

59TH CONGRESS, }
1st Session.

SENATE.

{ DOCUMENT
No. 144.

REPORT

OF THE

NATIONAL ACADEMY OF SCIENCES

FOR

THE YEAR 1905.

P C1112

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1906.

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LETTER FROM THE PRESIDENT OF THE NATIONAL ACADEMY
OF SCIENCES SUBMITTING A REPORT OF THE OPERATIONS OF
THE NATIONAL ACADEMY OF SCIENCES FOR THE PAST YEAR,
1905.

NATIONAL ACADEMY OF SCIENCES,
OFFICE OF THE PRESIDENT,
Washington, D. C., January 2, 1906.

SIR: In conformity with the requirements of the act of incorporation, approved March 3, 1863, I have the honor to submit herewith a report of the operations of the National Academy of Sciences for the past year.

Very respectfully,

The PRESIDENT OF THE SENATE.

ALEXANDER AGASSIZ.

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ACT OF INCORPORATION AND AMENDMENTS.

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. Rutherford, 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.

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.

DEPARTMENT OF STATE, June 10, 1882.

True copies.

SEVELLON A. BROWN,
Chief Clerk.

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.

DEPARTMENT OF STATE, June 24, 1884.

A true copy.

SEVELLON A. BROWN,
Chief Clerk.

REPORT OF THE NATIONAL ACADEMY OF SCIENCES.

SESSIONS OF THE NATIONAL ACADEMY.

During the year 1905 the Academy held three sessions. The first was the regular annual session held at Washington, April 18 to 20, inclusive; the second, a scientific session held at New Haven, November 14 and 15; the third, a special session held at New Haven, November 15, for the transaction of business.

ANNUAL MEETING.

The session was held at the U. S. National Museum, Washington, with the president, Mr. Alexander Agassiz, in the chair.

The following members were present during the session: Messrs. Agassiz, Allen, Becker, Billings, Boas, Boss, Brewer, Brooks, Brush, Cattell, Chittenden, Councilman, Dall, Davis, Dutton, Emmons, Gill, Hague, Langley, Merriam, Mitchell, Morse, Newcomb, Nichols, Osborn, Peirce, Putnam, Remsen, Walcott, Webster, Welch, Wells, White, Wood, and Woodward.

REPORT OF THE HOME SECRETARY.

THE PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES:

I have the honor to present herewith the annual report of the home secretary of the National Academy of Sciences for the year ending April 17, 1905.

The annual report of the president of the Academy for 1904 was transmitted to Congress February 20, 1905, through Senator Wetmore, chairman of the Committee on the Library. The usual edition of 500 copies was received from the Public Printer March 29. Of this edition 200 copies have been distributed, including those sent to members of the Academy, our foreign associates, and such libraries as are on our exchange list.

The fifth volume of the biographical memoirs was published during the past winter and a copy furnished to every member of the Academy and to about 200 of the most important reference libraries in the United States. The volume contains biographical sketches of 14 of our deceased members, in every case accompanied by a likeness. The biographies are those of Joseph Henry, J. E. Holbrook, L. F. de Pourtalès, A. A. Gould, H. A. Rowland, Theo. Lyman, M. C. Lea, F. A. Walker, J. G.

Barnard, J. E. Keeler, James Hadley, H. B. Hill, Sereno Watson, and R. E. Rogers.

Part II of Prof. A. S. Packard's work on the bombycinæ moths will soon be issued as Volume IX of the memoirs of the Academy. Owing to the protracted illness and death of Professor Packard, the work of revising the text and illustrations has been delayed. Mr. Samuel Henshaw, of the Museum of Comparative Zoology, kindly undertook the work of seeing the volume through the press, and in a few weeks the monograph will be mailed to every member of the Academy.

Mémoires I, II, and III, of Volume X are awaiting publication, and it is hoped they will soon be issued from the press of the Government Printing-Office.

At the time of the last annual meeting four new members were elected to the Academy. During the past year two members, William Sellers and Alpheus S. Packard, have died, leaving 91 names on the active membership list. The list of our foreign associates numbers 42.

Very respectfully,

ARNOLD HAGUE,
Home Secretary.

APRIL 17, 1905.

REPORT OF THE TREASURER.

WASHINGTON, D. C., April 18, 1905.

The PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES.

SIR: I have the honor to transmit herewith my financial report as treasurer of the National Academy of Sciences for the year ending April 18, 1905:

Income.	General fund.	Bache fund.	Watson fund.	Draper fund.	J. Lawrence Smith fund.	Gould fund.	Emmons and Gill, trustees.	Building fund.
Balance brought forward:								
Cash	\$290.59	\$826.06	\$1,763.04	\$122.16	\$717.50	\$656.95	\$175.65	\$133.12
Invested income	3,500.00	2,000.00	2,993.71		1,496.57	1,000.00		1,500.00
Interest	227.63	2,199.77	1,088.43	417.92	361.00	895.00	15.00	67.50
Members' tax	505.10							
Appropriation returned.		306.60	107.50					
Increase from sale of bonds	97.50		292.50					
Total	4,620.82	5,332.43	6,185.18	540.08	2,575.07	2,551.95	190.65	1,700.62
Disbursed	677.51	1,566.06	2,771.50	18.84	215.71	786.01	86.85	1.33
Transfer to Capital fund				450.00				
Balance:								
Cash	443.31	766.37	119.97	71.24	662.79	765.94	103.80	199.29
Invested income	3,501.00	3,000.00	3,233.71		1,746.57	1,000.00		1,500.00
Total	4,620.82	5,332.43	6,185.18	540.08	2,575.07	2,551.95	190.65	1,700.62

^a Outstanding obligation, \$100.

Very respectfully,

S. F. EMMONS, *Treasurer.*

The treasurer's report was referred to an auditing committee consisting of Messrs. Dall and Gill, who after due examination reported as follows:

The committee appointed to audit the accounts of the treasurer hereby certify that they have examined the statements of expenditures, receipts, and balances, and find them to correspond to the vouchers and accounts of the treasurer.

WM. H. DALL.
THEO. N. GILL.

REPORT OF TRUST FUNDS.

STATEMENT OF THE BOARD OF DIRECTORS OF THE BACHE FUND FOR 1904-1905.

The board of directors of the Bache fund herewith present as a matter of courtesy to the Academy, the following statement:

Since the last stated meeting of the Academy, April, 1904, the directors have authorized the following appropriations and payments:

1904.	
May 5.	To H. C. Wood, for investigation on the action of alcohol upon circulation
1905.	
Mar. 27.	To Charles L. Doolittle, being second year's installment of the total appropriation of \$1,000 to him, reported to the Academy in April, 1904
	500

The board has received from Dr. W. T. Porter the sum of \$300 returned as an unused appropriation made and paid to him March 17, 1904.

Respectfully submitted.

SETH C. CHANDLER.
IRA REMSEN.

REPORT OF THE DIRECTORS OF THE BENJAMIN APTHORP GOULD FUND FOR THE ACADEMY YEAR 1904-1905.

The directors of the Benjamin Apthorp Gould fund present the following report:

Since the last stated meeting of the Academy, April, 1904, the directors have authorized the payment to Charles L. Doolittle of the sum of \$500, this being the second installment of the appropriation of \$1,000 made to him and reported to the Academy in April, 1904.

They have also authorized the treasurer to carry the sum of \$500 from cash income account to invested income account as an addition to the sinking fund toward meeting the deferred contingent grant of \$2,500, reported on page 11 of the Academy's report of 1902.

Respectfully submitted.

ASAPH HALL.
LEWIS BOSS.
SETH C. CHANDLER.

REPORT OF THE WATSON TRUSTEES.

WASHINGTON, D. C., April 18, 1905.

To the NATIONAL ACADEMY OF SCIENCES:

The Watson trustees have the honor to submit the following report:

The only work which has been carried on during the past year has been on tables of the asteroids discovered by James C. Watson, as provided in his bequest. It will be recalled by the Academy that it was found by the trustees impossible to bring this work to completion within any reasonable time unless some competent mathematical astronomer, with a corps of computers at hand, devoted an important part of his time and energies to the work. Under these circumstances an arrangement was made with Professor Leuschner, of the University of California, for placing all the facilities in his hands, and paying all the computers whom he found necessary to carry on the work.

The trustees have much pleasure in reporting that this arrangement has been entirely successful. Tables of ten of the asteroids are approaching completion, and it is estimated by Professor Leuschner that the whole work, that on the lost Ethra excepted, will be ready within two years. For more detailed information a copy of a condensed report by Professor Leuschner is appended hereto.

The trustees can not speak too highly of the value of Professor Leuschner's services in this connection. The most complex problems of theoretical astronomy had to be dealt with on lines which might almost be regarded as new. Professor Leuschner has not only mastered and applied the best methods heretofore known, but has himself improved upon them, critically investigating and revising the basis on which they rest, thus making at the same time important contributions to celestial mechanics. He has at every step made complete and detailed reports of all of his proceedings. Recognizing the fact that the income of the fund would, during the progress of the work, barely provide for the payment of his computers, he has exacted no condition as to his own compensation for the time and labor devoted to the work.

Respectfully submitted.

SIMON NEWCOMB, *Chairman.*UNIVERSITY OF CALIFORNIA,
BERKELEY ASTRONOMICAL DEPARTMENT,

April 8, 1905.

A CONDENSED REPORT ON THE CONDITION OF THE WATSON WORK ON APRIL 1, 1905.

Prof. SIMON NEWCOMB, 1620 P. street, Washington, D. C., for the National Academy of Sciences.

My DEAR PROFESSOR NEWCOMB: The regular reports so far submitted to the Watson trustees cover more than 100 typewritten pages, and set forth in detail the work that has been accomplished up to April 1, 1905. In the present report I shall therefore confine myself to a brief statement of the present condition of the asteroid work.

A similar report was submitted two years ago. At that time the asteroid work received a serious interruption of about eight months, due to various changes in the staff of the Berkeley astronomical department and to the difficulty of securing efficient computers. With the arrival of Dr. Burt L. Newkirk in the latter part of September, 1903, the work was again regularly taken up, with Doctor Newkirk and Miss Hobe as computers.

The first work undertaken was an investigation of the discrepancies between the observed places of planet 93, Minerva, and those computed by Eichelberger from his perturbations and tables. After considerable fruitless search for an error in the work, the perturbations of Minerva were recomputed with satisfactory results. A motion of the node was discovered, which considerably improved the results. Mr. Eichelberger's numerical work was found to be entirely correct, but the programme of the work was found not to be consistent with the accuracy aimed at.

At the same time, with the perturbations of Minerva, the perturbations of (115) Thyra were computed by Hansen's method. This brought the list of asteroids for which perturbations, inclusively of the constants of integration, have been determined by the Berkeley astronomical department, up to 12.

Asteroids (119) Althea and (103) Hera were then taken up. Perturbations and tables had been computed for these by Ritter, and Ross had made a comparison of the theory with the observations for the purpose of correcting the elements, but found that the residuals could not be much improved. A determination of a possible motion of the node was therefore taken up, but it was found that the discrepancies could not be accounted for by a motion of the node.

The next step in the work was to prepare a complete programme for the tabulation of the perturbations of all of the asteroids, and considerable work in carrying out this programme has since been done. The first step of all in this connection was the collection of the necessary observations for all of the observed oppositions of all of the Watson asteroids. For the 12 planets for which perturbations have been computed here, observations were then selected with great care for the correction of the elements. For this purpose it was necessary to investigate the observations of nearly 130 oppositions by comparison with ephemerides and with each other. At this point Doctor Newkirk and Miss Hobe were assigned only such portions of the work as required technical preparation, a great part of the numerical work being left to piece computers employed at a cheap rate (30 cents per hour). All computations were made in duplicate. In order to compute the perturbations for the selected observations, such portions of the tables as would not be affected by a correction of the elements were constructed first, and then the perturbations were taken out for all of the 12 planets concerned, and the places computed for each opposition and compared with the observations. The necessary differential coefficients for the least square reduction were then computed by Bauschinger's method and the residuals in α and δ decomposed into residuals in and perpendicular to the plane of the orbit. The solution of the resulting equations of condition by the method of least squares for these 12 planets is completed and the residuals resulting from the least square solutions prove the correctness of the calculation.

The difficulties involved in the asteroid work are not merely numerical, but much time and energy has to be devoted to theoretical questions so as to produce for each planet the best possible result. Theoretical difficulties are somewhat lessened by the fact that the programme of the Watson trustees calls for tables which give the perturbations only to one-tenth of a minute, but even first-order perturbations are not sufficient for this purpose in some cases, no matter what method of determining the perturbations is used. It must be expected that as the calculation progresses, unforeseen difficulties arise which cause an unavoidable retardation. On that account I am now pushing forward the work on what might be termed the clear cases, so as to carry those to a rapid conclusion.

It has been found that in certain cases the perturbations need correction, owing to the large corrections to the elements resulting from the least square solution, but it is hoped that these corrections to the perturbations can be determined differentially by certain formulæ which I have derived for the purpose. This, however, may not be possible in cases like (121) Hermione and (104) Clymene, in which latter case the largest term in n amounts to about $4^{\circ}.5$. In many cases it is necessary to make two approximations to the corrections to the elements by successive corrections of the perturbations and least square reductions. There seems to be good reason to believe that tables for some ten planets will be ready for publication at the end of the summer months, and that the whole work can be wound up in from eighteen months to two years at the rate of progress hitherto made.

In conclusion, I present the following synopsis of the present condition of the work on each of the Watson asteroids.

Twelve asteroids.—We have fully completed the expressions for $n\delta z$, v , and $n \cos i$ for the perturbations, collected the observations, taken out the perturbations, etc., and have corrected the elements of the following 12 asteroids:

(93) Minerva.	(121) Hermione.	(150) Nuwa.
(104) Clymene.	(128) Nemesis.	(161) Athor.
(105) Artemis.	(133) Cyrene.	(174) Phædra.
(115) Thyra.	(139) Juwa.	(179) Clytemnestra.

Three asteroids.—(106) Dione, (168) Sybilla and (175) Andromache belong to the group $\frac{1}{2}$, and special tables for this group were prepared at Berkeley after Böhlin. Through discrepancies between our results and those of Böhlin certain errors in Böhlin's work were discovered after considerable investigation. Further investigation will be necessary owing to additional discrepancies in our tables, those of Böhlin and those of v. Zeipel. These investigations are still under way.

Two asteroids.—(119) Althea and (103) Hera. Perturbations and tables complete (by Ritter). Results not satisfactory, as appears from comparison of observations with theory by Ross. Further investigation necessary to discover cause of discrepancy.

One asteroid.—(79) Euryome. Perturbations by Becker, tables by Eicheberger. It seems that final comparison between observations and theory has not yet been made. It is therefore not possible to state at present whether the results so far obtained are satisfactory.

One asteroid.—(101) Helene. Perturbations and tables by Ritter. Complete. Comparison between observations and theory indicates that improvement is possible. Investigation of discrepancy desirable. Such investigation commenced by Lawton but not completed.

Two asteroids.—(94) Aurora and (100) Hekate. We supposed that these asteroids had already been taken up by others, but no computations or results referring to these planets are available, and their perturbations will, therefore, have to be computed here.

One asteroid.—(132) Aethra, lost planet. Fate of this planet is under investigation by Miss Hobe for her doctor's dissertation. (Twenty-two asteroids.)

In order to make the results of our work available as soon as possible, Professor Newcomb and I have agreed that the tables of the perturbations should be printed first, and that the necessary account of the work and the various investigations undertaken on each planet should be printed subsequently.

Very respectfully submitted.

ARMIN O. LEUSCHNER.

REPORT OF THE COMMITTEE ON THE BARNARD MEDAL.

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.

Respectfully submitted.

J. S. BILLINGS.

S. NEWCOMB.

E. L. NICHOLS.

ELECTIONS.

Messrs. Welch, Hale, Woodward, Chittenden, Osborn, and Billings were elected members of the council.

Messrs. Arthur A. Noyes, Michael I. Pupin, John C. Branner, William H. Holmes, and William H. Howell were elected members of the Academy.

Henri Becquerel, of Paris, and Paul von Groth, of Munich, were elected foreign associates of the Academy.

DEATHS.

Two members of the Academy died during the year 1905: William Sellers, January 24, and Alpheus S. Packard, February 14.

Four foreign associates died during the year: E. J. Marey, Otto von Struve, Ferdinand Freiherr von Richthofen, and Albert von Kölliker.

LIST OF PAPERS PRESENTED AT THE APRIL SESSION.

The Geographical Cycle in an Arid Climate. William M. Davis.

The Mechanical Equivalent of Light. Edward L. Nichols.

The Effects of Alcohol upon the Circulation. H. C. Wood and Daniel M. Hoyt.

The Axis of Symmetry of the Ovarian Egg of the Oyster. W. K. Brooks.

The Expedition of the U. S. Fish Commission Steamer *Albatross*, in charge of Alexander Agassiz, in the Eastern Pacific, Lieut. Commander L. M. Garrett, commanding. Alexander Agassiz.

A Catalogue of Spectroscopic Binary Stars. W. W. Campbell and Heber D. Curtis.

Discovery of the Sixth and Seventh Satellites of Jupiter, and their Approximate Orbits. C. D. Perrine. (Introduced by W. W. Campbell.)

Resequent Valleys. William M. Davis.

ANNOUNCEMENTS.

The president announced the appointment of Mr. R. S. Woodward as a member of the committee on weights, measures, and coinage; of Mr. George E. Hale as a member of the committee on the Henry Draper fund, in place of Mr. E. C. Pickering, resigned; of Mr. Edward L. Nichols as a member of the committee on the Barnard medal in place of Mr. William Sellers, deceased; and of Mr. Edward F. Smith as a member of the committee on the Wolecott Gibbs fund, in place of Mr. T. M. Drown, deceased.

The president also announced the appointment of Mr. William Trelease as a delegate to the International Botanical Congress to be held at Vienna, June 11 to 18, 1905; and of Messrs. George E. Hale and W. W. Campbell as delegates to represent the Academy on the solar research committee to meet in Oxford in September, 1905.

AMENDMENT TO RULES.

Rule IX was amended by adding the following paragraph:

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.

AUTUMN MEETING OF THE ACADEMY.

SCIENTIFIC SESSION.

[Held in New Haven, November 14 and 15, 1905.]

A scientific session for the reading of papers having been called by the council, the Academy met at the Sheffield Scientific School, of Yale University, New Haven, November 14 and 15, 1905.

President Agassiz presided at the sessions and the following members were in attendance: Messrs. Barus, Boas, Brewer, Brush, Cattell, Chandler (C. F.), Chittenden, Dana, Davis, Elkin, Gouch, Hague, Hall, Hastings, Johnson, Minot, Morse, Noyes, Osborn, Peirce, Penfield, Trowbridge, Verrill, Webster, Wells, Wilson, Wright.

The following papers were presented:

Studies on the Chemical Physiology of Development and Growth. L. B. Mendel. (Introduced by R. H. Chittenden.)

On a New Mineral from Borax Lake, California. S. L. Penfield.

Relation of the True Anomalies in a Parabola and a Very Eccentric Ellipse having the Same Perihelion Distance. A. Hall.

On Errors of Eccentricity and Collimation in the Human Eye. F. E. Beach. (Introduced by C. S. Hastings.)

On Pearson's Formulas of Skew Distribution of Variates. Franz Boas.

Sex-determination and the Chromosomes. E. B. Wilson.

The Dwyka Glacial Conglomerate of South Africa. W. M. Davis.

The Disintegration Products of Thorium as indicated by the Proportions of Lead and Helium in Minerals. B. B. Boltwood. (Introduced by H. L. Wells.)

The Relation of Betweenness and Royce's O-collections. C. S. Peirce.

Some Problems in Metallic Reflection. L. P. Wheeler. (Introduced by C. S. Hastings.)

Further Observations on Sedimentation. W. H. Brewer.

The Effect of Roentgen Rays on Certain Metals. H. A. Bumstead. (Introduced by C. S. Hastings.)

On the Variation in the Spines of Sea Urchins. A. Agassiz.

BUSINESS MEETING.

[New Haven, November 14, 1905.]

Mr. Agassiz stated to the Academy that at the last council meeting he had offered to hand over to the treasurer of the Academy the sum of \$5,000, or bonds to the value of \$5,000, approved by the treasurer on the following conditions: That the sum of \$5,000 subscribed by him to the building fund be credited to the general fund, the income to be used for general purposes of the Academy, but that the capital be available for the building fund whenever it is needed for that purpose, and that Mr. Billings had moved in the council that the offer of Mr. Agassiz be accepted with thanks, and that the treasurer be authorized to accept the same in the name of the Academy.

The president appointed Messrs. Brooks, Cattell, James, Newcomb, and Osborn as a committee to report to the council on the relations of the Academy to the philosophical, economic, historical and philological sciences.

The president announced the death of Baron F. von Richthofen, of Berlin, a foreign associate.

Mr. Agassiz presented the following report from the committee appointed by the council to consider the question of aiding the work of the International Association for Seismological Observations:

SEISMOLOGY.

Seismology is a field of geophysical research of the very first importance, but it still remains in a very rudimentary stage of development. Under ideal conditions, earthquake shocks should afford the means of sounding the very depths of the earth, and of determining the physical constants of the component materials of the globe.

along an endless number of chords or curvilinear paths between the centers of shock and observing stations. Even under present conditions, a considerable amount of interest attaches to seismological observations, and it is possible to determine the latitude and longitude of centers of shock. This achievement, however, is far short of what the method should be capable of yielding, nor does it seem possible, under present conditions, to obtain results radically different from those which have already been reached.

The theoretical basis for seismology is very imperfect. The interpretation of even very perfect observations on the intensity and direction of waves of transmission must depend on the mathematical theory of the vibrations of a sphere in which the elastic properties vary continuously or discontinuously with the distance from the center. There appears to be no reason to doubt that mathematical physicists could, with sufficient labor, develop such a theory with sufficient fullness to act as a guide in the interpretation of observations. This work, however, yet remains to be done. We consulted Sir George H. Darwin on the subject, and he referred us to Professor Chree, of Richmond, who, in Darwin's opinion, is the first authority on the subject of the vibrations of a sphere. Professor Chree informed us that our impression was entirely correct, and that the theory had been insufficiently elaborated as yet.

Even, however, had the necessary theoretical work been done, it would still be impracticable to use such observations as are now being made upon earthquake shocks. Wiechert's seismometer possesses extraordinary delicacy, quite sufficient for any needs yet known or likely to become known, so far as the horizontal components of the movements due to earthquakes are concerned. This, however, is entirely insufficient. It is almost unthinkable that formulas should ever be developed by mathematicians which should be applicable to earthquake shocks, unless the angle of emergence of the waves from the surface of the earth is known, as well as the azimuth of the movement. Many attempts have been made to contrive a seismometer which should record the vertical components of the shock. Hitherto, however, the success attained has been very small, and seismometers of this description record only very heavy shocks of an entirely different order of magnitude from that to which the horizontal instruments are sensitive.

It would seem to follow, therefore, that seismometry is open to improvement in two directions, and that the efforts of geophysicists interested in this subject should be directed accordingly. 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. Only when such an instrument is perfected can we begin to make observations which are capable of physical interpretation.

If the day ever comes when the theory and the seismometric apparatus are perfected, field observations can be undertaken, but only under certain conditions. It is in vain to attempt seismometric observations in the neighborhood of artificial disturbing cause. The jar of heavy machinery would be recorded by seismometers, as well as distant earthquake shocks, and even the beating of the waves on a rock-bound coast will affect seismometers at a distance of scores of miles. Hence to investigate the interior of the earth and the origin of earthquakes seismometrically, a series of stations should be selected, well distributed with reference to the earth's surface and in positions as remote as possible from disturbing causes of any description. We have long since dreamed of seeing such a station established in one of the branches of the Mammoth Cave, and have even gone so far as to ascertain that the owners of the Mammoth Cave would gladly give up some gallery or chamber to such a use. Seismometric stations could not profitably be established at large laboratories where machinery is employed. Thus a geophysical laboratory might be selected as the

administrative center for a series of seismological stations; observations could there be discussed and instruments invented or tested, but the actual field work would necessarily be performed at localities far removed from such center.

In our opinion it would be expedient for the National Academy to recommend to the Carnegie Institution grants for the development of the theory of vibrations and for experiments designed to lead to the invention of a vertical seismograph. It does not appear to us that the time has come to expend money on observing stations, nor that it will come until the preliminaries indicated above have been adequately dealt with.

(Signed.)

GEORGE F. BECKER.
A. AGASSIZ.

NOVEMBER, 1905.

The report was adopted by the Academy.

The home secretary was instructed to forward a copy of the report to the Carnegie Institution for its information and guidance.

S. Doc. 144, 59-1—2

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APPENDICES.

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APPENDIX A.

CONSTITUTION OF THE NATIONAL ACADEMY OF SCIENCES.

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.

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 sessions 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 fifty 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 session 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 session when such vacancy occurs, or at the next stated session 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 session of the Academy.

SEC. 2. The officers of the Academy, together with six members to be elected by the Academy at the first stated session in each year, 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 sessions 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 sessions 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 session shall be duly engrossed before the next stated session, 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 April session. 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 session in each year, in the city of Washington, on the third Tuesday in April, and another may be held at such place and time as the council shall determine.

Special sessions 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.

Scientific sessions 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 daily meeting shall be recorded in the minutes, and the members present at any meeting shall constitute a quorum for the transaction of business.

SEC. 3. Scientific meetings of the Academy, unless otherwise ordered by a majority of the members present, shall be open to the public; those for the transaction of business, closed.

SEC. 4. The stated meetings of the council shall be held during the stated or special sessions of the Academy. Special sessions 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 six additional members of the council shall be elected, on any day after the first of the first stated session in each year, by each voter inscribing six names on his ballot, and those six who have received more votes than any others shall be declared elected. If two or more names have received the lowest number of votes that would elect, additional balloting shall be had for as many members as remain each time to be elected until the number is full.

The term of the members so elected shall commence at the close of the session at which they are elected and continue until the close of the first stated session in the next year.

SEC. 4. Nominations of members may be made in writing, signed by any five members of the Academy, at any stated session, to be voted on at the next stated session held in Washington, and each nomination shall, at the time of election, be accompanied by a written list of the original works of the nominee.

SEC. 5. The Academy shall be divided into six standing committees. In this classification a member who is eminent in more than one subject may be assigned to a corresponding number of committees. The classification shall be the following:

1. Mathematics and astronomy.
2. Physics and engineering.
3. Chemistry.
4. Geology and paleontology.
5. Biology.
6. Anthropology.

In nominating for membership in the Academy, a statement must be made as to the subject or subjects in which the person nominated is eminent. Every nomination must be submitted, through the secretary, to all the members of the committee or committees representing the subject or subjects in which the person nominated is stated to be emi-

ment; and in order that his name may be brought before the Academy for election he must receive the votes of a majority of the members of the committee or committees to which his name has been referred.

Elections for membership shall be held in the following manner: Each member may inscribe on a ballot not more than five names of nominees selected from the list. Absent members may send such ballots to the home secretary. From the seven names receiving the highest number of votes in this preference ballot the members present may proceed to elect new members in the following manner: At each ballot each member present may vote for not exceeding three persons; and the person receiving the highest number of votes shall be declared elected, provided that he receive two-thirds of the votes cast and that his name appear on not less than twenty ballots; and provided further, that the number of members of the Academy be not already one hundred or over, in which case to be elected he must receive four-fifths of the votes cast, and his name must appear on at least twenty-five ballots.

Should several candidates have the same minimum number of votes on the preference list, the requisite number for completing the list shall be selected from them by a two-thirds vote of the members present.

Election of members shall be held only at the regular stated session of each year held in Washington, and not more than five members shall be elected at that session.

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 session 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. Foreign associates may be nominated by a committee of five members, to be appointed for that purpose by the president and elected at any stated session by a two-thirds vote of the members present. The election shall be had by each member indicating on a ballot those names for which he votes, and those nominees whose names appear on two-thirds of the ballots shall be declared elected.

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 meetings 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 president, with the advice of the council.

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 session.

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 sessions.

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, in stocks of the United States, or, with the approval of the council, in State bonds or first-mortgage bonds on real estate. The treasurer shall have authority, with the approval of the council, to sell and transfer any United States bonds 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 session of the Academy. Notice of a proposition for such a change must be given at a stated session, 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 session, and if it receive 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.

APPENDIX B.

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 be referred to an auditing committee of three members, to be appointed by the president at the meeting at which the accounts are presented, which committee shall report before the close of that session, and shall then be discharged.

The bonds, securities, and other property owned or held in trust by the Academy shall be inspected and verified by a committee to be annually appointed by the president. The report of this committee shall be presented to the Academy at its first stated session in each year and referred with the accounts to the auditing committee.

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. The death of members shall be announced by the president on the last day of any session, when a member shall be selected by the president to furnish a biographical notice of the deceased at the next stated session. If such notice be not then furnished, another member may be selected by the president in place of the first, and so on until the duty is performed.

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 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. At least sixty days before the election the members signing the nomination should furnish the home secretary with a sufficient number of printed copies of a list of the more important original works of the nominee to enable the secretary to furnish a copy to each member of the Academy.

XIX. 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.

XX. 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.

XXI. 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.

By a resolution adopted January 12, 1864, the president is ex officio a member of all government committees of the Academy.

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APPENDIX C.

ORGANIZATION OF THE ACADEMY, 1905-6.

	Expiration of term.
AGASSIZ, ALEXANDER, <i>President</i>	April, 1907.
REMSEN, IRA, <i>Vice-President</i>	April, 1909.
NEWCOMB, SIMON, <i>Foreign Secretary</i>	April, 1909.
HAGUE, ARNOLD, <i>Home Secretary</i>	April, 1907.
EMMONS, S. F., <i>Treasurer</i>	April, 1908.

ADDITIONAL MEMBERS OF COUNCIL, 1905-6.

BILLINGS, J. S.	OSBORN, H. F.
CHITTENDEN, R. H.	WEICH, W. H.
HALE, GEORGE E.	WOODWARD, R. S.

COMMITTEES OF THE ACADEMY.

On nominations of new members.

1. Mathematics and Astronomy.	Physics and Engineering—Continued.
ABBE, C.	BELL, A. G.
BOSS, L.	COMSTOCK, C. B.
CAMPBELL, W. W.	HASTINGS, C. S.
CHANDLER, S. C.	LANGLEY, S. P.
COMSTOCK, G. C.	MENDENHALL, T. C.
DAVIDSON, G.	MICHELSON, A. A.
ELKIN, W. L.	MORLEY, E. W.
HALE, G. E.	NICHOLS, E. L.
HALE, A.	NOYES, A. A.
HILL, G. W.	PICKERING, E. C.
HOLDEN, E. S.	PEPIN, M. I.
LANGLEY, S. P.	TROWBRIDGE, J.
MOORE, E. H.	WEBSTER, A. G.
NEWCOMB, S.	WOODWARD, R. S.
OSGOOD, W. F.	WRIGHT, A. W.
PERCE, C. S.	
PICKERING, E. C.	3. Chemistry.
WEBSTER, A. G.	BARKER, G. F.
WOODWARD, R. S.	BRUSH, G. J.
YOUNG, C. A.	CHANDLER, C. F.
	CHITTENDEN, R. H.
2. Physics and Engineering.	CRAFTS, J. M.
ABBE, C.	DANA, E. S.
ABBOT, H. L.	GIBBS, W.
BARKER, G. F.	GOOCH, F. A.
BARUS, C.	HILGARD, E. W.

COMMITTEES OF THE ACADEMY—Continued.

On nomination of new members—Continued.

Chemistry—Continued.

JACKSON, C. L.
JOHNSON, S. W.
MICHAEL, A.
MORLEY, E. W.
NEP, JOHN U.
NOYES, A. A.
PENFIELD, S. L.
REMSEN, I.
RICHARDS, T. W.

4. Geology and Paleontology.

AGASSIZ, A.
BECKER, G. F.
BRANNER, J. C.
CHAMBERLIN, F. C.

DALL, W. H.
DAVIS, W. M.
DUTTON, C. E.
EMMONS, S. F.
GILBERT, G. K.
HAGUE, ARNOLD.
OSBORN, H. F.
PENFIELD, S. L.
PUMPELTY, R.
VAN HISE, C. R.
WALCOTT, C. D.
WHITE, C. A.

5. Biology.

AGASSIZ, A.
ALLEN, J. A.
BOWDITCH, H. P.
BREWER, W. H.
BROOKS, W. R.
CHITTENDEN, R. H.
COUNCILMAN, W. T.

Biology—Continued.

DALL, W. H.
FARLOW, W. G.
GILL, T. N.
GOODALE, G. L.
HOWELL, W. H.
MARK, E. L.
MERRIAM, C. H.
MINOT, C. S.
MOISE, E. S.

OSBORN, H. F.
PRUDDEN, T. M.
PUTNAM, F. W.
SARGENT, C. S.
SCOTCHIE, S. H.
SMITH, S. I.
TRELEAVE, W.

6. Anthropology.

VERBURGH, A. J.
WALCOTT, C. D.
WELCH, W. H.
WHITE, C. A.
WHITMAN, C. O.
WILSON, E. B.
WOOD, H. C.
BILLINGS, J. S.
BOSS, E.
CATFELD, J. McK.
HOLMES, W. H.
JAMES, WM.
MINOT, C. S.
MERRIAM, C. H.
MITCHELL, S. W.
MOISE, E. S.
PERCE, C. S.
PUTNAM, F. W.
WELCH, W. H.

On Weights, Measures, and Coins.

MENDENHALL, T. C., *Chairman.*
MICHELSON, A. A.
NEWCOMB, S.

WOODWARD, R. S.

On the Election of Foreign Associates.

REMSEN, IRA, *Chairman.*
BRUSH, G. J.

MITCHELL, S. W.
NEWCOMB, S.

On Publication.

The PRESIDENT.

The HOME SECRETARY.

C. D. WALCOTT.

COMMITTEES OF THE ACADEMY—Continued.

On Solar Research.

HALE, GEORGE E., *Chairman.*
CAMPBELL, W. W.

LANGLEY, S. P.
MICHELSON, A. A.

YOUNG, C. A.

TRUST FUNDS.

Board of Direction of the Bacho Fund.

[1875, 37,340, estate, \$17,500.]

For researches in physical and natural science.

CHANDLER, S. C., *Chairman.*

REMSEN, IRA.

BOWDITCH, H. P.

Board of Trustees of the Watson Fund.

[1896, residue, estate, \$18,666.88.]

For the promotion of astronomical research.

NEWCOMB, S., *Chairman.*

ROSS, L.

ELKIN, W. L.

The Henry Draper Fund.

[1885, \$6,000.]

Award of medal for important discoveries in astronomy.

NEWCOMB, S., *Chairman.*

HALE, G. E.

MICHELSON, A. A.

TROWBRIDGE, J.

WRIGHT, A. W.

The J. Lawrence Smith Fund.

[1885, \$8,000.]

For the investigation of meteoric bodies.

BRUSH, G. J., *Chairman.*

MORLEY, E. W.

REMSEN, IRA.

JOHNSON, S. W.

PUMPELTY, R.

The Benjamin Apthorp Gould Fund.

[1897, \$20,000.]

For researches in astronomy.

HALE, ASAPH, *Chairman.*

ROSS, LEWIS.

CHANDLER, S. C.

The Barnard Medal.

BILLINGS, J. S., *Chairman.*

BOWDITCH, H. P.

CHANDLER, S. C.

JACKSON, C. L.

NEWCOMB, S.

NICHOLS, E. L.

The Wolcott Gibbs Fund.

[1893, \$2,673.17.]

For chemical research.

JACKSON, C. L., *Chairman.*

SMITH, EDGAR F.

REMSEN, IRA.

TRUST FUNDS—Continued.

The Joseph Henry Fund.

The sum of \$40,000 was contributed by Fairman Rogers, Joseph Patterson, George W. Childs, and others, as an expression of their respect and esteem for Prof. Joseph Henry. This amount was deposited with the Pennsylvania Company for the Insurance of Lives and Granting Annuities in Trust, with authorization to collect the income thereon 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 under the name and title of the 'Joseph Henry Fund.'"

MEMBERS OF THE NATIONAL ACADEMY OF SCIENCES.
JANUARY 2, 1906.

	Date of election.
ABBE, CLEVELAND.....	307 1 st NW, Washington, D. C. 1879
ABBOT, HENRY L., U. S. A.....	217 Park St., Cambridge, Mass. 1872
AGASSIZ, ALEXANDER.....	Cambridge, Mass. 1866
ALLEN, J. ASAPH.....	American Museum, New York City. 1876
BARKER, GEORGE F.....	100 Locust St., Philadelphia, Pa. 1876
BARUS, CARL.....	Brown University, Providence, R. I. 1892
BECKER, GEORGE F.....	U. S. Geological Survey, Washington, D. C. 1901
BELL, A. GRAHAM.....	101 Connecticut Ave., Washington, D. C. 1883
BILLINGS, JOHN S., U. S. A.....	107 The Argosy St., New York City. 1883
BOYS, FRANZ.....	107 W. Endwood St., New York City. 1900
BOSS, LEWIS.....	107 W. Endwood St., New York City. 1889
BOWDITCH, HENRY P.....	Harvard Medical School, Boston, Mass. 1887
BRANNEN, JOHN C.....	Stanford University, California. 1905
BREWSTER, WILLIAM H.....	248 Orange St., New Haven, Conn. 1880
BROOKS, W. K.....	Johns Hopkins University, Baltimore, Md. 1884
BUSH, GEORGE J.....	17 Tremont St., New Haven, Conn. 1868
CAMPBELL, WILLIAM W.....	Lock Observatory, Mt. Hamilton, California. 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.....	21 Craig St., Cambridge, Mass. 1888
CHITTENDEN, RUSSELL H.....	Sheffield Scientific School, New Haven, Conn. 1899
COMSTOCK, CYRUS D., U. S. A.....	114 E. Twenty-seventh St., New York City. 1884
COMSTOCK, GEORGE C.....	Washington Observatory, Madison, Wis. 1899
COUNCILMAN, WM. T.....	Harvard Medical School, Boston, Mass. 1904
CRAYST, JAMES M.....	88 Marlborough St., Boston, Mass. 1879
DALL, WILLIAM H.....	Smithsonian Institution, Washington, D. C. 1897
DANA, EDWARD S.....	Yale University, New Haven, Conn. 1884
DAVISON, GEORGE.....	111 Washington St., San Francisco, Cal. 1874
DAVIS, WILLIAM MORRIS.....	10 Francis Ave., Cambridge, Mass. 1901
DETFON, CLARENCE E., U. S. A.....	Englewood, N. J. 1884
ELKIN, WILLIAM L.....	Yale University Observatory, New Haven, Conn. 1895
ENMONS, SAMUEL F.....	U. S. Geological Survey, Washington, D. C. 1892
FARLOW, W. C.....	Harvard University, Cambridge, Mass. 1879
GIBBS, WOLCOTT.....	Newport, R. I. —
GILBERT, GROVE K.....	U. S. Geological Survey, Washington, D. C. 1883
GILL, THEODORE N.....	Smithsonian Institution, Washington, D. C. 1873

	Date of election.
GOODH, 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, Mount Wilson, Cal. 1902
HALL, ASAPH.....	Norfolk, Conn. 1875
HASTINGS, CHARLES S.....	Yale University, New Haven, Conn. 1889
HILGARD, EUGENE W.....	University of California, Berkeley, Cal. 1872
HILL, GEORGE W.....	West Nyack, N. Y. 1874
HOLDEN, EDWARD S.....	U. S. Military Academy, West Point, N. Y. 1885
HOLMES, WILLIAM H.....	Bureau of American Ethnology, Washington, D. C. 1905
HOWELL, WILLIAM H.....	62 W. Lanvale St., Baltimore, Md. 1905
JACKSON, CHARLES L.....	6 Bowdoin Hall, Cambridge, Mass. 1883
JAMES, WILLIAM.....	125 Irving St., Cambridge, Mass. 1903
JOHNSON, SAMUEL W.....	34 Tremont St., New Haven, Conn. 1866
LANGLEY, SAMUEL P.....	Smithsonian Institution, Washington, D. C. 1876
MALK, EDWARD L.....	109 Irving St., Cambridge, Mass. 1903
MENDENHALL, THOMAS C.....	Worcester, Mass. 1887
MERRIAM, C. HART.....	Department of Agriculture, Washington, D. C. 1902
MICHAEL, ARTHUR.....	Tufts College, Mass. 1889
MICHELSON, ALBERT A.....	University of Chicago, Chicago, Ill. 1888
MINOT, CHARLES S.....	Harvard Medical School, Boston, Mass. 1897
MITCHELL, S. WEIR.....	157 Walnut St., Philadelphia, Pa. 1865
MOORE, ELIAHIM H.....	University of Chicago, Chicago, Ill. 1901
MORLEY, EDWARD W.....	Adelbert College, Cleveland, Ohio. 1897
MORSE, EDWARD S.....	P. O. Box 268, Salem, Mass. 1876
NEE, JOHN ULRICH.....	University of Chicago, Chicago, Ill. 1904
NEWCOMB, SIMON, U. S. N.....	1626 P St. NW, Washington, D. C. 1869
NICHOLS, EDWARD L.....	Cornell University, Ithaca, N. Y. 1901
NOYES, ARTHUR A.....	Massachusetts Institute of Technology, Boston, Mass. 1905
OSBORN, H. F.....	American Museum of Natural History, New York City. 1900
OSGOOD, WILLIAM FOGG.....	Harvard University, Cambridge, Mass. 1904
PEIRCE, CHARLES S.....	Milford, Pa. 1876
PENFIELD, S. L.....	Yale University, New Haven, Conn. 1900
PICKERING, EDWARD C.....	2 Observatory, Cambridge, Mass. 1873
PRUDDEN, T. MITCHELL.....	Columbia University, New York City. 1901
PUMPELLY, RUPHARD.....	Gibbs Ave., Newport, R. I. 1872
PUPIN, MICHAEL I.....	Columbia University, New York City. 1905
PUTNAM, FREDERICK W.....	Peabody Museum, Cambridge, Mass. 1885
REMSEN, IRA.....	Johns Hopkins University, Baltimore, Md. 1882
RICHARDS, THEODORE W.....	Harvard University, Cambridge, Mass. 1899
SARGENT, CHARLES S.....	2 Arnold Arboretum, Jamaica Plain, Mass. 1895
SCEDDER, SAMUEL H.....	Cambridge, Mass. 1877
SMITH, EDGAR F.....	University of Pennsylvania, Philadelphia, Pa. 1899
SMITH, SIDNEY L.....	Yale University, New Haven, Conn. 1884
TRELEASE, WM.....	Missouri Botanical Garden, St. Louis, Mo. 1902
T. WERRIDGE, JOHN.....	Harvard University, Cambridge, Mass. 1878
VAN HISE, C. R.....	University of Wisconsin, Madison, Wis. 1902
VERRILL, A. E.....	Yale University, New Haven, Conn. 1872
WALCOTT, CHARLES D.....	U. S. Geological Survey, Washington, D. C. 1896
WEBSTER, ARTHUR G.....	Clark University, Worcester, Mass. 1903
WELCH, WILLIAM H.....	807 St. Paul St., Baltimore, Md. 1895
WELLS, HORACE L.....	Yale University, New Haven, Conn. 1903

	Date of election.
WHITE, CHARLES A.	330 T st. NW., Washington, D. C. 1889
WHITMAN, CHARLES O.	University of Chicago, Chicago, Ill. 1895
WILSON, EDMUND B.	Columbia University, New York City. 1899
WOOD, HORATIO C.	1925 Chestnut st., Philadelphia, Pa. 1879
WOODWARD, ROBERT S.	Carnegie Institution, Washington, D. C. 1896
WRIGHT, ARTHUR W.	Yale University, New Haven, Conn. 1881
YOUNG, CHARLES A.	36 North Main st., Hanover, N. H. 1872

FOREIGN ASSOCIATES.

AUWERS, ARTHUR.	Berlin.
BACKLUND, OSKAR.	Pulkova.
BAEYER, ADOLPH RITTER VON.	Munich.
BEQUEREL, HENRI.	Paris.
BERTHELOT, M. P. E.	Paris.
BOLTZMANN, LUDWIG.	Vienna.
BORNET, EDOUARD.	Paris.
BRÖGGER, W. C.	Christiania.
DARWIN, SIR GEORGE.	Cambridge.
EHRLICH, PAUL.	Frankfurt-am-Main.
FISCHER, EMIL.	Berlin.
GEIKIE, SIR ARCHIBALD.	London.
GILL, SIR DAVID.	Cape Town.
GROTH, PAUL VON.	Munich.
HOFF, J. H. VAN'T.	Berlin.
HOOKE, SIR J. D.	London.
HUGGINS, SIR WILLIAM.	London.
JANSSEN, J.	Paris.
KELVIN, LORD.	London.
KLEIN, FELIX.	Göttingen.
KOCH, ROBERT.	Berlin.
KOHLRAUSCH, FRIEDRICH.	Marburg.
KRONECKER, HUGO.	Bern.
LANKESTER, E. RAY.	London.
LISTER, LORD.	London.
LOEWY, MAURICE.	Paris.
MENDELEEFF, D. I.	St. Petersburg.
MOISSAN, HENRI.	Paris.
PFEFFER, WILHELM.	Leipzig.
PICARD, EMILE.	Paris.
POINCARÉ, HENRI.	Paris.
RAMSAY, SIR WILLIAM.	London.
RAYLEIGH, LORD.	London.
ROSENBUSCH, H.	Heidelberg.
STRASBURGER, EDOUARD.	Bonn.
SUËSS, EDOUARD.	Vienna.
THOMSON, JOSEPH JOHN.	Cambridge.
VOGEL, H. C.	Berlin.
VRIES, HUGO DE.	Amsterdam.
ZIRKLE, FERDINAND.	Leipzig.

DECEASED MEMBERS.

	Date of election.	Date of death.
AGASSIZ, LOUIS*		Dec. 14, 1873
ALEXANDER, J. H.*		Mar. 2, 1867
ALEXANDER STEPHEN*		June 25, 1883
BACHE, ALEXANDER DALLAS*		Feb. 14, 1867
BALD, SPENCER F.*	1864	Aug. 19, 1887
BARNARD, F. A. P.		Apr. 27, 1889
BARNARD, J. G.*		May 14, 1882
BARTLETT, W. H. C.		Feb. 11, 1893
BLECHER, CHARLES EMERSON*	1899	Feb. 14, 1904
BROWN-SQUARD, CHARLES E.*	1868	Apr. 2, 1894
CASEY, THOMAS L.*	1890	Mar. 25, 1896
CASWELL, ALEXIS*		Jan. 8, 1887
CHAUVENET, WILLIAM*		Dec. 13, 1870
CLARKE, HENRY JAMES*	1872	July 1, 1873
COFFIN, JAMES H.*	1869	Jan. 6, 1873
COFFIN, J. H. C.*		Jan. 8, 1890
COOK, GEORGE H.*	1887	Sept. 22, 1889
COOKE, JOSIAH P.*	1872	Sept. 3, 1894
COPE, EDWARD D.*	1872	Apr. 12, 1897
COUES, ELLIOTT.	1877	Dec. 25, 1899
DALTON, J. C.*	1864	Feb. 2, 1889
DANA, JAMES D.		Apr. 14, 1895
DAVIS, CHARLES H.*		Feb. 14, 1877
DRAPER, HENRY*	1877	Nov. 20, 1882
DRAPER, JOHN W.*	1877	Jan. 4, 1882
EADS, JAMES B.*	1872	Mar. 8, 1887
ENGELMANN, GEORGE*		Feb. 4, 1884
FERREL, WILLIAM*	1868	Sept. 18, 1891
FRAZER, JOHN FRIES*		Oct. 12, 1872
GARR, WILLIAM M.*	1876	May 30, 1878
GENTH, F. A.*	1872	Feb. 2, 1893
GIBBS, JOSIAH WILLARD.	1879	Apr. 28, 1903
GILLISS, JAMES MELVILLE*		Feb. 9, 1865
GOODE, G. BROWN*	1888	Sept. 6, 1896
GOULD, AUGUSTUS A.*		Sept. 15, 1866
GOULD, BENJAMIN A.		Nov. 27, 1896
GRAY, ASA*		Jan. 30, 1888
GUYOT, ARNOLD*		Feb. 8, 1884
HADLEY, JAMES*	1864	Aug. 1, 1872
HALDEMAN, S. S.*	1876	Sept. 20, 1880
HALL, JAMES.		Aug. 8, 1898
HAYDEN, F. V.*	1873	Dec. 22, 1887
HENRY, JOSEPH*		May 13, 1878
HILGARD, JULIUS E.*		May 8, 1891
HILL, HENRY B.*	1883	Apr. 6, 1903
HITCHCOCK, EDWARD*		Feb. 27, 1864
HOLBROOK, J. E.*	1868	Sept. 8, 1871
HUBBARD, J. S.*		Aug. 16, 1863
HUMPHREYS, A. A.*		Nov. 28, 1883
HUNT, T. STERRY.	1873	Feb. 12, 1892
HYATT, ALPHEUS.	1875	Jan. 16, 1902
KEELER, J. F.*	1900	Aug. 12, 1900
KING, CLARENCE*	1876	Dec. 24, 1901
KIRKLAND, JARED P.*	1865	Dec. 10, 1877

*Biographical notices have been presented of those designated by an asterisk.

DECEASED MEMBERS—Continued.

	Date of election.	Date of death.
LANE, J. HOMER *	1872	May 3, 1880
LE CONTE, JOHN *	1878	Apr. 23, 1891
LE CONTE, JOHN L. *		Nov. 15, 1883
LE CONTE, JOSEPH	1875	July 6, 1901
LEA, MATTHEW CAREY *	1892	Mar. 15, 1897
LEIDY, JOSEPH		Apr. 30, 1891
LESLEY, J. PETER		June 3, 1903
LESQUEREUX, LEO *	1864	Oct. 25, 1889
LONGSTRETH, MIERS F.		Dec. 27, 1891
LOOMIS, ELIAS *	1873	Aug. 16, 1889
LOVERING, JOSEPH	1873	Jan. 18, 1892
LYMAN, THEODORE *	1872	Sept. 10, 1897
MAHAN D. H. *		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
MEIGH, 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. *		Dec. 7, 1892
NEWTON, H. A. *		Aug. 1, 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
PETERS, C. H. F.	1876	July 18, 1890
POURTALFA, L. F. *	1873	July 19, 1880
POWELL, JOHN W.	1880	Sept. 23, 1902
RODGERS, JOHN		May 5, 1882
ROGERS, FAIRMAN		Aug. 23, 1900
ROGERS, ROBERT E. *		Sept. 7, 1884
ROGERS, WM. A. *	1885	Mar. 1, 1898
ROGERS, WILLIAM B. *		May 30, 1882
ROOD, OGDEN N.	1885	Nov. 12, 1902
ROWLAND, HENRY A. *	1881	Apr. 16, 1901
RUTHERFORD, LEWIS M. *		May 30, 1892
SAXTON, JOSEPH *		Oct. 26, 1873
SCHOTT, CHARLES A.	1872	July 31, 1901
SELLERS, WILLIAM	1873	Jan. 24, 1905
SILLIMAN, BENJ., Sr. *		Nov. 24, 1864
SILLIMAN, BENJ., Jr.		Jan. 14, 1885
SMITH, J. LAWRENCE *	1872	Oct. 12, 1883
STIMPSON, WILLIAM *	1868	May 26, 1873
STRONG, THEODORE *		Feb. 1, 1869
SULLIVANT, W. S. *	1873	Apr. 30, 1882
TORREY, JOHN *		Mar. 10, 1873
TOTTEN, J. G. *		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

*Biographical notices have been presented of those designated by an asterisk.

DECEASED MEMBERS—Continued.

	Date of election.	Date of death.
WARREN, G. K. *	1876	Aug. 8, 1882
WATSON, JAMES C. *	1868	Nov. 23, 1880
WATSON, SERENO *	1889	Mar. 9, 1892
WINLOCK, JOSEPH *		June 11, 1875
WOODWARD, J. J. *	1873	Aug. 17, 1884
WORTHEN, A. H. *	1872	May 6, 1888
WYMAN, JEFFRIES *		Sept. 4, 1874

*Biographical notices have been presented of those designated by an asterisk.

DECEASED FOREIGN ASSOCIATES.

SIR WM. ROWAN HAMILTON.	THEODORE VON OPPOLZER.
KARL ERNST VON BAER.	G. R. KIRCHOFF.
HENRY MILNE-EDWARDS.	RUDBOLPH CLAUSIUS.
MICHAEL FARADAY.	JAMES P. JOULE.
L. ELIE DE BEAUMONT.	CARLOS IBANEZ.
SIR DAVID BREWSTER.	JEAN SERVAIS STAS.
G. A. A. PLANA.	ALPHONSE DE CANDOLLE.
F. W. A. ARGELANDER.	A. W. HOFMANN.
FRIEDRICH WÖHLER.	BARON H. VON HELMHOLTZ.
J. B. DUMAS.	K. F. W. LUDWIG.
J. B. J. D. BOUSSINGAULT.	LOUIS PASTEUR.
M. E. CHEVREUL.	AUGUST KEKULÉ.
MICHEL CHASLES.	EMIL DU BOIS REYMOND.
SIR GEORGE B. AIRY.	J. J. SYLVESTER.
J. C. ADAMS.	KARL WEIERSTRASS.
SIR RICHARD OWEN.	RUDBOLPH LEUCKART.
C. H. C. BURMEISTER.	C. F. RAMMELSBERG.
ARTHUR CAYLEY.	SOPHUS LIE.
T. H. HUXLEY.	ROBERT W. BUNSEN.
HUGO GYLDÉN.	J. L. F. BERTRAND.
F. F. TISSERAND.	HENRI DE LACAZE-DUTHIERS.
JULIUS VON SACHS.	ALFRED CORNU.
SIR RODERICK I. MURCHISON.	RUDBOLPH VON VIRCHOW.
VICTOR REGNAULT.	SIR GEORGE G. STOKES.
H. W. DOVE.	KARL GEGENBAUR.
C. A. F. PETERS.	KARL ALFRED RITTER VON ZITTEL.
JUSTUS VON LIEBIG.	E. J. MAREY.
ALEXANDER BRAUN.	OTTO VON STRUVE.
JOACHIM BARRANDE.	F. VON RICHTHOFFEN.
ADOLPHE WÜRTZ.	ALBERT VON KÖLLIKER.