of the said die and of the fund, such surplus over or above the sum or sums so rquired for the purposes of the trust as hereinbefore recited and set forth shall be used in such manner as shall be selected by said National Academy of Sciences in aid of investigations and work in astronomical physics to be made and carried on by a citizen or citizens of the United States of America.

And the said National Academy of Sciences doth signify its acceptance of the said fund of Six thousand dollars, and doth engage to hold and manage the same upon the trusts and for the uses and purposes herein mentioned and set forth.

In Witness whereof, I, the said Mary Anna Palmer Draper have hereunto set my hand and seal, and the said National Academy of Sciences hath hereunto caused its corporate seal to be affixed and these presents to be subscribed by its President, this thirteenth day of April, in the year eighteen hundred and eighty-three.

MARY ANNA PALMER DRAPER, [SEAL.]
O. C. MARSH, [SEAL N. A. S.]
President National Academy of Sciences.

Sealed and delivered in presence of Edward H. Dixon, Mornay Williams, as to Mary Anna Palmer Draper.

Witnesses to signature of President Marsh: J. H. C. Coffin, Asaph Hall, Saml. H. Walker.

Executed and acknowledged before Mornay Williams, Notary Public, New York Co.

Acknowledgment of officer of the Academy before Saml. H. Walker, Notary Public, Dist. of Columbia.

THE WOLCOTT GIBBS FUND

MY DEAR PROFESSORS JACKSON AND LOEB:

May I beg you to present to those from whom I received, a few days since, so signal a mark of friendship and good will my heartiest, most earnest, and most grateful acknowledgment? The address which I received on my seventieth birthday, signed by more than 100 friends, pupils, and assistants, brings back my youth in recalling the names of those who now join to offer me more than mere good wishes to cheer my advancing age. Their active friendship has taken the form which was most acceptable to me—that of an endowment to assist research in my own branch of science; so that I can feel that in a certain sense my power to work will not terminate with my life. As the generosity of my friends permits me also to dispose of the manner in which the endowment shall be administered, I submit to them, through you, the plan which seems to me best adapted to carry out their wishes—a plan which has been fully tested in somewhat similar cases and found to work well in practice.

I therefore propose that the fund raised for endowment shall be given to the National Academy of Sciences, to hold the same in trust and to invest and reinvest as may be necessary or advisable. The income or interest of the fund shall be administered by a board of directors consisting of three persons, of whom at least two shall be members of the academy. The first board shall consist of Charles Loring Jackson, Thomas M. Drown, and Ira Remsen, and the directors shall have power to fill vacancies in their own number, notifying the academy of their action without delay. In case of the deaths of all the members of the board, their places shall be filled by persons holding professorships of chemistry, to be appointed by a vote of the academy. The directors shall make an annual report to the academy, stating the condition of the fund and the appropriations made during the year. They shall have absolute and entire control of the disposition of the income of the fund, employing it in such manner as they may deem for the best interest of chemical science.

It is my belief that the above or a similar arrangement is the best which can be made—that is to say, the one which is most likely to be of permanent benefit to science. I trust that it will meet with the approbation of those who have honored me with their confidence and their regard.

Sincerely, yours, WOLCOTT GIBBS.

NEWPORT, March 1, 1892.

THE BENJAMIN APTHORP GOULD FUND

Know all men by these presents that I Alice Bache Gould of the City of Boston and County of Suffolk, State of Massachusetts, in consideration of the acceptance of the within Trust by the National Academy of Sciences and also in consideration of divers other good and valuable considerations have given granted assigned transferred and set over and by these presents do give grant assign transfer and set over unto the said National Academy of Sciences and its successors forever a certain fund or sum of twenty thousand (20,000) dollars with the interest and income thereof to have and to hold the same in trust nevertheless upon the special trusts and for the uses and purposes following, to wit:

First. In trust, to invest and reinvest the said sum of twenty thousand dollars ($20,000.) and to keep the same invested under the ordinary rules governing trustees in good and safe securities in such manner as shall be deemed best for the preservation and maintenance of such fund, which shall be known as the "Benjamin Apthorp Gould Fund," in memory of my father, the late Benjamin Apthorp Gould, of Cambridge, Massachusetts.

Second. In trust to use the net interest and income thereof according to and under the direction of Lewis Boss of Albany New York Seth C. Chandler of Cambridge Massachusetts and Asaph Hall of Washington D. C. whom I hereby constitute a Board of Directors for the application of the income of the said Benjamin Apthorp Gould Fund, for the prosecution of researches in astronomy, by assisting such observers and investigators in such manner and in such sums as shall be agreed upon by the three above-mentioned persons or their successors or by a majority of the then Board.

The Board of Directors however instead of expending all the income of the Fund for the purposes aforesaid may from time to time vote that such portions thereof as they may prescribe shall be added to the principal of the said Fund, and such portion shall then be so added by the Trustees and all such sums once so added shall remain part of the principal.

The Board of Directors shall make an annual report to the National Academy of Sciences giving such information concerning the Fund as shall be desired by the said Academy.

In case of any vacancy occurring in the Board of Directors by reason of the death, inability or refusal to act or resignation of any of its members, then the surviving or remaining members or member for the time being shall have power to fill any vacancy so occurring in the Board by the selection of another person or persons to fill the same, and so on from time to time as vacancies shall occur provided however that at least two of the three directors shall always be members of the National Academy of Sciences. But if at any time the three Directorships of the Board shall simultaneously be vacant, then the National Academy of Sciences shall have power to fill these vacancies and the new Board of Directors in this as in all other cases shall succeed to all the rights duties and privileges of the former board.

Provided however that if at any time the said Academy from any cause whatever shall cease to exist or in case at any time any modification of its rights or powers shall be made by any action other than that of the said Academy itself and such modification shall be followed within six months thereafter by a vote of the then Board of Directors approving the passing and transfer hereinafter mentioned, then and in all of such cases the said Fund together with all accumulations and unexpended income thereof shall pass and be transferred to the said Board of Directors who shall thereafter exercise the functions of both Directors and Trustees, and the said National Academy shall no longer thereafter act as Trustee, and shall have no power of appointing Directors and none of the Directors need be members of the said National Academy; and furthermore after such transfer and passing the said Directors may at any time appoint any other persons or corporation as Trustees, reserving to themselves their powers and duties as Directors, and the Fund shall thereupon pass to such new Trustees to be held upon the same trusts upon which it is hereby given to the National Academy of Sciences, the principal with its accumulations to be always held intact and the income applied as shall be best for the advancement of astronomy and for the honor of my father's memory.

And the said National Academy of Sciences doth hereby signify its acceptance of the said Fund of twenty thousand dollars ($20,000.) and doth engage to hold the same upon the trusts and conditions, and for the uses and purposes herein mentioned and set forth.

In witness whereof I the said Alice Bache Gould have hereto set my hand and seal and the said National Academy of Sciences has caused its corporate name and seal to be hereto affixed by Wolcott Gibbs its President thereunto duly authorized this seventeenth (17th) day of November in the year eighteen hundred and ninety seven (1897).

ALICE BACHE GOULD. [SEAL.]
WOLCOTT GIBBS.
President of the National Academy of Sciences.

W. W. Vaughan, witness to Alice Bache Gould.
O. C. Marsh, witness to Wolcott Gibbs.
J. M. Crafts, witness to Wolcott Gibbs.
C. B. Comstock, witness to Wolcott Gibbs.

TO THE BOARD OF DIRECTORS OF THE BENJAMIN APTHORP GOULD FUND.

GENTLEMEN: Believing that elaborate legal restrictions upon the uses of a perpetual fund may often under changing circumstances hinder the accomplishment of the general intention of the donor, I have in the deed creating the Benjamin Apthorp Gould Fund defined its uses as briefly as possible, namely, as "for the prosecution of researches in astronomy."

Nevertheless I wish hereby to record with you some personal preferences, based upon what I believe would have been my father's opinions regarding the best use of such a Fund, expressly stating however that this letter is not intended to restrict the action of the Board of Directors more than shall in their judgment be expedient and fitting.

First. My object in creating the Fund is two-fold; on the one hand to advance the science of astronomy, and on the other to honor my father's memory and to insure that his power to accomplish scientific work shall not end with his own life.

Second. Throughout my father's lifetime his patriotic feeling and scientific ambition were closely associated, and I wish therefore that a fund bearing his name should be used primarily for the benefit of investigators in his own country or of his own nationality. I recognize however that sometimes the best possible service to American science is the maintenance of close communion between the scientific men of Europe and of America and that therefore even while acting in the spirit of the above restriction it may occasionally be best to apply this money to the aid of a foreign investigator working abroad.

In connection with this I must refer to the strong interest felt by my father in the National Academy of Sciences, and to his belief in the importance of creating and maintaining a single national scientific body whose preeminence should be unquestionable, and of concentrating power in its hands. I wish to recommend that all three Directors shall be members of the Academy, although I have made this legally necessary for only two of the three, and to record the desire to serve the Academy so far as I am able as one of my minor motives in creating the Trust.

Third. I have copied many of the provisions of the Bache Fund, and it is my hope that the Boards of Direction of the two Funds may always act in friendly unison, as befits the long and intimate friendship of the men whose work they perpetuate. I trust that the new Fund may relieve the Bache Directors of many astronomical expenses, and thus enable them to devote the same amounts of money to other branches of science. And I recommend the adoption of a custom now followed by the Bache Board of Directors, by which each Director upon his own election names to his colleagues the person whom he believes most fit to succeed him.

Fourth. I wish that in all cases work in the Astronomy of Precision should be distinctly preferred to any work in Astrophysics, both because of my father's personal preference and because of the present existence of generous endowments for Astrophysics.

Fifth. The Astronomical Journal long conducted by my father has in my belief exerted a powerful influence in raising the standard of American astronomy; and in case at some future time its existence should be imperiled by lack of funds, I wish to recommend it to the attention of the then Board of Directors. As however I believe that the granting to any scientific journal of definite rights over such a Fund would be a dangerous precedent, I here repeat that the Directors are not to consider themselves bound by these my present wishes further than they deem appropriate in connection with a journal associated with my father's name.

Sixth. The Benjamin Apthorp Gould fund is intended for the advancement and not for the diffusion of scientific knowledge. Moreover I prefer that it should be used to defray the actual expenses of an investigation rather than for the personal support of the investigator during the time of his researches. I do not wish absolutely to exclude the latter important use, but such an employment of funds seems to me more appropriately the function of a university than of the National Academy, and I hope therefore that before granting money for such a purpose the Directors will consider the existing university endowments and other sources of pecuniary aid for able workers in science.

Finally I wish to express my entire faith in the wise judgment of the first Board of Directors and my sense of my own good fortune in being able to intrust a memorial of my father to the hands of men who have been both his scientific associates and his intimate personal friends.

ALICE BACHE GOULD.

BOSTON, November 17, 1897.

THE JOSEPH HENRY FUND

The " Joseph Henry fund " of $40,000 was contributed by " Fairman Rogers, Joseph Patterson, George W. Childs, A. J. Drexel, F. A. Drexel, Charles H. Rogers, J. G. Fell, Isaac Lea, Asa Packer, John Welsh, William Blanchard, James Lenox, The Executors of the Estate of John C. Green, Mrs. John C. Green, Robert L. Stuart, Miss C. L. Wolfe, William Libbey, E. N. Dickerson, Cyrus W. Field, Thomas A. Scott, Wm. W. Corcoran, George P. Wetmore, Thomas H. Powers, J. S. Morgan, J. Pierpont Morgan, I. V. Williamson, John W. Garrett, Charles S. Coxe, Cyrus H. McCormick, J. E. Caldwell, Wm. Weightman, Alex[r]. Brown, Henry C. Gibson, J. Donald Cameron, Samuel M. Felton, Henry H. Houston, Nathaniel Thayer, John L. Cadwalader, and J. F. Navarro "—

as an expression of the donors' respect and esteem for Prof. Joseph Henry's personal virtues, their sense of his life's great devotion to science with its results of important discoveries, and of his constant labors to increase and diffuse knowledge and promote the welfare of mankind.

This sum of $40,000 the contributors caused to be invested in certain securities, and to be deposited with and held by the Pennsylvania Company for Insurance of Lives and Granting Annuities in Trust, which company was required to collect the income thereon from time to time, and to pay over the same to Prof. Joseph Henry during his natural life, and after his death, to his wife and daughters, and after the death of the last survivor " to deliver the said fund and the securities in which it shall then be invested to the National Academy of Sciences, to be thenceforward forever held in trust by the National Academy of Sciences under the name and title of ' the Joseph Henry fund,' the principal to be forever held intact and the income to be from time to time applied by the said National Academy of Sciences in its sole discretion to assist meritorious investigators especially in the direction of original research."

THE JOHN L. LE CONTE FUND

The will of Professor Le Conte contains the following clause:

In case all my said children shall die before my said wife without lawful issue, then I direct the whole income to be paid to her during her natural life and upon her death or in case my said children shall all die after my said wife without lawful issue and intestate, the whole of my said Estate shall be distributed as follows:

I give and bequeath unto * * * the National Academy of Sciences incorporated by Act of Congress of the United States of America the sum of Twenty-five thousand dollars ($25,000).

THE MORRIS LOEB BEQUEST

The will of Morris Loeb, signed January 11, 1912, contains the following clause:

" SEVENTEENTH: I give and bequeath to the National Academy of Sciences in Washington, in the District of Columbia, the sum of Two thousand five hundred Dollars as a contribution toward the Wolcott Gibbs Fund, founded in 1892."

THE O. C. MARSH FUND

The will of Professor Marsh contains the following clause:

"I give, devise, and bequeath to the corporation known as the National Academy of Sciences, in Washington, D. C., the sum of $10,000, as a trust fund, the income to be used and expended by it for promoting original research in the natural sciences."

THE JOHN MURRAY FUND

This fund came to the Academy in the form of a personal letter to the Home Secretary, as follows:

To ARNOLD HAGUE, ESQ.,
Secretary of the National Academy,
Washington, D. C., U. S. A.

MY DEAR HAGUE:

I enclose you a cheque for $6000 (= £1233) which sum I trust the National Academy will accept from me, for the purpose of founding an Alexander Agassiz gold Medal, to be awarded for original contributions in the Science of Oceanography to scientific men in any part of the world, whenever and as often as the President and Council may deem desirable.

Yours very sincerely,
(Signed) JOHN MURRAY.

THE BELLEVUE-STRATFORD,
Philadelphia, 22 April, 1911.

THE J. LAWRENCE SMITH FUND

Know all men by these presents, that I, Sarah Julia Smith, of the City of Louisville, and County of Jefferson, State of Kentucky, in consideration of the premises and of the acceptance of the within trust by the National Academy of Sciences, and, also, in consideration of divers other good and valuable considerations, I, the said Sarah Julia Smith, hereto moving, have given, granted, assigned, transferred, and set over, and by these presents do give, grant, assign, transfer, and set over unto the said National Academy of Sciences and to their successors forever, a certain fund or sum of Eight thousand dollars with the interest and income thereof, to have and to hold the same in trust nevertheless—upon the special trusts and for the uses and purposes following, to wit:

First. In trust to invest and to reinvest the said sum of Eight thousand dollars, and to keep the same invested in good and safe securities, or in such other manner as shall be in their opinion best for the preservation and maintenance of such fund.

Second. In trust to use the interest and income thereof for the purpose of striking a gold medal which shall be called the "Lawrence Smith Medal," shall be of the value of Two hundred dollars in gold, and shall be struck in a die to be selected and presented to the said National Academy of Sciences, by me, the said Sarah Julia Smith. And the said medal shall be awarded and presented from time to time, by the said National Academy of Sciences, to any person in the United States of America or elsewhere who shall make an original investigation of meteoric bodies the results of which shall be made known to the public, such results being in the opinion of the said National Academy of Sciences of sufficient importance and benefit to science to merit such recognition, provided, however, that said medal shall not be presented or awarded more frequently than once in two years, and provided, also, that the investigation for which it is awarded or the completed publication thereof shall have been made since the time of the last preceding award and presentation of said medal.

Third. In trust that if investigations of equal importance shall be made in regard to meteoric bodies at or about the same time in the United States of America and, also, in some other part of the world, each of which investigations might in the opinion of said Academy entitle the investigator to be considered as a competitor for said medal, preference shall be given in the awarding thereof to investigations made by a citizen of the said United States of America.

Fourth. In trust, that if the said die shall at any time be lost, destroyed, broken, or in any manner rendered unfit for the purpose of striking the said medal, a new die shall be procured exactly similar to the one so selected and presented as aforesaid, and shall be paid for out of the interest and income of the said fund; and such sum or sums of money as shall at any time or times be necessary for the care, custody and protection of the said die or of the said fund hereby given, shall also be taken from and out of the interest and income of the said fund whenever the same shall be deemed necessary by the said National Academy of Sciences.

Fifth. In trust that, if at any time or times the interest and income of said trust fund of Eight thousand dollars shall exceed the amount necessary for the striking of said medal and the care of the said die and of the fund, such surplus over and above the sum or sums so required for the purposes of the trust as hereinbefore recited and set forth shall be used in such manner as shall be selected by the National Academy of Sciences in aid of investigations of meteoric bodies to be made and carried on by a citizen or citizens of the United States of America.

And the said National Academy of Sciences doth signify its acceptance of the said fund of Eight thousand dollars and doth engage to hold and manage the same upon the trusts and for the uses and purposes herein mentioned and set forth.

In witness whereof, I, the said Sarah Julia Smith, have hereunto set my hand and seal, and the said National Academy of Sciences hath hereunto caused its corporate seal to be affixed and these presents to be subscribed by its President, this sixth day of May, in the year one thousand eight hundred and eighty-four.

SARAH JULIA SMITH, [SEAL.]
O. C. MARSH, [SEAL N. A. S.]
President of the National Academy of Sciences.

Sealed and delivered in presence of Annie C. Norton, J. H. Caperton as to Sarah Julia Smith.

Witnesses to signature of President Marsh: George J. Brush, E. S. Dana.

THE J. C. WATSON FUND

The will of Mr. James C. Watson, dated July 11, 1874, contains the following provisions:

Fifth. I give and devise subject to conditions and legacies hereinbefore and hereafter mentioned all the rest, residue and remainder of my real and personal estate to the National Academy of Sciences of the United States of America, of which I am a member, which said Academy was incorporated by Act of Congress, approved March third, A. D., 1863, to be aggregated, kept and invested as a perpetual fund the income from which shall be expended by said Academy for the promotion of Astronomical Science. * * * * I direct that all other [other than those specifically bequeathed otherwise] stocks bonds and securities owned by me be converted into money on the most advantageous terms possible and as soon as it may be advantageous to do so and paid over to the Treasurer of said National Academy of Sciences. I direct that any other personal property belonging to me, as well as any real estate of which I may die possessed, except my books and scientific papers, be sold and disposed of as soon as may possibly be done advantageously to the interests of my estate and that the proceeds thereof be paid over to the Treasurer of said National Academy of Sciences.

I direct that my books and scientific papers be transferred to said National Academy of Sciences, to become a part of the library of said Academy.

In order to carry out the wish hereinbefore expressed as to the disposal of the income from the fund resulting from my estate hereby devised to said National Academy of Sciences, I do hereby direct that the designation of the particular objects and works which may be aided by this fund shall be determined, subject to approval by a vote of the Academy, by a Board of Trustees, three in number, who shall be members of the Academy and elected, after the first herein named, by said Academy whenever a vacancy may occur by death or otherwise. The trustees so appointed shall hold said office, unless voluntarily relinquished by them, during the period of their membership in the said National Academy of Sciences, and I do hereby appoint and constitute Julius E. Hilgard of the United States Coast Survey and Simon Newcomb and J. H. C. Coffin, Professors of Mathematics U. S. Navy, all of Washington in the District of Columbia, to be the first Board of Trustees for the purposes herein named.

It is my wish that the Academy may if it shall seem proper provide for a gold medal of the value of one hundred dollars to be awarded with a further gratuity of one hundred dollars, from time to time to the person in any country who shall make any astronomical discovery or produce any astronomical work worthy of special reward as contributing to our science. It is my further wish that provision be made for preparing and publishing tables of the motion of all the planets which have been discovered by me, as soon as it may be practicable to do so and I desire that in all cases the trustees and the Academy shall act in harmony to obtain results of the greatest possible aid to our Science from the income fund resulting from my estate. I desire that results so obtained shall be published as speedily as possible in such manner as may be provided by the Academy.

I direct that the said National Academy of Sciences take all necessary and proper measures to invest the funds resulting from the property hereby devised where they may be safe and yield the largest income possible consistent with safety.

APPENDIX VII

LIST OF PUBLICATIONS

ANNUALS

Annual of the National Academy of Sciences for 1863-1864. Cambridge, 1865. 12°. Pp. 1-112.

Annual of the National Academy of Sciences for 1865. Cambridge, 1866. 12°. Pp. 1-130.

Annual of the National Academy of Sciences for 1866. Cambridge, 1867. 12°. Pp. 1-154.

ANNUAL REPORTS

	Date of Publication		Date of Publication
For the year 1863	1864	For the year 1892	1893
" " " 1864	1865	" " " 1893	1895
" " " 1865	1866	" " " 1894	1895
" " " 1866	1867	" " " 1895	1896
" " " 1867	1868	" " " 1896	1897
" " " 1872	1873	" " " 1897	1898
" " " 1878	1879	" " " 1898	1899
" " " 1879	1880	" " " 1899	1900
Report of Proceedings of the National Academy of Sciences from November 16, 1880, to the close of the year 1881	1882	" " " 1900	1901
		" " " 1901	1902
		" " " 1902	1903
		" " " 1903	1904
For the year 1882	1883	" " " 1904	1905
" " " 1883	1884	" " " 1905	1906
" " " 1884	1885	" " " 1906	1907
" " " 1885	1886	" " " 1907	1908
" " " 1886	1887	" " " 1908	1909
" " " 1887	1888	" " " 1909	1910
" " " 1888	1890	" " " 1910	1911
" " " 1889	1891	" " " 1911	1912
" " " 1890	1891	" " " 1912	1913
" " " 1891	1892		

BIOGRAPHICAL MEMOIRS

Volume 1. 1877. 8°. Pp. i-vi, 1-343

Volume 2. 1886. 8°. Pp. i-iv, 1-388

Volume 3. 1895. 8°. Pp. i-iv, 1-441

Volume 4. 1902. 8°. Pp. i-iv, 1-240

* With portrait.

VOLUME 5. 1905. 8°. PP. i-vi, 1-309

VOLUME 6. 1909. 8°. PP. i-vi, 1-472

* With portrait.

Volume 7

CONSTITUTION AND BY-LAWS

1864, [1872].

CONSTITUTION AND MEMBERSHIP

1876, 1879, 1882, 1883, 1884, 1885, 1886, 1887, 1888, 1890, 1891, 1892, 1893, 1895.

LIST OF OFFICERS AND MEMBERS

1910, 1911, 1912.

MEMOIRS

Volume 1. 1866. 4°. Pp. i-iv, 1-343

* With portrait.

Volume 2. 1884. 4°. Pp. 1-262

1. Report of the Eclipse Expedition to Caroline Island, May, 1883. Pp. 5-146.
2. Experimental Determination of Wave-lengths in the Invisible Prismatic Spectrum. By Prof. S. P. Langley. Pp. 147-162, 4 pls.
3. On the Subsidence of Particles in Liquids. By W. H. Brewer. Pp. 163-175.
4. On the Formation of a Deaf Variety of the Human Race. By A. Graham Bell. Pp. 177-262.

Volume 3. 1885-6. 4°. Pp. 1-110, 1-169

Part 1. 1885

1. The Sufficiency of Terrestrial Rotation for the Deflection of Streams. By G. K. Gilbert. Pp. 7-10.
2. On the Temperature of the Surface of the Moon. By Prof. S. P. Langley. Pp. 11-42, pls. 1-6.
3. On a Method of Precisely Measuring the Vibratory Periods of Tuning-forks, and the Determination of the Laws of the Vibrations of Forks; with Special Reference of these Facts and Laws to the Action of a Simple Chronoscope. By Prof. Alfred M. Mayer. Pp. 43-59, 4 pls.
4. The Baumé Hydrometers. By Prof. C. F. Chandler. Pp. 61-71.
5. On Small Differences of Sensation. By Prof. C. S. Peirce and J. Jastrow. Pp. 73-83.
6. Description of an Articulate of Doubtful Relationship, from the Tertiary Beds of Florissant, Colorado. By Dr. S. H. Scudder. Pp. 85-90.
7. On Structure of the Columella Auris in the Pelycosauria. By Prof. E. D. Cope. Pp. 91-95.
8. On the Structure of the Brain of the Sessile-eyed Crustacea. 1. The Brain of *Asellus* and the Eyeless Form *Cecidotæa*. By Prof. A. S. Packard. Pp. 97-110, pls. 1-5.

Part 2. 1886

9. Contribution to Meteorology. By Elias Loomis. Pp. 1-66, pls. 1-16.
10. On Flamsteed's Star, "Observed, but not Existing." By C. H. F. Peters. Pp. 69-83.
11. Corrigenda in Various Star Catalogues. By C. H. F. Peters. Pp. 87-97.
12. Ratio of Meter to Yard. By C. B. Comstock. Pp. 101-103.
13. On Composite Photography as Applied to Craniology, by J. S. Billings; and on Measuring the Cubic Capacity of Skulls, by Washington Matthews. Pp. 105-116, 20 pls.
14. On a New Craniophore for Use in Making Composite Photographs of Skulls. By J. S. Billings and Washington Matthews. Pp. 119-120, 4 pls.

VOLUME 4. 1888-1889. 4°. PP. 1-270, 1-223

PART 1. 1888. PP. 1-270

PART 2. 1889. PP. 1-223

VOLUME 5. 1891. 4°. PP. 1-590

[4.] The Embryology and Metamorphosis of the Macroura. By W. K. BROOKS and F. H. HERRICK. Pp. 319-576, pls. 1-57.

[5.] On the Application of Interference Methods to Astronomical Measurements. By A. A. MICHELSON. Pp. 577-590, 7 pls.

VOLUME 6. 1893. 4°. PP. 1-331

1. On the Capture of Comets by Planets, especially their Capture by Jupiter. By H. A. NEWTON. Pp. 5-23.
2. Atmospheric Electricity. By ROBERT CATLIN, U. S. A. Pp. 25-33, 7 pls.
3. On Certain new Methods and Results in Optics. By CHARLES S. HASTINGS. Pp. 35-47.
4. The Proteids or Albuminoids of the Oat Kernel. By THOMAS B. OSBORNE. Pp. 49-87.
5. A Comparison of Antipodal Faunas. By THEODORE GILL. Pp. 89-124.
6. Families and Sub-Families of Fishes. By THEODORE GILL. Pp. 125-138.
7. Human Bones of the Hemenway Collection in the United States Army Medical Museum. By WASHINGTON MATTHEWS, Surgeon, U. S. Army; DR. J. L. WORTMAN, and DR. JOHN S. BILLINGS, Surgeon, U. S. Army; Pp. 139-286, pls. 1-59.
8. Further Studies of the Brain of *Limulus Polyphemus,* with notes on its Embryology. By ALPHEUS S. PACKARD. Pp. 287-331, pls. 1-36.

VOLUME 7. 1895. 4°. PP. 1-484

1. Monograph of the Bombycine Moths of America, North of Mexico, including their Transformations and Origin of the Larval Markings and Armature. By PROF. ALPHEUS S. PACKARD. Pp. 3-291 (explanation of plates, 293-390), pls. 1-49, maps 1-10.
2. On Reaction-Times and the Velocity of the Nervous Impulse. By PROF. J. MCKEEN CATTELL and DR. CHARLES S. DOLLEY. Pp. 391-415.
3. The Bacteria of River Waters. By JOHN S. BILLINGS. Pp. 417-484, pls. 1-5, diagrams 1-5.

VOLUME 8. 1902. 4°. PP. i-iv, 1-648

1. Notes on the Bacteriological Examination of the Soil of Philadelphia. By M. P. RAVENEL. Pp. 1-41, 3 pls.
2. A Contribution to the Study of the Effect of the Venom of *Crotalus Adamanteus* upon the Blood of Man and Animals. By S. W. MITCHELL and ALONZO H. STEWART. Pp. [43-56], pls. 1-6.
3. General Perturbations of Minerva (93), by Jupiter, including Terms only of the First Order with Respect to the Mass, together with a Correction of Elements. By W. S. EICHELBERGER. Pp. 57-77.

4. *Ophiura Brevispina.* By W. K. BROOKS and CASWELL GRAVE. Pp. 79-100, pls. 1-3.
5. Anatomy of *Nautilus Pompilius.* By LAWRENCE E. GRIFFIN. Pp. 101-197 (explanation of plates, 198-230), pls. 1-17.
6. An Experimental Inquiry Regarding the Nutritive Value of Alcohol. By W. O. ATWATER and F. G. BENEDICT. Pp. 231-397.
7. West Indian Madreporarian Polyps. By J. E. DUERDEN. Pp. 399-599 (explanation of plates, 600-648), pls. 1-25.

VOLUME 9. 1905. 4°. PP. 1-149

Monograph of the Bombycine Moths of North America, including their Transformations and Origin of the Larval Markings and Armature. Part II. Family Ceratocampidæ, sub-family Ceratocampinæ. By ALPHEUS SPRING PACKARD. Pp. 1-149 (explanation of plates, 151-272), pls. 1-61.

VOLUME 10. 1911. 4°. PP. i-vi, 1-377

1. The Absolute Value of the Acceleration of Gravity determined by the Ring-pendulum Method. By CHARLES E. MENDENHALL. Pp. 1-23, pls. 1-3. 1905.
2. *Claytonia* Gronov. A Morphological and Anatomical Study. By THEODORE HOLM. Pp. 25-37, pls. 1-2. 1905.
3. A Research upon the Action of Alcohol upon the Circulation. By HORATIO C. WOOD and DANIEL M. HOYT. Pp. 39-70, pls. 1-3. 1905.
4. *Phoronis architecta:* Its Life History, Anatomy, and Breeding Habits. By WILLIAM KEITH BROOKS and RHEINART PARKER COWLES. Pp. 71-113 (explanation of plates, 115-148), pls. 1-17. 1905.
5. The Affinities of the Pelagic Tunicates, No. 1: On a new *Pyrosoma.* By WILLIAM KEITH BROOKS. Pp. 149-156, pls. 1-2. 1906.
6. Commelinaceæ. Morphological and Anatomical Studies of the Vegetative Organs of some North and Central American Species. By THEODORE HOLM. Pp. 157-192, pls. 1-8. 1906.
7. Tables of Minor Planets discovered by James C. Watson, Part I: Tables of (93) *Minerva,* (101) *Helena,* (103) *Hera,* (105) *Artemis,* (115) *Thyra.* (119) *Althaea,* (128) *Nemesis,* (133) *Cyrene,* (139) *Juewa,* (161) *Athor,* (174) *Phaedra,* and (179) *Klytaemnestra.* By ARMIN O. LEUSCHNER. Pp. 193-374. 1910.

VOLUME 11. 1913. 4°. PP. 1-298

1. Agave in the West Indies. By WILLIAM TRELEASE. Pp. 1-298, pls. A-E, 1-116. 1913.

PROCEEDINGS

VOLUME 1. 1896. 8°. Pp. 1-406

PART 1. Pp. 1-120. Published 1877.
PART 2. Pp. 121-240. Published 1886.
PART 3. Pp. 241-406. Published 1896.

REPORTS OF COMMITTEES

[Report on the question of the value of the water-proofing process employed in the manufacture of the fractional currency.] In House Misc. Doc. no. 163, part 2, 44th Congress, 1st Session, pp. 22-28. April 3, 1876.

Forty-fifth Congress, 3d Session, House of Representatives Misc. Doc. no. 5. Surveys of the Territories. Letter from the Acting President of the National Academy of Sciences, transmitting a report on the surveys of the Territories. Ordered printed, December 3, 1878. 8°. Pp. 1-27.

Forty-seventh Congress, 2d Session. Senate Misc. Doc. no. 51. National Academy of Sciences. Investigation of the scientific and economic relations of the sorghum sugar industry, being a report made in response to a request from the Hon. George B. Loring, U. S. Commissioner of Agriculture, by a committee of the National Academy of Sciences. November, 1882. Washington: Government Printing Office. 1883. 8°. Pp. 1-152.

United States Internal Revenue.—Report on glucose, prepared by the National Academy of Sciences, in response to a request made by the Commissioner of Internal Revenue. Washington: Government Printing Office. 1884. 8°. Pp. 1-108.

Report of committee of National Academy of Sciences concerning classification of Donskoi wool, Jan. 30, 1886. 1886. Treasury Department Doc. no. 805.

Forty-ninth Congress, 1st Session. Senate, Ex. Doc. no. 67. Letter from the Secretary of the Navy, transmitting, in compliance with the Senate resolution, February 2, 1886, report of National Academy of Sciences upon the proposed new Naval Observatory. Ordered printed, February 10, 1886.

[Report on the organization of the National Surveys and the Signal Service.] In Senate Misc. Doc. no. 82, 49th Congress, 1st Session. Pp. 1*-37*. Ordered printed, March 16, 1886. 1886.

National Academy of Sciences. Standards for Electrical Measure, February 20, 1895. Printed for the Academy. Washington: Judd & Detweiler, Printers. 1895. 8°. Pp. 1-9.

Fifty-third Congress, 3d Session. Senate, Misc. Doc. no. 115. Report of the National Academy of Sciences, made in compliance with a requirement of the law (H. R. 6500) entitled "an act to define and establish the units of electrical measure," approved July 12, 1894. Ordered printed, February 19, 1895.

Report of the committee appointed by the National Academy of Sciences upon the inauguration of a forest policy for the forested lands of the United States to the Secretary of the Interior, May 1, 1897. Washington: Government Printing Office. 1897. 8°. Pp. 1-47.

Fifty-eighth Congress, 3d Session. Senate Doc. no. 145. Report by committee appointed by Academy to consider desirability of instituting scientific explorations of Philippine Islands. Pp. 1-22. 8°. Ordered printed, February 7, 1905.

Sixtieth Congress, 2d Session. House of Representatives, Doc. no. 1337. Conduct of scientific work under United States Government. Message from the President of the United States, transmitting report of the National Academy of Sciences relating to the conduct of the scientific work under the United States Government. Pp. 1-5. 8°. Ordered printed, January 18, 1909.

APPENDIX VIII

LIST OF MEETINGS

1863,	April	22.	New York City. Chapel of the University of the City of New York (Organization).
1864,	January	4-9.	Washington (Capitol).
	August	4-6.	New Haven, Connecticut.
1865,	January	3-7.	Washington.
	August	23-26.	Northampton, Massachusetts.
1866,	January	24-27.	Washington.
	August	7-12.	Northampton, Massachusetts.
1867,	January	23-27.	Washington.
	August	13-16.	Hartford, Connecticut (State House).
1868,	January	22-25.	Washington (Capitol).
	August	25-29.	Northampton, Massachusetts.
1869,	April	13-17.	Washington.
	August 31-September 3.		Northampton, Massachusetts.
1870,	April	14-17.	Washington.
1871,	April	18-23.	Washington.
1872,	April	16-19.	Washington.
	November	20-22.	Cambridge, Massachusetts.
1873,	April	15-19.	Washington.
	October	28-30.	New York City.
1874,	April	21-25.	Washington.
	November	3-6.	Philadelphia.
1875,	April	20-23.	Washington.
	November	2-5.	Philadelphia.
1876,	April	18-22.	Washington.
	October	17-19.	Philadelphia.
1877,	April	17-20.	Washington.
	October	23-25.	New York City.
1878,	April	16-19.	Washington.
	November	5-8.	New York City.
1879,	April	15-18.	Washington.
	October	25-30.	New York City.
1880,	April	20-23.	Washington.
	November	16-19.	New York City (Columbia College).

1881, April 19-22. Washington (All Souls' Church).
November 15-17. Philadelphia.
1882, April 18-21. Washington.
November 14-17. New York City.
1883, April 17-21. Washington.
November 13-16. New Haven, Connecticut.
1884, April 15-18. Washington (U. S. National Museum).
April 17, Evening. Memorial Service (U. S. National Museum).
October 14-17. Newport, Rhode Island (Court House).
October 15. Special business session.
1885, April 21-24. Washington (U. S. National Museum).
November 10-13. Albany, New York (Assembly Parlor at the Capitol).
1866, April 20-23. Washington (U. S. National Museum).
November 9-11. Boston (Massachusetts Institute of Technology).
1887, April 19-22. Washington (U. S. National Museum).
November 8-11. New York City (Columbia College).
1888, April 17-20. Washington (U. S. National Museum).
November 13-15. New Haven, Connecticut (North Sheffield Hall, Yale University).
1889, April 16-19. Washington (U. S. National Museum).
November 12-14. Philadelphia (University of Pennsylvania).
1890, April 15-18. Washington (U. S. National Museum).
November 11-13. Boston (Boston Society of Natural History).
1891, April 21-24. Washington (U. S. National Museum).
November 10-12. New York City (Columbia College).
1892, April 19-22. Washington (U. S. National Museum).
November 1-3. Baltimore (Johns Hopkins University).
1893, April 18-21. Washington (U. S. National Museum).
November 7-9. Albany, New York (Capitol).
1894, April 17-20. Washington (U. S. National Museum).
October 30-November 1. New Haven, Connecticut (North Sheffield Hall, Yale University).
1895, February 9 (Special). New York City (Columbia College).
April 16-19. Washington (U. S. National Museum).
October 30-November 1. Philadelphia (University of Pennsylvania Department of Hygiene).
1896, April 21-24. Washington (U. S. National Museum).
November 17-18. New York City (Columbia University).
1897, April 20-22. Washington (U. S. National Museum).
November 16-18. Boston (Massachusetts Institute of Technology).
1898, April 19-22. Washington (Congressional Library).
November 15-17. New Haven, Connecticut (Sheffield Scientific School).

1899,	April	18-20.	Washington (Columbian University).
	November	14-16.	New York City (Columbia University).
1900,	April	17-19.	Washington (Columbian University).
	November	13-14.	Providence, Rhode Island (Brown University).
1901,	April	16-18.	Washington (U. S. National Museum).
	November	12-14.	Philadelphia (Houston Hall, University of Pennsylvania).
1902,	April	15-17.	Washington (U. S. National Museum).
	November	11-12.	Baltimore (Physical Laboratory, Johns Hopkins University).
1903,	April	21-23.	Washington (U. S. National Museum).
	November	17-18.	Chicago (Haskell Oriental Museum, University of Chicago).
1904,	April	19-21.	Washington (U. S. National Museum).
	November	15-16.	New York City (Havemeyer Hall, Columbia University).
1905,	April	18-20.	Washington (U. S. National Museum).
	November	14-15.	New Haven, Connecticut (Sheffield Scientific School, Yale University).
1906,	April	16-18.	Washington (U. S. National Museum).
	November	20-22.	Boston (Harvard Medical School).
1907,	April	16-18.	Washington (Smithsonian Institution and U. S. National Museum).
	November	19-20.	New York City (Schermerhorn Hall, Columbia University).
1908,	April	21-23.	Washington (Smithsonian Institution).
	November	17-18.	Baltimore (Johns Hopkins University).
1909,	April	20-22.	Washington (Smithsonian Institution).
	November	16-18.	Princeton, New Jersey (Guyot Hall, Princeton University).
1910,	April	19-21.	Washington (Smithsonian Institution).
	November	8-10.	St. Louis (Missouri Botanical Garden).
1911,	April	18-20.	Washington (U. S. National Museum).
	November	21-22.	New York City (New York Public Library).
1912.	April	16-18.	Washington (U. S. National Museum).
	November	12-13.	New Haven, Connecticut (Sloane Physical Laboratory, Yale University).

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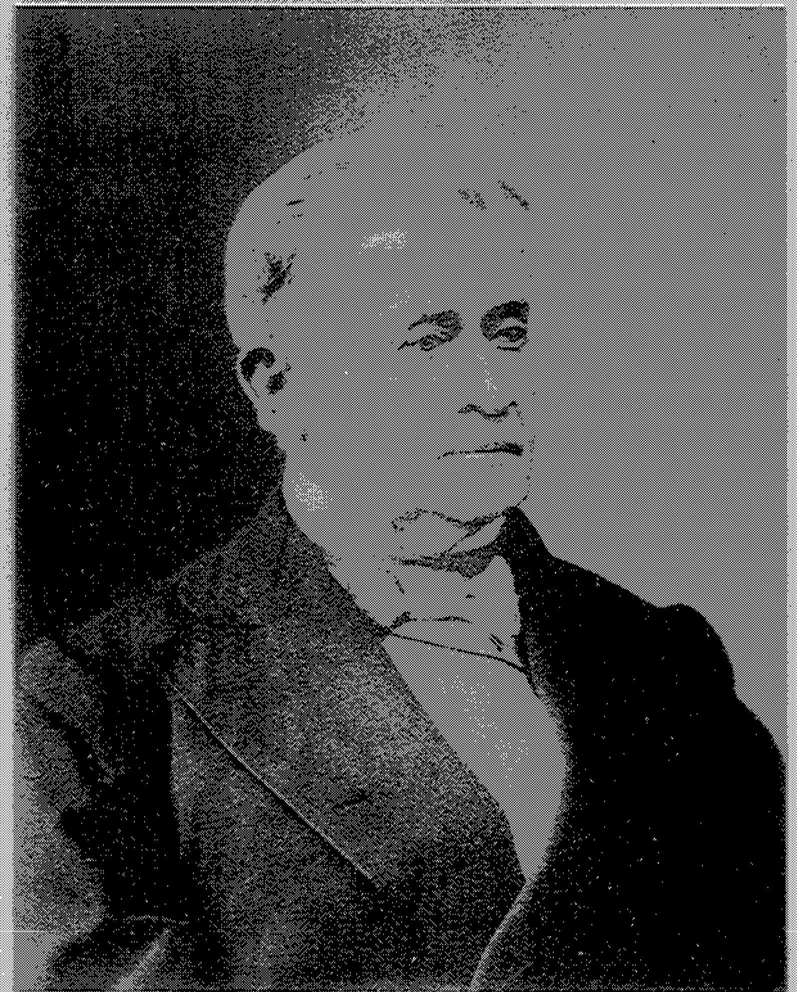
* The letter J was added by Lesley to his name when he came of age, to distinguish his signature from that of his father.

H Wilson

A. D. Bache

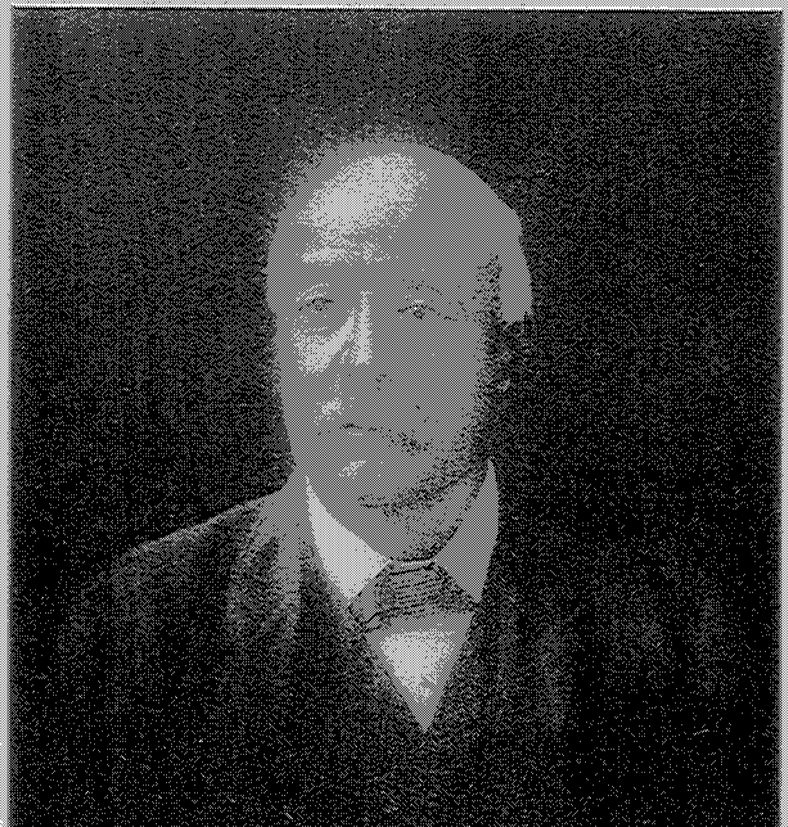


Joseph Henry

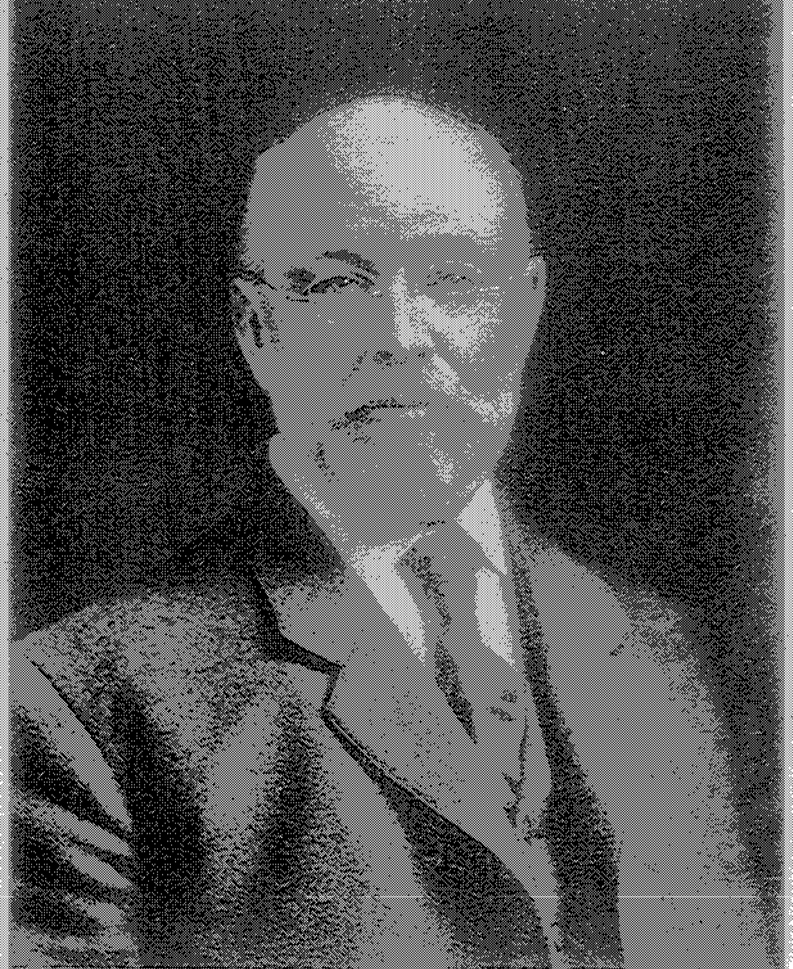
William B Rogers

O. C. Marsh

Wolcott Gibbs



A. Agassiz

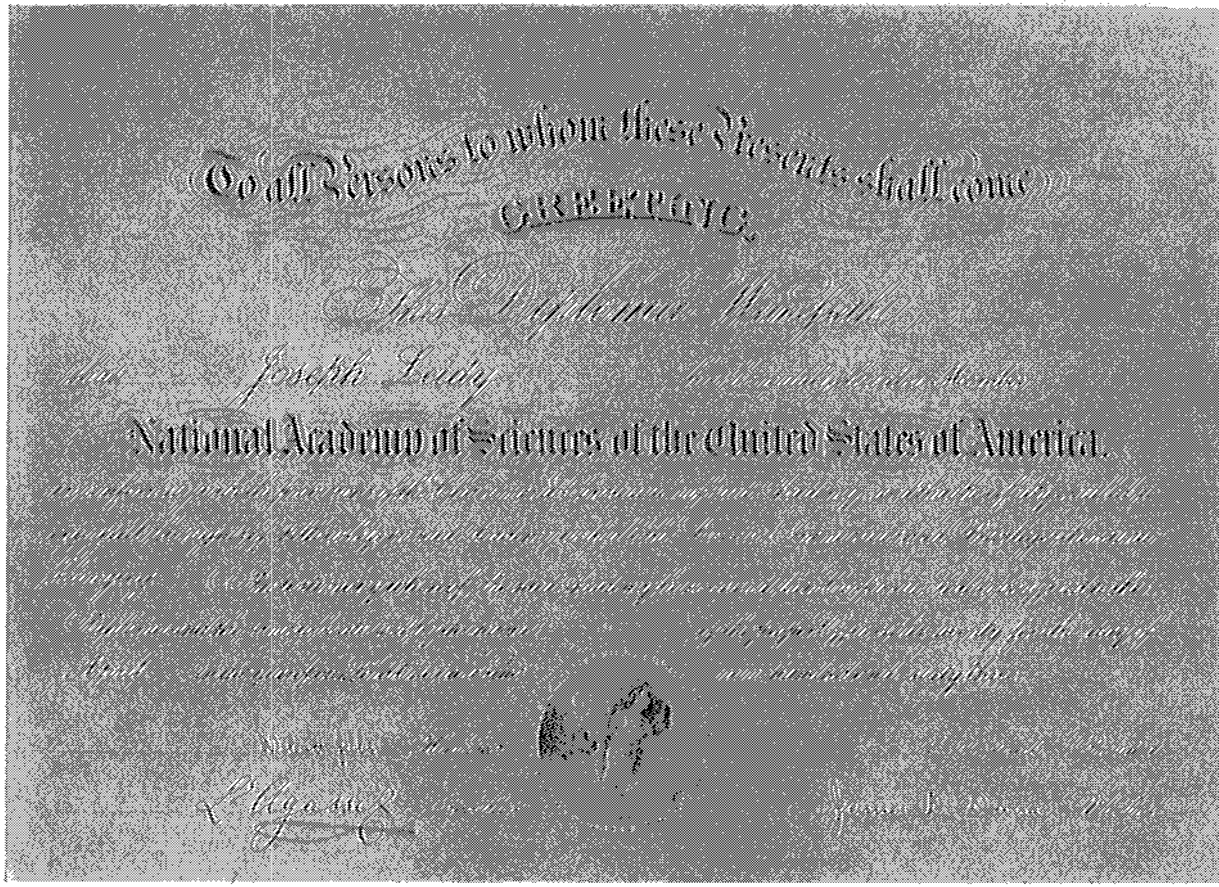


Ira Remsen

HENRY DRAPER MEDAL

LAWRENCE SMITH MEDAL

WATSON MEDAL



DIPLOMA OF THE ACADEMY

ERRATUM

Page 86, after "Report on the Awarding of the Henry Draper Medal to George Ellery Hale" insert

"The Henry Draper Gold Medal, awarded to W. W. Campbell, of Lick Observatory, Mount Hamilton, California, during the meeting of the National Academy of Sciences, held in Washington, April 16–18, 1906."

ERRATUM

Page 341 under "Deceased Members", after Brown-Séquard insert BRUSH, GEORGE JARVIS, elected 1868, died February 6, 1912.