ANNUAL REPORT

OF THE

BOARD OF REGENTS

OF THE

SMITHSONIAN INSTITUTION,

SHOWING

THE OPERATIONS, EXPENDITURES, AND CONDITION
OF THE INSTITUTION

FOR

THE YEAR 1883.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1885.

FORTY-EIGHTH CONGRESS, FIRST SESSION.

The following resolution was agreed to by the Senate June 10, 1884, and concurred in by the House of Representatives June 24, 1884:

Resolved by the Senate (the House of Representatives concurring therein), That the annual report of the Smithsonian Institution for the year 1883 be printed; and that there be printed sixteen thousand and sixty extra copies, of which three thousand shall be for the use of the Senate, six thousand and sixty for the use of the House of Representatives, and seven thousand copies for the use of the Smithsonian Institution.

LETTER

FROM THE

SECRETARY OF THE SMITHSONIAN INSTITUTION

ACCOMPANYING

The annual report of the Board of Regents of that Institution for the year 1883.

JUNE 24, 1884.—Ordered to be printed.

SMITHSONIAN INSTITUTION,
Washington, D. C., January 21, 1884.

SIR: In accordance with section 5593 of the Revised Statutes of the United States, I have the honor in behalf of the Board of Regents to submit to Congress the annual report of the operations, expenditures, and condition of the Smithsonian Institution for the year 1883.

I have the honor to be, very respectfully, your obedient servant,

SPENCER F. BAIRD,
Secretary Smithsonian Institution.

Hon. GEORGE F. EDMUNDS,
President of the United States Senate.

Hon. JOHN G. CARLISLE,
Speaker of the House of Representatives.

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION FOR THE YEAR 1883.

SUBJECTS.

1. Proceedings of the Board of Regents for the session of January, 1884.

2. Report of the Executive Committee, exhibiting the financial affairs of the Institution, including a statement of the Smithson fund, the receipts and expenditures for the year 1883, and the estimates for 1884.

Report of the same committee on the inauguration of the Henry statue.

3. Annual report of the Secretary, giving an account of the operations and condition of the Institution for the year 1883, with the statistics of collections, exchanges, &c.

4. General appendix, comprising a record of recent progress in the principal departments of science, and special memoirs, original and selected, of interest to collaborators and correspondents of the Institution, teachers, and others engaged in the promotion of knowledge.

CONTENTS.

REPORT OF THE SECRETARY.

GENERAL APPENDIX.

LIST OF ILLUSTRATIONS.

REGENTS OF THE SMITHSONIAN INSTITUTION.

By the organizing act approved August 10, 1846, Revised Statutes, title LXXIII, section 5580, "The business of the Institution shall be conducted at the city of Washington by a Board of Regents, named the Regents of the Smithsonian Institution, to be composed of the Vice-President, the Chief Justice of the United States [and the Governor of the District of Columbia], three members of the Senate, and three members of the House of Representatives, together with six other persons, other than members of Congress, two of whom shall be resident in the city of Washington, and the other four shall be inhabitants of some State, but no two of them of the same State."

REGENTS FOR THE YEAR 1883.

	Term expires.
The Vice-President of the United States:	
DAVID DAVIS (*pro tem.*)	Mar. 3, 1883
GEORGE F. EDMUNDS (elected March 3, 1883)	Mar. 3, 1885

The Chief Justice of the United States:
MORRISON R. WAITE.

United States Senators:	
GEORGE F. HOAR (from Feb. 21, 1881. Resigned Jan. 19, 1883)	Mar. 3, 1883
NATHANIEL P. HILL (from May 19, 1881)	Mar. 3, 1885
SAMUEL B. MAXEY (from May 19, 1881)	Mar. 3, 1887
GEORGE F. EDMUNDS (appointed Jan. 19, 1883. Resigned Feb. 21, 1883)	Mar. 3, 1885
JUSTIN S. MORRILL (appointed Feb. 21, 1883)	Mar. 3, 1885
Members of the House of Representatives:	
OTHO R. SINGLETON (appointed Jan. 7, 1884)	Dec. 23, 1885
WILLIAM L. WILSON (appointed Jan. 7, 1884)	Dec. 23, 1885
WILLIAM W. PHELPS (appointed Jan. 7, 1884)	Dec. 23, 1885
Citizens of Washington:	
PETER PARKER (first appointed in 1868)	Dec. 19, 1885
WILLIAM T. SHERMAN (first appointed in 1871)	Mar. 25, 1885
Citizens of a State:	
JOHN MACLEAN, of New Jersey (first appointed in 1868)	Dec. 19, 1885
ASA GRAY, of Massachusetts (first appointed in 1874)	Dec. 19, 1885
HENRY COPPÉE, of Pennsylvania (first appointed in 1874)	Dec. 19, 1885
NOAH PORTER, of Connecticut (appointed in 1878)	Jan. 26, 1884

MORRISON R. WAITE, Chancellor of the Institution and *President of the Board of Regents.*

JOURNAL OF PROCEEDINGS OF THE BOARD OF REGENTS OF THE SMITHSONIAN INSTITUTION.

WASHINGTON, D. C., *April* 19, 1883.

An adjourned meeting of the Board of Regents was held this day, at 4 o'clock p. m., to attend the ceremonies of unveiling the statue of Professor Henry.

At the conclusion of the ceremonies the Board adjourned *sine die.*

WASHINGTON, *January* 16, 1884.

In accordance with a resolution of the Board of Regents of the Smithsonian Institution fixing the time of the annual session on the third Wednesday in January of each year, the Board met to-day at 10 o'clock a. m.

Present: The Chancellor, Chief Justice MORRISON R. WAITE; the Acting Vice-President, Hon. GEORGE F. EDMUNDS; Hon. NATHANIEL P. HILL, Hon. SAMUEL B. MAXEY, Hon. JUSTIN S. MORRILL, Hon. OTHO R. SINGLETON, Hon. WILLIAM L. WILSON, Hon. WILLIAM W. PHELPS, Hon. PETER PARKER, General WILLIAM T. SHERMAN, Dr. ASA GRAY, Dr. HENRY COPPÉE, Dr. NOAH PORTER, and the Secretary, Professor BAIRD.

The Secretary stated that since the last meeting the following changes had taken place in the Board: Hon. G. F. Hoar had resigned as Regent, and Hon. G. F. Edmunds had been appointed by the President of the Senate to fill the vacancy. Mr. Edmunds had declined the appointment and Hon. J. S. Morrill had been appointed and accepted for the term ending March 3, 1885.

Hon. G. F. Edmunds having been elected President of the Senate became *ex-officio* Regent.

The Speaker of the House of Representatives (Mr. Carlisle) had appointed Hon. O. R. Singleton, Hon. W. L. Wilson, and Hon. W. W. Phelps as Regents for the Forty-eighth Congress, in place of Hon. N. C. Deering, Hon. E. B. Taylor, and Hon. S. S. Cox.

The journal of the Board was read and approved.

A letter from Rev. Dr. John Maclean was read, regretting that the condition of his health would not permit him to attend the meeting of the Board.

Dr. Parker presented the report of the Executive Committee, which was read by General Sherman.

On motion of Dr. Gray the following resolution was adopted:

"*Resolved*, That the report of the Executive Committee be accepted, and that the income for the year 1884 be appropriated for the service of the Institution upon the basis of the above report, to be expended by the Secretary, with full discretion as to the items, subject to the approval of the Executive Committee."

Dr. Parker, from the Executive Committee, presented a final report on the Henry statue.

On motion of Dr. Coppée it was resolved that the report of the Executive Committee on the Henry statue be printed as a part of the annual report of the Institution.

The Secretary presented the annual report of the operations of the Institution for the year 1883, which was read in part.

On motion of General Sherman it was resolved that the annual report of the Secretary be referred to the Executive Committee, with authority to transmit it to Congress.

Dr. Coppée called the attention of the Board to the subject of the publication of the scientific writings of Professor Henry, and suggested the propriety of providing that a part of the edition should be bound in library style, and much better than that of the "Henry Memorial" volume.

Dr. Gray suggested the importance of careful selection of the manuscripts of Professor Henry and judicious arrangement of the material, which might require two volumes, one for his published scientific papers, the other for miscellaneous writings, extracts from correspondence, &c.

The Secretary stated that nothing had yet been done in arranging the material for the work proposed, but copies had been made of a large number of Professor Henry's letters, to be carefully examined before printing. It would be edited by Mr. W. B. Taylor, of the Institution, a gentleman perfectly acquainted with Professor Henry's scientific work, and in every respect well qualified for the duty.

After some discussion as to the scope of the work, on motion of Mr. Edmunds it was—

"*Resolved*, That the publication of the writings of Professor Henry be supervised by a committee consisting of Dr. Gray, Hon. Mr. Wilson, and Professor Baird, to act in conjunction with Mr. W. B. Taylor, the editor assigned to that duty by the Secretary."

Senator Edmunds called attention to the phraseology of the act of Congress in regard to the appointment of an Acting Secretary in case of the death, disability, or absence of the Secretary, which he considered imperfectly adapted to provide for an emergency, and, on motion of Senator Maxey, it was—

"*Resolved*, That Senator Edmunds be requested to prepare an amendment to the act to be submitted to Congress."

On motion of Senator Maxey the Board then adjourned *sine die*.

REPORT OF THE EXECUTIVE COMMITTEE OF THE BOARD OF REGENTS OF THE SMITHSONIAN INSTITUTION FOR THE YEAR 1883.

The Executive Committee of the Board of Regents of the Smithsonian Institution respectfully submit the following report in relation to the funds of the Institution, the appropriations by Congress for the National Museum and other purposes, the receipts and expenditures for the Institution and the Museum for 1883, and the estimates for the year 1884.

Condition of the fund, January 1, 1884.

The bequest of James Smithson, deposited in the United States Treasury, act of Congress, August 10, 1846....	$515,169 00
Residuary legacy of Smithson, added to the fund in the United States Treasury, act of Congress, February 8, 1867	26,210 63
Addition to the fund from savings, &c., act of Congress, February 8, 1867	108,620 37
Addition to the fund by bequest of James Hamilton, of Pennsylvania, 1874....	1,000 00
Addition to the fund by bequest of Simeon Habel, of New York, 1880....	500 00
Addition to the fund by proceeds of sale of Virginia bonds, 1881	51,500 00
Total permanent Smithson fund in the United States Treasury (bearing 6 per cent. interest) January 1, 1884	$703,000 00

Statement of the receipts and expenditures of the Smithsonian Institution for the year 1883.

RECEIPTS.

Interest from the fund	$42,180 00
Balance cash on hand January 1, 1883....	29,637 45
Total receipts....	$71,817 45

EXPENDITURES.

Building:	
Repairs and improvements....	$935 15
Furniture and fixtures	556 09
General expenses:	
Meetings of the Board....	985 05
Lighting and heating....	38 51
Postage and telegraph....	319 06

Expenditures—Continued.

Stationery	$850 72
General printing, blanks, &c	266 45
Incidentals, ice, hauling, &c	520 21
Books and periodicals	1,747 60
Salaries and labor	15,773 67
Publications and researches:	
Smithsonian Contributions to Knowledge	3,047 24
Smithsonian Miscellaneous Collections	9,565 78
Smithsonian Annual Report	2,255 81
Explorations	2,799 47
Apparatus	50 10
Literary and scientific exchanges	6,192 34
Total expenditures	$45,903 25
Balance, January 1, 1884	$25,914 20

ESTIMATES FOR 1884.

The following are the estimates of receipts by the Institution for the year 1884, and of the appropriations required for carrying on its operations during the same period:

Receipts.

Interest on the permanent fund, receivable July 1, 1884, and January 1, 1885	$42,180 00

Expenditures.

For building and repairs	$1,500 00
For general expenses, including salaries	19,000 00
For publications and researches	12,000 00
For exchanges	7,000 00
For contingencies	2,680 00
Total	$42,180 00

NATIONAL MUSEUM, AND OTHER OBJECTS COMMITTED BY CONGRESS TO THE SMITHSONIAN INSTITUTION.

The following is a statement of the accounts of appropriations made by Congress for disbursement under the direction of the Smithsonian Institution:

PRESERVATION OF COLLECTIONS, NATIONAL MUSEUM.

Balance available January 1, 1883	$44,823 30
Appropriated for fiscal year ending June 30, 1884 ($96,000, $4,112.82)	100,112 82
	144,936 12

Expended in 1883, as per vouchers audited by the Treasury Department	$98,277 61
Balance January 1, 1884, (available for six months ending with fiscal year June 30, 1884)	46,658 51

ARMORY BUILDING.

Balance available January 1, 1883	$1,495 79
Appropriated for fiscal year ending June 30, 1884	2,500 00
	3,995 79
Expended in 1883, as per vouchers audited by the Treasury Department	2,470 29
Balance January 1, 1884 (available for six months ending June 30, 1884)	1,525 50

FURNITURE AND FIXTURES.

Balance available January 1, 1883	$31,182 12
Appropriated for fiscal year ending June 30, 1884	60,000 00
	91,182 12
Expended in 1883, as per vouchers audited by the Treasury Department	55,161 63
Balance January 1, 1884 (available for six months ending June 30, 1884)	36,020 49

NORTH AMERICAN ETHNOLOGY.

Balance available January 1, 1883	$20,440 44
Appropriated for fiscal year ending June 30, 1884	40,000 00
	60,440 44
Expended in 1883, as per vouchers audited by the Treasury Department	40,495 04
Balance January 1, 1884 (available for six months ending June 30, 1884)	19,945 40

INTERNATIONAL EXCHANGES.

Balance available January 1, 1883	$2,500 00
Appropriated for fiscal year ending June 30, 1884	7,500 00
	10,000 00
Expended in 1883, as per vouchers audited by the Treasury Department	6,500 00
Balance January 1, 1884 (available for six months ending June 30, 1884)	3,500 00

RECONSTRUCTION EASTERN PORTION SMITHSONIAN BUILDING.

Appropriated by act of Congress March 3, 1883	$50,000 00
Expended as per vouchers audited by the Treasury Department in 1883	37,322 86
Balance January 1, 1884	12,677 14

POLARIS REPORT.

Balance available of $8,000 appropriated by act of Congress, 1880	$1,918 90
Expended in 1883, as per vouchers audited by the Treasury Department	1,116 73
Balance January 1, 1884	802 17

CONCLUSION.

The Committee has examined 835 vouchers for payments made from the Smithson income during the year 1883, and 2,014 vouchers for payments made from appropriations by Congress for the National Museum, making a total of 2,849 vouchers. All these bear the approval of the Secretary of the Institution, and a certificate that the materials and services charged were applied to the purposes of the Institution or of the Museum.

The balances above given correspond with the certificates of the disbursing clerks of the Interior and Treasury Departments.

The quarterly accounts, the bank and check books and journals have been examined and found correct.

Respectfully submitted.

PETER PARKER,
W. T. SHERMAN,
Executive Committee.

WASHINGTON, *January* 16, 1884.

BRONZE STATUE OF JOSEPH HENRY.

ERECTED ON THE SMITHSONIAN GROUNDS BY AUTHORITY OF AN ACT OF CONGRESS APPROVED JUNE 1, 1880; AND UNVEILED APRIL 19, 1883.

REPORT OF THE EXECUTIVE COMMITTEE OF THE BOARD OF REGENTS ON THE HENRY STATUE.

To the Board of Regents of the Smithsonian Institution:

GENTLEMEN: An act of Congress (No. 71), approved by the President June 1, 1880, authorized "the Regents of the Smithsonîan Institution to contract with W. W. Story, sculptor, for a statue in bronze of JOSEPH HENRY, late Secretary of the Smithsónian Institution, to be erected upon the grounds of said Institution; and for this purpose, and for the entire expense of the foundation and pedestal of the monument, the sum of $15,000" was appropriated.

In accordance with the authority conferred in the above act, the Regents of the Institution executed a contract with Mr. Story on the 8th of December, 1880, for the statue. At Mr. Story's request a number of photographs of Professor Henry were sent to him to be used in preparing the model of the statue, and also a cast of the face and bust executed by Mr. Clark Mills, together with an academic gown similar to the one used by the professor when a member of the faculty of Princeton College. A contract was made with the Maine Red Granite Company and the Quincy Granite Polishing Works for a pedestal according to a design furnished by Mr. Story—the die of Red-Beach granite finely polished, octagonal in shape, 4 feet in diameter, 4 feet high, and the cap and bases of Quincy gray granite, fine-axed, the whole pedestal being 7 feet 3 inches in height. The statue itself is nine feet high.

Owing to certain imperfections found in the statue after it had been cast, it became necessary to reproduce it, and it was not until November, 1882, that it was actually completed and shipped from Rome. The statue was received in Washington in December, but, owing to the lateness of the season, it was decided to defer its erection until the following spring, and the date selected was the 19th of April, 1883, that being the time when the National Academy of Sciences (of which Professor Henry had been president at the time of his death) would hold its semi-annual meeting in Washington. For the site of the statue a triangular plot on the Smithsonian grounds, about 150 feet to the northwest of the building, was chosen by the Regents, and the selection met the full approval of Mr. Story, who visited Washington in the winter.

The Chancellor of the Institution was requested by the Regents to perform the ceremony of unveiling it.

Hon. Hiester Clymer was selected to deliver an address appropriate to the occasion, but on account of ill health declined the appointment, and President Noah Porter, of Yale College, one of the Regents, was invited by the Executive Committee to perform the service.

Rev. Dr. John Maclean and Rev. A. A. Hodge, of Princeton, N. J., were invited to offer prayer on the occasion. By reason of ill health, however, Dr. Maclean was prevented from attending.

The direction of the executive details of the occasion were assigned by Professor Baird to Mr. William J. Rhees, the chief clerk.

By direction of the Board of Regents, the following letter was addressed by Professor Baird, Secretary of the Institution, to the Hon. Speaker of the House of Representatives, January 17, 1883:

"SIR: I have the honor to inform the House of Representatives that in accordance with the act of Congress of June 1, 1880, providing that the Regents of the institution be 'authorized to contract with W. W. Story, sculptor, for a bronze statue of Joseph Henry, late Secretary of the Smithsonian Institution, to be erected in the grounds of said institution,' the statue has been executed and received in Washington, and that Thursday the 19th of April has been selected as the day for the public unveiling of the same.

"The Congress of the United States having ordered this statue and made the appropriation necessary therefor, the Board of Regents respectfully invite the Senate and House of Representatives to be present on the occasion of its formal presentation to the public.

"I am, sir, very respectfully, your obedient servant."

A joint resolution was passed by Congress, February 24, 1883, accepting the invitation to attend the inauguration of the statue.

"No. 16. Joint resolution accepting the invitation of the Regents of the Smithsonian Institution to attend the inauguration of the statue of Joseph Henry.

"Whereas, in a communication from Spencer F. Baird, Secretary of the Smithsonian Institution, Congress was informed that in accordance with an act of June first, eighteen hundred and eighty, the bronze statue of Joseph Henry, late Secretary of the Smithsonion Institution, had been completed; and whereas, in the same communication, Congress was respectfully invited to be present on the occasion of its formal presentation to the public, upon Thursday the nineteenth of April next; Therefore be it

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the said invitation be, and the same is hereby, accepted by the Senate and House of Representatives; and that the President of the Senate select seven members of that body, and the Speaker of the House of Representatives fifteen members of that body, to be present and represent the Congress of the United

States upon the occasion of the presentation and inauguration of said statue."

Approved February 24, 1883. (Statutes, volume XXII, page 659.)

The following gentlemen were selected as the joint committee to represent Congress:

Senators: Hon. George F. Hoar, of Massachusetts; Eli Saulsbury, of Delaware; Samuel J. R. McMillan, of Minnesota; Joseph R. Hawley, of Connecticut; William Mahone, of Virginia; Omar D. Conger, of Michigan; James B. Groome, of Maryland.

Members of the House of Representatives: Hon. John T. Wait, of Connecticut; William Aldrich, of Illinois; Thomas M. Browne, of Indiana; John A. Kasson, of Iowa; George M. Robeson, of New Jersey; John W. Candler, of Massachusetts; R. J. Walker, of Pennsylvania; A. H. Pettibone, of Tennessee; J. Proctor Knott, of Kentucky; J. Randolph Tucker, of Virginia; Andrew G. Curtin, of Pennsylvania; Randall L. Gibson, of Louisiana.

In accordance with the previous arrangements, the statue was unveiled on Thursday afternoon, April 19, 1883, at 4 o'clock. The day was clear, mild, and propitious, and about ten thousand people assembled to witness the ceremonies.

The invited guests met in the lecture hall of the National Museum, and proceeded to the platform which had been erected around the statue. General O. M. Poe acted as chief marshal, and Messrs. Daniel Leech, John D. McChesney, and George S. Hobbs as assistant marshals.

The following order of arrangement was adopted:

The President of the United States;* the Chief Justice of the United States, Chancellor of the Institution; the orator of the day, President Noah Porter, LL.D., of Yale College; the chaplain of the day, Rev. A. A. Hodge, D. D.; the family of Professor Henry.

The establishment of the Smithsonian Institution, viz, the Vice-President, Secretary of State, Secretary of the Treasury, Secretary of War, Secretary of the Navy, Secretary of the Interior, Postmaster-General, Attorney-General, Commissioner of Patents.

The Regents and Secretary of the Smithsonian Institution, and Ex-Regents; the Joint Committee of the Senate and House of Representatives, appointed to represent Congress; the Diplomatic Corps; the Associate Justices of the Supreme Court of the United States; Judges of United States Courts; Claims Commissions; Judges of the Supreme Court of the District of Columbia; Senators and Members of the House of Representatives; Commissioners of the District of Columbia; the General and Officers of the Army; the Admiral and Officers of the Navy; Ex-Members of the Cabinet and Ex-Ministers of the United States; National Academy of Sciences; Founders of the Henry trust fund for Science; the Commissioner of Agriculture; the Assistant Secretaries of

* The President was absent from the city at the time.

Departments; Solicitor-General and Assistant Attorneys-General; the United States Marshal and Officers of courts; the Light-House Board; the Heads of Bureaus; the Superintendent of the Coast Survey, the Superintendent of the Naval Observatory, the Superintendent of the Nautical Almanac, the Director of the Geological Survey, the Librarian of Congress; the Commissioner of Public Buildings, the Architect of the Capitol, the Superintendent of the Government Printing Office, the Superintendent of the Botanical Gardens, the Visitors of the Government Hospital for the Insane; officers of the Senate and House of Representatives; Trustees of the Corcoran Gallery of Art; the Washington Monument Society; officers and employés of the Smithsonian Institution, Bureau of Ethnology, National Museum, and United States Fish Commission; Alumni of the College of New Jersey; members of scientific organizations, &c.

While this procession was moving from the hall in the Museum building to the platform at the statue, the Marine Band, furnished through the courtesy of Hon. William E. Chandler, Secretary of the Navy, and of Colonel McCawley, Commandant of the Marine Corps, played a grand march, "*Transit of Venus*," composed by J. P. Sousa, the leader of the band.

The following was the order of exercises:

I. MUSIC—Marine Band (J. P. Sousa, conductor), "The Hallelujah Chorus" (Messiah), *Händel.*

II. PRAYER—Rev. A. A. HODGE, D. D., of Princeton, N. J.

III. ADDRESS—Chief Justice WAITE, Chancellor of the Institution.

IV. UNVEILING THE STATUE.

V. MUSIC (Philharmonic Society and full Marine Band, R. C. Bernays, conductor)—Grand chorus, "The Heavens are Telling" (Creation), *Haydn.*

VI. ORATION—Rev. DR. NOAH PORTER, President of Yale College.

VII. MUSIC (J. P. Sousa, conductor)—Grand March Triumphale, "Schiller," *Meyerbeer.*

The Philharmonic Society was assisted by members of the Washington Operatic Association, the Rossini and Church Choir Choral Societies, the Washington Sangerbund and Germania Mannerchor. The arrangements for the music were made by a Committee of the Philharmonic Society, of which Prof. F. Widdows was chairman. The Chief of Police furnished a detail for the grounds; Mr. Edward Clark, Architect of the Capitol, supplied music stands and stools for the Marine Band; the Quartermaster's Department lent flags, and the Department of Agriculture living plants for decorating the platform. Mr. W. R. Smith, Superintendent of the Botanic Gardens, also furnished floral decorations.

The platform was constructed under the superintendence of Mr. C. W. Schuerman and Mr. G. W. Field, and the mechanical arrangements for unveiling the statue were devised by Mr. Joseph Palmer. At the moment of unveiling the statue the news was telegraphed from an instrument on the platform, which had been placed there by Mr. L. Whitney, the Superintendent of the Western Union Telegraph Company. The ushers on the platform were Messrs. W. C. Lewis, Harry C. Shuster, Henry D. Finckel, William T. Wyman, Edward C. Bryan, Frank Bryan, William B. Stimpson, and Ellis Lammond; Mr. Henry Horan, Superintendent of the National Museum, having general charge of the accommodations of the public.

Respectfully submitted.

PETER PARKER,
W. T. SHERMAN,
Executive Committee.

WASHINGTON, *December* 15, 1883.

PRAYER

BY

REV. DR. HODGE.

Eternal and almighty God, Creator, Preserver, and Governor of the world, we have gathered here to adore Thy holy name, to implore Thy divine protection, and to invoke Thy blessing.

We bless Thee that, having brought the physical universe to its present perfection and made it the vehicle of reflecting and expressing Thy transcendent perfections, Thou hast made man in Thine own likeness and endowed him with intelligence, capable of discerning and of interpreting the intellectual basis of all phenomena, the personal element in all law. We bless Thee that Thou hast never left Thyself without a witness even in the darkest period of human history; that wherever men have sought the Lord, however feebly, if haply they might feel after Him and find Him, He has been found always to be not far from any one of us, seeing that He is imminent in all existence and in all life, and that in Him we live and move and have our being.

We bless Thee that Thou hast sent through the ages a long line of inspired prophets and teachers, crowned by the incarnation in human flesh of Thy co-equal Son, to reveal in ever-increasing fullness the nature of Thy moral government, the method of Thy redemption, and the glory of Thy kingdom; so Thou hast in these later days sent into the physical universe many intelligent and earnest students, who, in various departments, are investigating the secrets of nature, and interpreting the methods of Thy sublime working throughout the vast areas of time and space. We bless Thee that Thou art gathering to Thyself so vast and rich and constant a revenue of glory through the loving ministry of science in all her various provinces. We thank Thee that so many of her princes have been loyal to Thy service and have rejoiced to make all men to realize the depth of the riches both of the wisdom and of the knowledge of God.

Especially we thank Thee for the spotless example of Thy servant, whose illustrious career is to be commemorated throughout all time by the monument we are now unveiling. We bless Thee that he was as humble and simple in his Christian faith as he was great in his intellectual achievements or pre-eminent in his world-wide fame. We pray Thee that his memory as a Christian philosopher may be preserved in imperishable freshness and force through succeeding generations, that his influence for good may be ever extended, and that his example may be followed as his serene fame excites the emulation of multitudes of the interpreters of nature and of the teachers and benefactors of mankind.

And now, in anticipation of the general judgment, when in the resurrection the perfected Church shall enter the new heavens and the new earth of the perfected physical universe, we ascribe unto Thee, at once the Lord of nature and of grace, blessing and glory, and wisdom, and thanksgiving, and honor, and power, and might, unto our God that sitteth upon the throne, and unto the Lamb, for ever and ever. Amen.

ADDRESS

OF

CHIEF JUSTICE WAITE.

On the 1st of June, 1880, at the instance of Mr. Morrill, of Vermont, in the Senate, and of Mr. Clymer, of Pennsylvania, in the House of Representatives, Congress authorized the Regents of the Smithsonian Institution to contract with Mr. W. W. Story "for a statue, in bronze, of Joseph Henry, late Secretary of the Smithsonian Institution, to be erected on the grounds of the Institution"; and the Regents, availing themselves of the presence in Washington of the members of the National Academy of Sciences, with which Professor Henry was so prominently and so honorably connected for many years, have asked you here to-day to witness the presentation to the public of the result of what has been done under this authority.

On the 10th of August, 1846, Congress established the Smithsonian Institution, to take the property which had been given to the United States by the will of James Smithson, of England, to found an establishment of that name "for the increase and diffusion of knowledge among men."

The business of the Institution was to be managed by a Board of Regents, and they were required to elect some suitable person as Secretary of the Institution. On the 3d of December, 1846, the Board met to perform that duty, and before entering on the election adopted the following resolution:

"*Resolved*, That it is essential for the advancement of the proper interests of the trust that the Secretary of the Smithsonian Institution be a man possessing weight of character and a high grade of talent; and that it is further desirable that he possess eminent scientific and general acquirements; that he be a man capable of advancing science and promoting letters by original research and effort, well qualified to act as a respected channel of communication between the Institution and scientific and literary individuals and societies in this and foreign countries; and, in a word, a man worthy to represent before the world of science and letters the Institution over which this Board presides."

Immediately after the adoption of this resolution the Board proceeded to the election, and the first ballot resulted in the choice of Professor Henry, then occupying the chair of natural philosophy in Princeton College. Experience has shown that the world possessed no better man for such a place. He was all the resolution required, and more; and from the day of his election until now, the wish has never been expressed that another had been chosen in his stead.

He accepted the appointment on the 7th of December, and on the next day, the 8th, finished and sent to the Regents an elaborate paper giving his views of the will of Smithson, and presenting a plan for the organization of the Institution. He entered on the performance of his duties on the 21st of December, and from that day until his death. on the 13th of May, 1878, almost one-third of a century, he was engaged in making the Smithsonian Institution what its munificent founder desired it to be—an active and efficient instrument for the increase and diffusion of knowledge.

The statue which will now be unveiled has been erected by the United States as a token of gratitude for the labors of his useful life, and for his faithful administration of the important public trust so long in his keeping.

ORATION

BY

PRESIDENT NOAH PORTER.

We are assembled to complete the long series of public honors to the late Joseph Henry by unveiling the statue which has been erected to his memory. These honors have been manifold, but each one of them has been well deserved and most cordially bestowed.

His funeral obsequies were attended by the President of the United States and other officials of the Government which he had so faithfully served, by representatives from the many learned and scientific societies of which he had been a conspicuous member and ornament, and by a large following of those who honored and mourned him as a friend.

Subsequently a more formal commemoration of his scientific and public services was held at the Capitol, at which were present the Executive of the nation, the Judiciary, the Senate, and the House of Representatives. On this occasion a discriminating and sympathizing sketch of his personal and public life was given by one who had known him long and was singularly qualified to do him justice in every particular. This was followed by other warm and eloquent tributes to his genius as a philosopher and his excellence as a man. Memorable among these were the ringing words of the noble Rogers, whose own sudden euthanasia was like the translation of a prophet; and the warm-hearted eulogy of the generous and glowing Garfield, whose noble life was slowly wasted that it might measure the intensity of the nation's grief.

Many, if not all, of the institutions of the country with which Professor Henry had a more or less intimate connection have also honored him by records and estimates of his services to science, education, and philosophy. The tributes to his honor from other countries have also been cordial and numerous.

Last of all, the two Houses of Congress, with the approval of the President, have ordered that a statue in bronze should be erected within the grounds of the Institution, which was the creation of his genius and industry, as a permanent memorial of his services and his worth. This statue is now completed, and has this moment been unveiled to public view. We are here to receive the first impressions of this enduring monument, which we trust will stand for many generations, to declare the fame and attest the manifold excellences of this eminent servant of science and benefactor of the American people.

The proprieties of the occasion forbid that I should recite the events of Professor Henry's life or attempt a critical judgment of his services or his merits as a philosopher. To do either were superfluous, in view of the accuracy and fullness with which both have been done by others. All that I shall aim to do is to give a summary expression to that estimate of the man and his work which I am confident other generations will accept, and which this statue is designed to suggest and perpetuate.

It is pleasant for us to notice that Professor Henry was born on the eve of this century, so memorable for the development of the sciences of nature and their splendid applications to art; that just as this new era was opening, the wonders of the physical universe were beginning to be explored by the wondering eyes of our infant philosopher. They were wondering eyes indeed, wakeful, sensitive, and responsive from the first. It is a mistake to suppose, because Professor Henry's external circumstances were unfavorable to the early discipline of books and the school, that his mind was ever crass and inactive. His own testimony and that of his friends is positive that from the first he was a sensitive and dreamy boy, who found enough in the common earth and air, and the play of common scenes to stimulate his creative powers and to furnish material for his long day dreams, as he lay on the sunny hillside and looked up into the glowing sky. Against the animalism and sensuality which are incident to an aimless youth he was defended by the stern moralities and the wholesome religion of his domestic training, enforced as these were by the economies of a straitened but not ignoble household. Indeed, the household was far removed from either. Were we curious in these matters we should find that he was born of gentle blood, being of Celtic stock on the mother's side, running back through many generations to a noble house, and preserving its coat of arms and motto, "I fear no one, I despise no one," which this noble descendant never dishonored. His mother was beautiful and refined and full of spirit, who had a home in Albany, and but little else, when her husband died, the son being then seven years of age. Before this event he had been removed to the country, the mother's original home, the family retaining their house in Albany as their principal reliance. In this village young Henry was the pet for several years, handsome, frolicsome, and venturesome on the one hand, and dreamy, wondering, and self-reliant on the other, rejoicing in adventure rather than in books, till a romance suddenly falling in his way kindled his imagination, and unveiled human life as pictured by the fancy with prismatic hues—awakening thus a brief passion for fiction and the drama. The transition to the acted drama was natural to his inventive and energetic nature, and for a time he delighted to attend dramatic representations when at Albany for longer or shorter periods, and to reproduce them at home, as his changing life led him from one occupation to another. If we connect these well-known facts with what he himself has written of the elements and order of education, we conclude that his early musings and questionings, his boyish sports and adventures, were fondly remembered by him as the inspiration of his rational and scientific life. "The cultivation of the imagination," he writes, "should be considered an essential part of a liberal education, and this may be spread over the whole course of instruction, for, like the reasoning faculties, the imagination may continue to improve until late in life." "Memory, imitation, imagination, and the faculty of forming mental habits exist in early life, while the judgment and reasoning faculties are of slow growth." "The order of nature is that of art before science, the entire concrete first and the entire abstract last." These are wise and weighty words, but they are of special interest when we bethink ourselves that the writer, when he penned them, was doubtless all the while thinking of a dreaming boy, half buried in the grass, looking up wistfully into the sky, thinking wondrous thoughts too deep for tears, perhaps peopling with phantoms and fairies that world of nature which he subsequently penetrated by those wise questionings and ingenious theories which his sagacious experiments turned into solid verities. He certainly could have been thinking of no one else when in the same connection he so positively affirms, "The future character of a child, and that of a man also, is in most cases formed probably before the age of seven years."

From these musings he was awakened in his later boyhood suddenly and abruptly, as by a call from nature herself. During a week of indisposition, perhaps of serious reflection over an aimless and possibly a tempted life, he was suddenly aroused by the consciousness that the common phenomena of nature are the products of forces acting under laws, and that it is possible for man to interpret these mysteries. It was a simple sentence or two from a common-place though useful book, but the thought in that sentence kindled a fire in the mind prepared for a flame which was never extinguished. This thought held his attention; it took possession of his memory; it quickened the imagination already glowing with romances of another sort; it decided his life. These words had been read and recited by thousands of boys before, but to this boy they were spirit and life. They became a fire in his bones, and proved the intellectual energy which had been slumbering within, by the force of the reaction which they aroused. So definite was the impression which they made, and so fervent and serious the resolve which they called into life, that he promptly summoned his companions, that he might solemnly announce to them his purpose henceforth to dedicate himself to a priesthood of love and service at the altar of science. To prepare for this service was no holiday work. His novitiate involved labor and self-denial. He must earn the means which would buy not only books and leisure and tuition, but also food and clothing. How these difficulties were surmounted it is needless to recite. The story is more or less familiar to you all.

It is important to notice that this work of preparation was neither hasty nor superficial. He did not rush with reckless impetuosity within the temple, nor leap with a bound to the footsteps of the altar. He mastered the geometry, without which Plato admitted no man even to the vestibule of science. He became familiar with the Calculus, as the magic spell by which to interpret her inner mysteries. Experiments with that wondrous chemistry which was then at its most brilliant stage of promise and performance fascinated and quickened his imagination and his intellect. Each forward step was taken in orderly succession, though each single step was the stride of a giant.

At the age of twenty-eight we find him a professor in the Albany Academy, of which he had been a graduate, charged with the work of teaching several hours every day, and tasking himself with burning zeal over every possible inquiry in chemistry and physics. As we have said already, it was in the brilliant dawn of modern chemistry. As this new science steadily rose above the horizon, one new discovery after another flashed its light toward the zenith and indicated its upward path of triumph. In its train appeared those new and mysterious agencies which were then just beginning to fix the attention and to task the analysis of the oldest and the newest discoverer. To these novel phenomena the young Professor Henry devoted his special attention, and soon astonished the world by achievements which first awakened the excitement of bewildered wonder, to convert it into the homage of amazed conviction. There was nothing to be said when, as the plunger went down into its bath, the impotent bar of iron became possessed of a giant's strength, and could pick up and hold a weight of more than a solid ton, and as the same plunger was lifted this gigantic energy vanished as at the word of an enchanter. The speaker well remembers the excitement which this discovery occasioned when the first experiment was tried at Yale college, in presence of a few spectators who casually met at the call of Professor Silliman, who was glowing with animation and delight. The ponderous platform was loaded with pig-iron and other heavy weights, with a few slight additions of living freight. Among the last was the speaker, being the lightest of all, and therefore convenient to serve on the sliding scale. It is more than fifty years ago, but the scene is as vivid as the events of yesterday. The question went around, "Who is Professor Henry, and how did it happen that nature revealed to him one of her choicest secrets?" Thoughtful men asked, "What is this wondrous Protean force which he was the first to follow in its sinuous hiding places and evoke by a magician's wand; and what are its relations to its kindred agents, and, above all, to the matter about us, which we can measure and weigh and see and handle?" Others asked the still more important question, "How came the discoverer to surmise its mysterious capacities and to penetrate to the laws of its action?" To some it seemed but a successful guess by a daring adventurer, a happy hit by a rude fumbler among nature's tools, a lucky accident, like the drawing of a prize in a lottery. It was not so with those who retraced the successive steps of close observation, of sagacious interpretation, of boundless invention, of ingenious construction, of patient trial, of loving sympathy, which preceded this single achievement, and all of which combined lifted at once this youth, hitherto unknown, into the rank of the most eminent discoverers, brilliant as was their company then and since. This achievement was not solitary. It was quickly followed by others almost as fruitful as the parent discovery. Conspicuous among these were the possible and certain application of the electro-magnetic power to distant communication, by the alternate lifting and dropping of the armature, moving as a lever, when conjoined with the indefinite linear extension and multiplied intensification of the subtile and enormous agency. Herein was discovered the scientific secret and the assured prophecy of telegraph and telephone, with their wonders of written language and audible speech.

From Albany, in the year 1832, Professor Henry was transferred to Princeton, through the wise sagacity of our honored associate, Rev. President John Maclean, and the generous and cordial recommendations of some of the most honored leaders of American science. The step was a bold one, and might seem almost rash, to transfer to a college a man who had himself lacked the breadth of early culture and the discipline and acquisitions of scientific thought which the college curriculum is supposed to give. His insight into nature's secrets might seem to be magical; but for this very reason could he share these secrets with his pupils? Would not the very swiftness of his own processes of thought disqualify him from imparting them to others? Would not the lightning rapidity with which, as a discoverer, he had leaped from indication to theory, and combined probabilities into evidence, hinder him from discerning that there were any steps in the process or any articulation in the proofs? Whatever misgivings of this sort there might have been—and the failures of many eminent scientists have proved that they were not without reason—were all set aside by his acknowledged skill as an instructor at Albany and his pre-eminent success at Princeton. Not only did he give himself to instruction with exemplary zeal and painstaking, but he studied the theory of teaching as he studied electromagnetism, by reflecting upon its conditions and laws, and using wise experiments in concrete applications. He did more. He used his special studies as examples of general philosophical inquiry, whatever might be the subject-matter, and sought by means of these to introduce his pupils to the theory of inductive research and the nature of scientific evidence, however these should be applied. This was a subject which he had ever at heart—the discipline of the mind to a true philosophic method, as the best preparation and security for sound science, clear insight, strong convictions, and practical wisdom. But he was none the less but rather the more active and enterprising in his favorite studies, a living and inspiring example of scientific ardor, of wakeful enterprise, and unceasing experimentation. It would seem as though every thunder storm brought him a new opportunity; every gale of wind swept into his mind some new freightage of thought; every apartment proposed or solved some problem in acoustics; every morning dawn waked him for some fresh experiment, and every evening shut down the day with some new acquisition. His very house was made an enormous electric accumulator and conductor of electric energy. In all these varied avocations it was not in that he was busy or many-sided that his marked superiority was seen, but in that he was original, wide-minded, and persevering. His insight seemed to penetrate at a glance into the secrets of nature, and his capacity for sagacious hypothesis almost to call into being the forces which it uncovered and to impose the laws which it interpreted. Besides this there was a largeness and originality in his experiments which invested him with the authority of priest and magician in the presence of nature. In all combined there was the strength and simplicity of scientific genius.

This active and fruitful life continued for fourteen years, when, at the age of forty-eight, in the year 1846, he was called to Washington as the first Secretary of the Smithsonian Institution.

At first it might seem that a situation like this would be attractive to any man, but on second thought many reasons would suggest themselves why, to a man like Professor Henry, interested as he was in teaching, devoted to research, and with the scientific world watching eagerly his experiments, the attractions of the place should be scanty and feeble. It is only when we learn how he regarded the possibilities and demands of the place, and his own capacity and purpose to meet them, that we can explain the readiness with which he responded to this call. The Secretary was to initiate and control the policy of a novel institution, with a handsome but not extravagant endowment given to the United States, for the increase and diffusion of knowledge among men. Loosely interpreted, the terms of the gift might admit any application of popular usefulness. But when read in the light of the known tastes of the giver and the previous bequest of his estate to a society which was severely scientific in its functions, and especially when interpreted by the eminent need and certain usefulness of a special application, it became clear to Professor Henry that this gift should be used exclusively in the interests of the increase and diffusion of *scientific knowledge*. He foresaw and foretold that his theory would at first encounter active dissent and opposition. He was equally confident that it would finally become popular and attractive. Before he entered upon his duties the Institution had been partially committed to another policy. It was not till after eight years of discussion and reports in committees and in both houses of Congress, in which some of the ablest and most brilliant members were conspicuous, that the policy of Professor Henry at last prevailed, and has ever since justified itself to the approval of the nation. It was not because Professor Henry despised literature that he did not favor the attempt to found a splendid library, for few men were more sensitive to its charms or appreciative of its power. Much less that he did not understand the value of a museum to an ardent interest in which he was pledged by his fondness for natural history and his curious zeal in ethnology and archæology, but because he saw a need and opportunity for an institution that should be limited to the increase and diffusion of scientific knowledge. *Finis coronat opus.* The experiment has justified the theory. Not only have the workings of the Smithsonian Institution vindicated the wisdom of his anticipations, but it is itself a monument to his strong convictions and unyielding tenacity, tempered as these were by singular simplicity, patience, and unselfishness. Had it not been for these characteristics the Smithsonian Institution as we know it would never have existed at all. Were it not for the modesty of the man we could hear this statue speak as it surveys the scene of his life-work, *Si monumentum quæris, circumspice.* More than this should be said. Every one of the great interests which were at first loaded upon the Institution, as the National Library, the Museum, and a collection of Art, has in the end been better provided for and attained a more vigorous growth or a more hopeful promise than had Professor Henry's policy failed. Had he relaxed from his tenacity, or had a man of less commanding influence represented his opinions, these separate interests might have foundered with the central bureau, or had the Smithsonian Institution survived, it might have been what it seems to many a casual visitor—merely a show place to stimulate and gratify an aimless curiosity, or in which to pass an idle hour of gazing and wonder—instead of being what it is, a busy working place, where research is devised, directed, stimulated, and rewarded, at which its results are reported and thence diffused through the countless nerve centers which animate and build the complicated organism which maintains the scientific life of the civilized world. In this organism this Institution holds a place and performs a function which has no exact counterpart. It is a function which is specially needed in a young and growing country like our own, so vast in its spaces, so comprehensive in its geology, so varied in its climate, so ample in its physical resources, so fascinating in its archæology, so mysterious in its ethnology, so instructive in its history—all the parts of which are connected by political bonds with its capital, and respond with a more or less ready sympathy to the pulses of life which throb at the Nation's heart. It was no slight service which Professor Henry rendered to his country as well as to the world when he gave character and efficiency to this new agency in the life of both.

To mature and carry into effect the conception of such an institution, with no model after which to copy, was the work of a master mind and was worthy of a devoted and laborious life. That Professor Henry gave to this work the best activities of more than thirty years no man will doubt; that he was unwearied in his labors and cares, faithful to the minutest details and energetic in administration, is confessed by all men. His official correspondence would have been burdensome had it been merely a correspondence of routine, but much of it involved profound reflection, productive invention, and the skillful enforcement of principles. Into all these services he entered with a spirit which was conscientious and patient in the extreme.

It would not have been surprising if his scientific ardor had thereby been cooled, his invention had been limited, and his many-sidedness had been curtailed. This does not seem to have been true. From the beginning to the end of these more than thirty years he was almost as inventive, ingenious, alert, and wide-minded as when he achieved the triumphs of his earliest manhood. Though many of his discoveries and inventions were in the line of his official responsibilities, they all bore the stamp of scientific genius. During all this period, it should be remembered, the sciences of nature were making a progress such as the world had never witnessed before—progress in every form, from the severest mathematical analysis, through the ever ascending steps of adventurous speculation, up to the most gorgeous cloud-lands of theory. Experiment, too, had never made such daring ventures, whether in the form of applications to art or the determination of problems purely scientific. With every one of these onward movements, whether of theory or experiment, Professor Henry was in active sympathy. In many of the most important he was the leader of thought and act, as witness his place in the very earliest anticipations of the doctrine of the correlation of force; his prophetic experiments and suggestions in respect to the use of the telegraph in meteorological observations and the reports of astronomical discovery; his devices to render available the reports and essays scattered over the scientific world by a systematized bibliography; his long-continued researches in respect to light and sound which were incidental to his official experiments as a member of the Light-House Board; his comprehensive experiments in respect to the sustaining capacity of building stone; and his never-ceasing study of acoustics in every possible production, prolongation, and disturbance of sound, whether in his own parlor, in solitary walks, in fog or sunshine, or in travel by land or sea.

It was, as I have said, a great thing for science and for the country, that in this formative and fermenting period such a man resided at the capital and represented the interests of science by his official connection with this one national institution which was sacredly devoted to scientific research and information. He had foreseen and foretold from the first that Washington would certainly become a great center of scientific activity; that it must inevitably be the residence and resort of an increasing number of men of scientific tastes and pursuits. He had this in mind from the first, and uttered it as a prophecy, before his own policy in respect to the Smithsonian Institution had been accepted, and long before the signs had multiplied of its speedy fulfillment.

This fulfillment was indeed conditional on the continuance of the nation's integrity and the perpetuation of its united life. There were times when this seemed doubtful, when from the Capitol itself, and even from this Institution below it, there might almost be descried the threatening lines and fortifications of those who would not scruple to sacrifice both to the impetuous necessity of what was called lawful war. During these years of agitating strife it was but the dictate of a well-poised self-command which kept Professor Henry quietly at his work, with no doubtful loyalty indeed, but in such singleness of aim, that when peace was conquered it found no personal bitterness towards himself in the ranks of scientific men. To his philosophic wisdom and his unquestioned integrity it may, in part, be owing that, after the centennial anniversary of 1876, the nation was so ready to enlarge the appliances of science and at the same time to commemorate its own continued life by erecting upon these grounds, under the care of the Smithsonian Institution, the splendid National Museum, which all delight to visit and to praise.

The fact cannot be disguised that the devotees of science have alienations and strifes of their own, sometimes arising from personal jealousies and more frequently from opposing theories. Professor Henry was lifted above all personal partisanship by the severe singleness with which he devoted himself to his scientific and official activities. He never sought for place or honor, directly or indirectly. He was fastidiously sensitive in respect to the appropriation of his own inventions by the production of a patent or a claim for extra compensation. His salary was notoriously smaller than he might have earned in other posts, but he never either deserted his post, or asked for increase of pay. Indeed the last was declined more than once when suggested by his friends. It was only when his truthfulness was questioned in respect to one of the most important of his discoveries, that he vindicated his claims to scientific confidence. Whoever might be jealous of his fellow scientists, no one could question Henry's even-handed justice or his personal uprightness.

In the wars of theory against theory he was recognized as an upright mediator, who thoroughly understood the criteria by which scientific truth can be established and would impartially apply them. If political or ethical or theological traditions seemed to conflict with established scientific principles or facts, he calmly awaited the issue and insisted that science must have its rights whatever might be the consequences to any received ethical or theological interpretations. Though his own faith was fixed and fervent in respect to the leading Christian verities, he scorned with all the energy of scientific integrity to apply these convictions as a test to any question that was properly scientific. It would have been strange if a man who was always learning something new had not modified his views of objective and practical Christian truth with the progress of his mind and his manhood, but he would never acknowledge any base compromise of sentimentalism or mysticism or one-eyed dogmatism with the processes or conclusions of his scientific thinking. Within the domain of science proper he was a clear-eyed, impersonal, and uncompromising arbiter and judge. Theorists might complain, dogmatists might rage, zealots might bemoan, but not one of them would dare accuse the judge of an ignorant or partisan decision.

The multitude of fancied inventors, discoverers, and projectors who came to him for help and encouragement, the crowd of scientific dreamers who craved a favorable decision or official help or patronage, the scores and hundreds whom he was forced to reject and disappoint often of the hopes and dreams of their lives, these all felt that however mistaken he might be, he was upright and kind so far as he knew. They were always patiently listened to and gently dismissed, though they did not always heed his benediction to *go in peace.*

For all these high and varied functions, in his high position, Professor Henry had one supreme advantage, in that he had not only studied and mastered so many of the sciences of nature, but that he made science itself in its principles and processes the subject of his profoundest reflection. We have abundant evidence that from the time when he made his earliest discoveries his mind was not content to search after the secrets of nature without, but was equally curious to discover the secret of the processes by which man interprets the forces and laws which nature hides with such studious reserve. From the time when he began at Albany till the end of his life this was prominently and avowedly the theme of his constant meditation. In making this a study he was not singular among eminent scientists, but only in that from the beginning to the end this seemed to haunt him as the most wonderful problem of all. This habit forced him to contemplate all the sciences of nature as an organic whole, having intimate relations that are broader and deeper than those which are limited to any single class of phenomena. It forced him to study and question most closely the process of knowledge, the sublimest and most fundamental phenomenon in nature, that he might know how far to trust its products and by what criteria to test its conclusions. We find evidence of this habit of mind in the questions which he suggests in his earlier essays and in the partial solutions which he gives in his miscellaneous writings. Such a habit would insensibly train him to exalt the human intellect in its higher functions, with its principles and laws, its axioms and intuitions, its theories and anticipations, its forecasting questionings, its creative hypotheses, its tentative theories, and its decisive experiments, and to assure himself that an agent or agency such as this could have no affinity with matter and own no allegiance to physical laws. Even in the suggestion that the thinking agency which interprets the universe by authoritative question and answer, could once have slumbered in a fiery cloud or could have been evolved from any material mind-stuff, by any series of physical processes, however daintily phrased, seems never to have been entertained by him for an instant as having the semblance of scientific probability. And yet there is abundant evidence from his writings, both early and late, that he was in no sense behind the times or ignorant of the fascinating plausibilities of the newest and the most fantastic of theories. While he was almost the earliest in the field to formulate and defend the doctrine of the correlation of force and to concede that it may be applied to all the processes that are properly physiological, he was equally sharp and positive in the assertion that the mental agencies of every kind cannot be the correlate of any physical or biological agency. He insisted with equal positiveness that the so-called vital force cannot be the product of any mechanical or chemical activity, single or in combination, but must be a directive and constructive agent of itself. Later in life he recognized the manifold indications of the presence of a law of progressive variation in the history of animal and vegetable life, and so far accepted evolution as a working hypothesis. But had he been asked at any time whether evolution as a force or evolution as a law, one or both, apart or together, could explain the origin of life and of living men, of intellect and will and the capacity for science and faith in science, I think he would have regarded the question somewhat as though he had been asked whether he believed in the vortices of Descartes or in Kepler's directing angels. Had this doctrine been defended in a scientific association, either in the soaring gyrations of winged speech or the dry assertions of dogmatic positiveness, I am confident he would have remanded its champions at once to the blackboard, and have begged them first to explain whether evolution were an agent, a force, or a law, and then desired them to identify it if it were an agent, to define it if it were a force, or to formulate it if it were a law. Large as was the sphere which he assigned to the imagination, and important as the role which he allowed to hypotheses, he would bring every theory, however brilliant and plausible, to the triple test of coherence, sufficiency, and experiment.

Forward and hopeful as he had been all his life long to follow the fruitful suggestions of analogy, he never would allow this winged steed to cross the chasms of scientific theory with any flying leaps, without insisting that it should first fold and pack its pinions, and then carefully retrace its steps along that hard pathway of fact and law which alone can carry us safely from a scientific hypothesis to a scientific truth. The science of America owes somewhat to his example and authority in this regard, that its brilliant promises and solid achievements have been so far kept free from the speculative audacities and the physiological cosmogonies from which the science of England and Germany has not been wholly exempt.

This, be it observed, was his position within the domains of pure science. For the region beyond, whether it is called the domain of philosophy or the domain of faith, let it suffice to say that he had too positive a respect for his own mind to doubt for an instant that this intellect was the reflex of that supreme intellect which sustains and controls the universe which the scientist interprets. The existence of a personal God was accepted by him as a well nigh self-evident truth which is as necessary to our confidence in scientific study as to our hopes for man's social and moral well being. The moral and spiritual capacities and destiny of man were regarded by him as dominant facts and chief ends in the universe made up of matter and spirit, facts and ends so important and so pressing as to create the need and establish the truth of the Christian's faith and hope. He believed moreover in no inherent law of progress in human nature or human society as such. On the contrary he asserted often that our supreme hope of such progress, even in scientific culture and achievement, must rest on moral integrity and culture as the supreme conditions. In his closing address to the National Academy he urged "that moral integrity is essential to conscientious fidelity in scientific research," and added, "Indeed, I think that immorality and great mental power 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." To the Philosophical Society of Washington he had designed to give, as probably his last formal communication, an address upon the relations of science and religion, and also upon the true import of prayer. This he was not permitted to do, but those who knew him best knew most fully that in prayer he found constant delight and strength. Almost the last lines which he penned contain a positive and tender yet rational confession of his Christian faith. Almost the last words which he uttered were with tearful eyes and from quivering lips, "Upon Jesus Christ as the one who, for God, affiliates himself with man—upon Him I rest my faith and my hope."

Such a man was Joseph Henry. With eminent truth may we say of him, as Wordsworth wrote of Milton:

Thy soul was like a star, and dwelt apart;
  Thou hadst a voice whose sound was like the sea,
  Pure as the naked heavens, majestic, free;
  So didst thou travel on life's common way,
In cheerful godliness; and yet thy heart
  The lowliest duties on itself did lay.

For more than fifty years, the most memorable and critical which the sciences of nature have ever seen, he has been indeed a guiding star to their devotees in all this land, ever shining with a serene yet commanding light. During the critical years of its young and buoyant life, American science has found much of the guidance and inspiration which it needed in his childlike yet kingly spirit. And now as it rejoices in the security of its position and its ever-increasing honors, it is most fitting that its assembled representatives should here gratefully acknowledge their obligations to their eminent benefactor and distinguished leader, and cordially welcome this statue, which by its commanding proportions gives new dignity to the ground so long honored by his presence and associated with his name. Long may it stand to express to them and to other generations the sturdy self-confidence, the keen insight, the benignant spirit, the soaring yet docile genius, the self-relying yet devout temper which made JOSEPH HENRY a leader and commander in their conquering hosts. And as here by day and by night, in sunshine and in storm, our honored friend shall ever as in his lifetime keep watch and guard over the scene of his cares and labors, of his conflicts and triumphs, so may his memory be kept in fresh and grateful recollection by the coming generations. And as this Institution, so eminently the creation of his mind, shall become more and more busy in its activities and more and more conspicuous in its usefulness and its fame, may the spirit of its eminent originator continue to inspire its aims and direct its counsels—to the strength and glory of this nation and the well-being of man.

To the well-being of man. For let us never forget that science knows no nationality, least of all in this place and in this Institution, which was the gift from the mother to the daughter land, whose sacred trust and solemn duty has ever been, as it ever should be, to promote "*the increase and diffusion of knowledge among men.*"

THE SMITHSONIAN INSTITUTION.

MEMBERS EX OFFICIO OF THE "ESTABLISHMENT."

(January 1, 1884.)

CHESTER A. ARTHUR, President of the United States.
GEORGE F. EDMUNDS, President *pro tempore* of the United States Senate.
MORRISON R. WAITE, Chief Justice of the United States.
FREDERICK T. FRELINGHUYSEN, Secretary of State.
CHARLES J. FOLGER, Secretary of the Treasury.
ROBERT T. LINCOLN, Secretary of War.
WILLIAM E. CHANDLER, Secretary of the Navy.
W. Q. GRESHAM, Postmaster-General.
HENRY M. TELLER, Secretary of the Interior.
BENJAMIN H. BREWSTER, Attorney-General.
B. BUTTERWORTH, Commissioner of Patents.

REGENTS OF THE INSTITUTION.

(January, 1884.)

MORRISON R. WAITE, Chief Justice of the United States, *President of the Board.*
GEORGE F. EDMUNDS, President *pro tempore* of the United States Senate.
NATHANIEL P. HILL, member of the Senate of the United States.
SAMUEL B. MAXEY, member of the Senate of the United States.
J. S. MORRILL, member of the Senate of the United States.
O. R. SINGLETON, member of the House of Representatives.
W. L. WILSON, member of the House of Representatives.
W. W. PHELPS, member of the House of Representatives.
JOHN MACLEAN, citizen of New Jersey.
PETER PARKER, citizen of Washington, D. C.
ASA GRAY, citizen of Massachusetts.
HENRY COPPÉE, citizen of Pennsylvania.
WILLIAM T. SHERMAN, citizen of Washington, D. C.
NOAH PORTER, citizen of Connecticut.

Executive Committee of the Board of Regents.

PETER PARKER. JOHN MACLEAN. WILLIAM T. SHERMAN.

OFFICERS OF THE INSTITUTION.

(January 1, 1884.)

SPENCER F. BAIRD, *Secretary, Director of the Institution.*
WILLIAM J. RHEES, *Chief Clerk.*
DANIEL LEECH, *Corresponding Clerk.*

REPORT OF PROFESSOR BAIRD,

SECRETARY OF THE SMITHSONIAN INSTITUTION, FOR 1883.

To the Board of Regents of the Smithsonian Institution:

GENTLEMEN: I have the honor to present herewith the annual report of the operations and condition of the Smithsonian Institution for the year 1883.

This, in accordance with the usual custom, will include an account of the work performed by the Smithsonian Institution proper, and also that by the branches of the public service placed by Congress under its charge, namely, the National Museum and the Bureau of Ethnology. To this will be added a sketch of the work of the United States Fish Commission, which is also under my charge.

THE SMITHSONIAN INSTITUTION.

INTRODUCTORY.

The principal points of interest to be considered in more or less detail, apart from an account of the regular routine work, are the arrival and inauguration of the memorial statue of Professor Henry, the reconstruction in a fire-proof manner of the eastern end of the Smithsonian building, and the use, under the authority of the Regents, of the halls of the National Museum by the National Academy of Sciences and the American Pharmaceutical Association.

The general progress of the Institution and its dependencies has been very satisfactory. The funds are in good condition, those of the year being sufficient to meet all its liabilities. The publications of the Institution and of the National Museum have been much larger than usual, and constitute an important contribution to theoretical and practical science. The labors of the Bureau of International Exchanges have been more extensive than ever; the additions to the library have been of unusual magnitude; while in no year of the history of the Institution, with perhaps the single exception of the Centennial year, have the collections received by the National Museum been more varied and important.

THE HENRY STATUE.

I am gratified to announce the completion and erection of the statue of Prof. Joseph Henry, ordered by Congress in June, 1880.

Mr. Story, the artist, visited Washington last winter, and fully approved the site for the statue which had been selected by the Executive Committee of the Board of Regents.

It was deemed appropriate to have the ceremonies of unveiling performed at the time when the National Academy of Sciences held its annual meeting in this city, and April 19 was accordingly chosen. The day was propitious, the attendance of distinguished men of science and an audience of ten thousand persons very gratifying, and the ceremonies in every respect were successful and satisfactory.

The following was the order of exercises:

I. MUSIC—Marine Band, J. P. Sousa, conductor, "The Hallelujah Chorus." (Messiah.) *Händel.*

II. PRAYER—Rev. A. A. Hodge, D. D., of Princeton, N. J.

III. ADDRESS—Chief Justice Waite, Chancellor of the Institution.

IV. UNVEILING THE STATUE.

V. MUSIC—(Philharmonic Society and full Marine Band, R. C. Bernays, conductor.) Grand chorus, "The Heavens are Telling." (Creation.) *Haydn.*

VI. ORATION—Rev. Dr. Noah Porter, President of Yale College.

VII. MUSIC—J. P. Sousa, conductor. Grand march triumphale, "Schiller." *Meyerbeer.*

A full report by the Executive Committee in relation to the statue, with the addresses delivered on the occasion of its unveiling, accompanies the proceedings of the Board of Regents.

It is proper to remark that the execution of the statue by Mr. Story has added to the high reputation of that eminent artist, and gives satisfaction to the family of Professor Henry, to his former friends and associates, and to the public, and contributes a notable addition to the works of art which adorn the capital of the nation.

SCIENTIFIC WRITINGS OF PROFESSOR HENRY.

The Board of Regents having at its last meeting instructed the Secretary to collect and publish the scientific papers of Professor Henry, several assistants have been employed in collecting the material for this work, and a large amount of manuscript has been prepared to be carefully examined and edited for the press.

It is proposed to reprint *verbatim* all the contributions made by Professor Henry to the Transactions of the Albany Institute, the Reports of the Regents of the University of New York, the Edinburgh Journal of Science, Silliman's American Journal of Science, the Journal of the Royal Institution of Great Britain, the Transactions of the American Philosophical Society, the Journal of the Franklin Institute, the Princeton Review, the Smithsonian Reports, the Agricultural Reports, the Proceedings of the American Association for the Advancement of Science, the Proceedings of the American Association for the Advancement of Education, the Proceedings of the American Academy of Arts and Sciences, Appleton's Cyclopedia, the Bulletins of the Philosophical Society of Washington, the Reports of the Light-House Board, Johnson's Cyclopedia, the Proceedings of the National Academy of Sciences, etc.

Besides these published papers, others in manuscript and extracts from his extensive correspondence will be collected, the whole forming one or more volumes of the series of "Miscellaneous Collections."

The printing will probably be commenced during the present year, and it is hoped that the work will be ready for distribution at the next meeting of the Board.

THE BOARD OF REGENTS.

The annual meeting of the Board was held on the 17th of January last, and a special meeting on the 19th of April, for the purpose of attending the ceremonies of dedication of the Henry statue.

The resignation of Senator Hoar, of Massachusetts, as a member of the Board of Regents, was followed by the appointment of Senator Edmunds, of Vermont, in his place. That gentleman, however, declining to serve, Senator Justin S. Morrill was appointed to fill the vacancy.

The terms of office of the members of the Board from the House of Representatives, Messrs. Deering, Cox, and Taylor, having expired with the termination of the Forty-seventh Congress, new appointments have been made by Hon. J. G. Carlisle, Speaker of the House, for the term of the Forty-eighth Congress, viz: Hon. O. R. Singleton, of Mississippi; Hon. William L. Wilson, of West Virginia; Hon. William Walter Phelps, of New Jersey.

Provision for Acting Secretary of the Smithsonian Institution.—In the original law establishing the Smithsonian Institution the only officer recognized was the Secretary, and no action was valid excepting as performed directly by him. In the event, therefore, of his death or disability, the operations of the Institution would be greatly embarrassed, if they did not stop altogether; and it was for this reason that, on the death of Professor Henry, in May, 1878, his successor was appointed almost immediately. To provide for this contingency a bill was introduced by Senator Hamlin, shortly after Professor Henry's death, and was, on January 24, 1879, enacted into a law, providing that "in the case of the death, resignation, sickness, or absence of the Secretary of the Smithsonian Institution, the Chancellor thereof shall be, and he is hereby, authorized to appoint some person as Acting Secretary, who for the time being shall be clothed with all the powers and duties which by law are devolved upon the Secretary, and he shall hold said position until an election of Secretary shall be duly made, or until the Secretary shall be restored to his health, or, if absent, shall return and enter upon the duties of his office."

No appointment has been made under this provision until the present year. The Chancellor expecting to make a long trip in the West, requiring several months for its completion, and involving an interruption of mail or telegraphic communication of possibly a week or more at a time, it was thought desirable that a provisional appointment of Acting Secretary should be made in readiness for any emergency that might arise. I therefore nominated for the position Mr. William J. Rhees, the chief clerk of the Institution, who, more than any one else, is conversant with its working and policy, and he was accordingly so designated by the Chancellor.

FINANCES.

Nothing unusual has occurred in the financial affairs of the Institution. The principal of the fund remains the same as at the last annual report, namely, $703,000, on which the interest at 6 per cent. is paid by the Treasurer of the United States on the 1st of each January and July.

The appropriation by Congress for the international exchange system was increased last year from $5,000 to $7,500, half of which was available in 1883.

The balance of the Smithsonian income on the 1st of January, 1884, is $25,914.20, which will be required for carrying on the operations of the establishment until the 1st of July next.

BUILDINGS.

Smithsonian Building.—In the last report an urgent plea was presented for measures to secure the removal of the old combustible and decayed wood-work of the interior of the eastern portion of the Smithsonian building and the substitution of fire-proof materials. The Regents having directed the Secretary to memorialize Congress on the subject, the facts in the case and the arguments in favor of the measure were presented by him. The result, I am happy to state, was the appropriation of $50,000 "for fire-proofing the eastern portion of the Smithsonian Institution."

The preparation of plans, the details of construction, and architectural requirements were placed in charge of Messrs. Cluss and Schulze.

Advertisements of proposals for the work to be done were inserted in the newspapers, and the bids were opened on the 26th of April, 1883. The removal of the contents of the building was soon effected, the offices of clerks and others were transferred to the large hall on the first floor of the main building, and accommodation for storage provided by the erection of a temporary wooden shed on the south of the Institution.

The following contracts were awarded:

Description.	Contractors' names.	Amount.
Carpentry	Thomas Norwood	$4,699 00
Brick-work	John M. Lloyd	10,500 00
Iron roof and floor beams	C. A. Schneider's Sons	8,219 00
Cut stone	Rees Evans	5,157 00
Iron ceiling	Phœnix Iron Company	892 00
Water and sewer pipes	E. A. Ridgway	828 00
Skylights	A. E. Rendle	134 20
Turret skylight	O. L. Wolfsteiner	150 00
Gas piping	E. A. Ridgway	450 00
Clock pipes	Wenzel Pneumatic Clock Company	156 00
Iron stairs	George White & Co	948 00
Plastering	James Hughes	1,532 00
Slate roofing	C. J. Fanning	454 00

The work has progressed satisfactorily and without interruption, and the building will be ready for occupancy in a few weeks.

The appropriation was found sufficient to secure the fire-proofing of the building, but a number of other desirable objects remain to be secured, such as a heating apparatus, a passenger elevator, a freight lift; the introduction of speaking tubes, electric bells, telephones; a concrete floor in the basement, an underground communication between the Smithsonian and the new Museum buildings, &c., for which an additional appropriation of $15,000 has been asked.

As the whole interior of the eastern end of the Smithsonian building, including both range and wing, was to be torn out, it of course became necessary to provide accommodations elsewhere for the officers and employés, and as already stated the lower museum hall of the center building was made use of for this purpose. The table cases in the alcoves were removed elsewhere, and the spaces fitted up for the purposes in question. The Regents' room was re-occupied by the librarian, and my own offices were established in the northwest pavilion of the Museum building.

The greatest difficulty was experienced in properly providing for the archives and the books and packages in storage. This matter was, however, ultimately arranged, and with much less inconvenience to the current work of the Institution than might be reasonably expected. It is hoped that by the 1st of April, 1884, a portion, at least, of the reconstructed part of the building can be occupied.

The principal work of repair in the main building has been the renewal of the water-closets on the lower floors of the northeastern tower of the central edifice, the old ones having become unfit for use. Connections were prepared for closets on the upper stories of the reconstructed portion, should they be considered necessary.

The west basement was provided with wire screens, dividing the room into two apartments—one for the storage of bird skins, and the other for alcoholic specimens of fishes.

National Museum Building.—This building continues to preserve the reputation it has acquired as representing the maximum of convenience and adaptation to its purposes with the minimum of original cost and expense for repairs. The principal expenditure during the year for the latter object has been made in the tinting of the walls, mending of broken glass, occasional slight repairs to the plumbing, &c.

Some of the down-spouts carrying off the water from the roofs were frozen up and burst during the cold of the past winter, causing leaks in the walls, which have all been duly repaired.

Ever since the completion of the Museum building there has been more or less trouble in regard to the drainage, especially on the western side, where the rain or melting snow banks up against the building and soaking down enters the basement rooms, and produces very serious inconvenience. Several temporary arrangements were made to obviate this evil, but as these were not satisfactory, Colonel Rockwell, the Superintendent of Public Buildings and Grounds, very kindly undertook the work as a part of the general improvement of the Smithsonian reservation, which is in his charge. A trench was dug, and the water carried northward instead of discharging into an already overtaxed sewer on the south side of the building. No trouble has been experienced since the work was completed, and it is hoped that there will be none at any time in the future.

Armory Building.—This edifice has been used during the past year mainly for the purposes of the United States Fish Commission. The lower story has been converted into a fish-propagating establishment, for the hatching of shad, salmon, and other food-fishes; and as a storehouse from which to distribute carp, black bass, &c. The second floor is devoted to a series of offices, laboratories, and rooms for the messengers connected with the fish distribution service. The third floor is used as a depot for supplies and materials, and the fourth story as a storage room. A large shed has been built on the Armory grounds for the deposit of the collections from the International Exhibition at Philadelphia.

The entire reservation belonging to the Armory has been inclosed by a high and substantial fence, and the interior space concreted, with the exception of two oval spaces, in which it is proposed to construct ponds for holding carp and other fish while awaiting distribution to distant points of the country.

In these grounds are also two tracks connecting with the Baltimore and Potomac Railway system, and capable of holding four passenger cars or six freight cars. This is a very great convenience both to the Fish Commission and to the Smithsonian Institution, as, apart from the facility for distributing fish, it makes it possible to load and unload cars containing collections relating to the National Museum or to the Smithsonian Institution. The entire shipment of articles for the London Exhibition, filling some fifteen cars, was put on board directly from the Armory yard, the boxes and packages being carried over by the wagon of the Institution and loaded directly in place, thus greatly facilitating the work.

In a similar manner the cars containing the return exhibits were brought into the yard and the contents transferred either to the storage shed adjacent or brought over to the National Museum.

Natural History Workshop.—This building continues to be used as a workshop for the modeling of plaster and *papier-maché* casts of specimens and for the photographic service of the Geological Survey.

The work of taxidermy has been removed in part to a temporary wooden structure on the grounds east of the Museum. The necessity for providing suitable work rooms for the taxidermists has become very great, and in connection with this, provision for the storage of alcoholic collections and for the packing and unpacking of boxes of specimens is urgently required. I have therefore submitted an estimate to Congress for an appropriation of $10,000 "for the erection of a fire-proof brick storage building east of the National Museum, for receiving, unpacking, assorting, and storing the natural history collections of the Government, to replace the wooden structures now used for the purpose."

Necessity for an additional Museum Building.—No better illustration can be had of the increase in the collections of the National Museum than the fact that an additional building is urgently required for their proper accommodation, as explained in the last report (1882).

In 1875 the collections then in charge of the Smithsonian Institution were comfortably accommodated within the limits of the Smithsonian building, in rooms having an aggregate area of 30,000 square feet. They consisted principally of specimens of natural history and ethnology; confined almost entirely to North America, with the exception of objects of Polynesian manufacture, forming part of the Wilkes collection.

In 1875 an appropriation was made by Congress to enable the Smithsonian Institution and the Fish Commission to prepare an exhibit of objects illustrating the resources of the United States, as derived from the animal and mineral kingdoms, and, with the assistance of a special appropriation to the Indian Bureau, of a collection of North American anthropology. A large sum of money was expended in the preparation of this exhibit, which was forwarded to Philadelphia in 1876, and constituted a part of the Government display which attracted much attention.

At the close of the Philadelphia Exhibition very large donations were made to the United States by foreign countries, including both the official commissioners and individual exhibitors. Many objects of much interest were contributed on the same occasion from American displays. These collections, filling some fifty freight cars, were brought to Washington, and were stored for a time in the Armory building, assigned by Congress for their reception.

After several fruitless efforts an appropriation of $250,000 was obtained for the purpose of putting up an inexpensive edifice for the storage of these articles, and their transfer was begun in the autumn of 1881, but little more than two years ago.

Since then large numbers of collections of very great importance have come to hand, chief among them being the gatherings of the United States Geological Survey, and of the Ethnological Bureau, made on a scale of unexampled magnitude, and well befitting the operations of a nation like the United States. The many scientific explorations, made either separately by the Smithsonian Institution, or conjointly with the United States Signal Service or other Bureaus or bodies, the work of the Fish Commission, and the enormous aggregate of many smaller collections, have tended largely to increase the material to be provided for.

In addition to this, the exhibition by the United States, at London, of illustrations of its fisheries, (the freight bulk of which amounted to not less than 24,000 cubic feet, and consisting, in very large part, of new objects and articles, obtained at the expense of the appropriations of Congress for that purpose,) must also be provided for; as also the very valuable and extensive collections in mineralogy, geology, and metallurgy made by the American Institute of Mining Engineers, and presented to the United States, but stored in Philadelphia, awaiting an appropriation for its transfer.

It may be stated in brief, therefore, that, at the present time, the vast building, finished scarcely more than two years ago, is now filled to overflowing; while there is additional material enough on hand belonging to the Government to occupy fully half of a second building of the same size, and with a probability that the entire space will be required before the construction can be accomplished, even supposing that it is begun at the earliest possible time.

The Smithsonian Institution has always acted in hearty co-operation with the affiliated scientific branches of the Government even where no official relationship existed, this being notably the case in regard to the United States Geological Survey. This important Bureau, in the rapid increase of its work, has been greatly hampered by want of the necessary accommodations; and it was with much gratification that the Institution proffered a share of the new building to the Director, Major Powell, for the accommodation of his collections, and for the office and laboratory work. It was, however, unable to do as much as was desirable, owing to the inadequacy of quarters for the purpose.

Should an appropriation be made for the new building, for which the Board authorized application to Congress, it is intended to share it with the Geological Survey so that it may have all the facilities required for its important work.

It will be remembered that Congress in the act of 1846 set aside for the use of the Smithsonian Institution 20 acres in the southwest corner of the square bounded by Seventh and Twelfth streets, and north and south B streets, the center of the Smithsonian building being exactly in the middle of the square. It was in the southeast quarter of this reservation that the new Museum building was erected, forming a very unsymmetrical annex to the original Smithsonian building. It is now proposed to take the southwest corner of the reservation for the new edifice, which, when completed, will be essentially of the general character of the present Museum building, and will restore the proper architectural balance.

Congress has now been asked to make an appropriation for one wing of this new building to be specially fitted for the use of the officers and laboratories of the National Museum and of the Geological Survey; and, if the amount can be obtained at the present session, occupation of the building can be assured within eighteen months from the commencement of operations. The vacating of the rooms now occupied by the Geological Survey will also furnish much-needed accommodation to the Museum; possibly enough until the remainder of the building can be provided for. The proposed wing, however, will be complete in itself, architecturally, and will not involve any addition for its proper harmonious effect.

MEETINGS OF SCIENTIFIC BODIES.

On the 17th of April the annual meeting of the National Academy of Sciences was held in the hall of the National Museum, and, in accordance with the authority granted by the Executive Committee, the same room was also used by the American Pharmaceutical Association. The meeting of this body, which lasted several days, was attended by a large number of delegates, who found in the building all the accommodations necessary for their purpose. A large floor space was vacated temporarily and filled by the extensive collections brought for exhibition on the occasion, and in many instances the Institution was able to supply empty cases, constituting a great convenience to the exhibitors.

The collections of materia medica belonging to the Museum were greatly appreciated, and it was resolved that the collections of the National Museum should be considered as under the special patronage of the association, and that all new preparations devised by members of the association should be deposited therein.

Similar action was taken by the Association of Wholesale Druggists, which met in New York later in the year; so that the collections of the Museum are likely to receive great benefit.

The "Saturday lectures," under the auspices of the Anthropological and Biological Societies of Washington, were continued during the winter of 1882–'83. The following is a list of the lectures delivered:

On rivers. Capt. Clarence E. Dutton, U. S. A. January 13.

The races of men. Prof. Otis T. Mason. January 20.

Mountains and mountaineers of the Caucasus. Mr. George Kennan. January 27.

Mesmerism in animals (with experiments). Dr. D. Webster Prentiss. February 3.

Mythical animals. Prof. Theodore Gill. February 10.

Germs and epidemics. Dr. John S. Billings, U. S. A. February 17.

The plant life of the globe, past and present. Prof. Lester F. Ward. February 24.

Pearls and pearl fisheries. Mr. William H. Dall. March 3.

Indian mythology. Maj. J. W. Powell. March 10.

Adaptation and interdependence between plants and insects. Prof. C. V. Riley. March 17.

The teachings of paleontology. Prof. C. A. White. March 24.

Human proportion in art and anthropometry. Dr. Robert Fletcher, U. S. A. March 31.

Dr. D. W. Prentiss, of Washington, delivered, by invitation, a course of lectures in connection with the department of Materia Medica of the National Museum. The lectures were illustrated by specimens and other material from the collections selected for that purpose by Dr. Flint, curator of the department of Materia Medica. The following was the programme:

LECTURE I.—*Introductory:* Remarks upon the general plan of the National Museum. Description of the Materia Medica department; its high value for the purpose of study. Classification and arrangement.

LECTURE II.—*On the classification of medicinal forms:* Illustrated by specimens. Exhibition of microscopical sections.

LECTURE III.—*Opium:* Its value as a medicine. Cultivation and statistics of consumption. In legitimate medicine. In patent medicines. In opium habit. Exhibition of specimens.

LECTURE IV.—*Cinchona:* Natural history and sources. Native forests. Cultivation. Artificial quinine. Alkaloids. Exhibition of specimens.

LECTURE V.—*Vegetable cathartics:* Rhubarb, aloes, senna, manna, colocynth, elaterium. Exhibition of specimens.

LECTURE VI.—*Vegetable cathartics:* Jalap, scammony, gamboge, croton oil, podophyllum. Exhibition of specimens.

LECTURE VII.—*Vegetable astringents:* Tannic acid, gallic acid, nutgalls, catechu, kino, krameria, logwood. Exhibition of specimens.

LECTURE VIII.—*Animal products used in medicine:* Cantharis (Spanish fly), coccus cacti (cochineal), castoreum (castor), moschus (musk), fel tauri (ox bile), ichthyocolla (isinglass). Exhibition of specimens.

On the completion of the lectures by Dr. Prentiss, a number of persons who profited by the occasion addressed a formal letter of thanks to the Institution.

The annual address of Major Powell, the retiring president of the Philosophic Society of Washington, to which the members of the Anthropological and Biological Societies were invited, was held in the lecture-room of the Museum on the 8th day of December. On this occasion the room was lighted by the Brush-Swan storage-battery system, supplied by the dynamo machine lent to the Institution indefinitely by the Brush Company, of Cleveland. Several exhibitions of this light had previously been made in the lecture-room under the direction of Mr. A. A. Hayes, and the plant was left in the room for any subsequent demand that might be made upon it.

The Biological Society has held regular fortnightly meetings in the Museum lecture-room.

On the 26th and 27th of February an exhibition was held of the collections about to be sent to the Fisheries Exhibition in London, which attracted large crowds of interested spectators.

ROUTINE WORK OF THE INSTITUTION.

Administration.—No change of importance has taken place in the *personnel* of the Institution during the year, and all of the several divisions have discharged their functions satisfactorily. The usual increase in the magnitude of the work has, however, been strongly marked, and this, in connection with the inconvenient accommodations referred to above, has naturally taxed the abilities of all concerned to the utmost.

Correspondence.—The work in this department—steadily increasing—is not marked by any special departures from its accustomed range. The number of visionary projects and of novel or ancient scientific speculations presented and urged for publication has rendered necessary the following circular, to accompany the letter of reply:

"This Institution being in frequent receipt of communications announcing discoveries or theories supposed by the writers to be both new and important, it should be stated that owing to the number of such papers the usual course is to refer them to one or more specialists in the particular subject discussed, and to communicate briefly by letter to the authors the results of such examination. This may sometimes involve a delay of several weeks before the expected answer is returned.

"In order to correct a very common misapprehension, it is proper to state that the Institution has not offered any standing prizes for the solution of difficult problems or for the discovery of new scientific principles. The proper course for those who wish to obtain pecuniary advantage from their supposed contributions to knowledge is to make some practical application thereof, for which they may secure a patent from the United States Patent Office. It may also be remarked that a rule adopted by the Board of Regents forbids the Secretary or his assistants giving, for personal benefit, an official opinion as to the merits or demerits of inventions or other projects."

EXPLORATIONS.

A very important part of the work of the Smithsonian Institution, representing no inconsiderable portion of its expenditures, consists in the prosecution of explorations having for their principal object the gathering of material illustrating the natural history and the physics of the regions involved.

The hearty co-operation of the Signal Office and of other branches of the Government, and the associated work of the Ethnological Bureau, during the year have greatly increased the amount of research in this direction, and it may safely be claimed that in no year in the history of the Institution has more been accomplished. The actual expenditures on the part of the Institution have amounted to $2,733.35, no inconsiderable portion of the entire income, the largest amount expended in any one direction being about $600, and from that down to very small amounts. The results, however, are, in most cases, of a magnitude far out of proportion to the cost.

A special report will be made by Mr. Goode, Assistant Director of the Museum, upon the collections as such; my duty here being to present the historical part of the subject, and to give the history and places of operation of the more important expeditions. In doing this, as heretofore, I take up the subject by regions, commencing with the circumpolar area of North America.

Labrador and Newfoundland.—In the report for 1882 reference was made to the establishment at Fort Chimo, in Ungava Bay, Northern Labrador, of an observing station by the United States Signal Office, and of the detail of Mr. Lucien M. Turner, for many years in the service of that Bureau. As on previous occasions, Mr. Turner was furnished by the Institution with all the materials necessary to make collections and observations in natural history; this, of course, in addition to what was done for him by the Signal Office in connection with the more important object of his mission, namely, the observation of meteorological and physical phenomena.

As in many cases heretofore, the Hudson's Bay Company extended a hearty co-operation, in the first place, by authorizing the sending of Mr. Turner to one of its posts, and then by taking him to destination on its vessel and caring for him on his arrival. Embarking at Montreal on a schooner, Mr. Turner was transferred at Rigolet to the steamer, and reached his place of destination in due season. Some collections made by him on the way were received in Washington in the latter part of that year. Since then, advices from Mr. Turner to date of September 8, 1883, show that he has been very successful in his work, has made continued and uninterrupted observations in climatology, and has also collected very largely of objects of natural history and ethnology. These were sent home by him by the Hudson's Bay Company's vessels to London, where they were transshipped in bond and forwarded to New York, coming from London by the Monarch Line of steamers without any charges, in accordance with the courtesy of that company mentioned in another part of this report.

Twenty-seven boxes and casks have been received from Mr. Turner, containing rich treasure of birds and eggs, mammals, and marine animals, and many interesting specimens of ethnology.

Mr. Turner will probably return from his post of duty in the summer of 1884, which will give him an additional season of research.

This portion of Northern Labrador has for many years been a region of great interest to the naturalist and ethnologist; and Mr. Turner's experience as a collector and observer will undoubtedly enable us to solve, for the most part, the principal problems in regard to it.

Mr. Turner has also made arrangements to obtain specimens from Eastern Labrador, especially at Rigolet, Nain, Ovac, &c.

In connection with the researches of Mr. Turner in Northern Labrador, it may be stated that the Institution, in return for the many favors rendered by the Hudson's Bay Company in that connection, offered to present to it a series of his collections, to be sent to such point as it might designate. Professor Dawson, of McGill College, of Montreal, asked the company to indicate the Redpath Museum, of which he was the director, as the repository in question. This was assented to, and the Institution has promised that the collection shall be forwarded as soon as the expedition is completed and the materials can be suitably overhauled.

Dr. C. Hart Merriam, of Locust Grove, N. Y., one of the most accomplished of the young school of American naturalists, has been very much interested in questions of the specific relationships and the natural history of the American seals, and, for the purpose of studying this group of animals, left his home February 21, 1883, and proceeded by rail to Halifax, whence, sailing per steamship *Newfoundland*, he reached Saint John's, Newfoundland, on the night of March 2, after passing through nearly 500 miles of "pan-ice." Through the courtesy of J. & W. Stewart, and the kindness of their manager, John Syme, esq., he was accorded the rare privilege of visiting the seal fishery as a guest upon their fine steamship *Proteus*, Capt. Richard Pike, master. At 6 o'clock on the morning of the 10th of March the *Proteus* left, and encountered a belt of heavy drift-ice near the island of Baccalieu, remaining beset in the proper field-ice at 11 p. m. the same day. From that time until the return no open water was seen excepting in narrow leads and ice-holes, her progress being exceedingly slow, and she was often nipped, and several times jammed in the heavy ice.

Seals were first met with in numbers on the 18th, in latitude 52° 42′ N. They were the large hooded or bladder-nose seal (*Cystophora cristata*), and no less than a thousand were killed and hauled aboard that day. When not beset, the steamer was among the "hoods" the greater part of the time till the 29th, when the cargo was completed, every available space having been filled with skins and fat. Returning in a storm, during which the vessel, thus heavily laden, narrowly escaped being swamped, the party re-entered the harbor of Saint John's on the 1st of April. This trip was one of the quickest and most successful on record, the skins and fat of 42 harp seals and 14,623 hooded seals, weighing gross 686½ tons, being deposited in the company's factory.

The results of this expedition, from a scientific point of view, were particularly gratifying, the specimens obtained being of extreme rarity both in the museums of this country and in those of Europe. They consisted of the skins and skulls of 7 harp seals (*Phoca grœnlandica*), and 112 hooded seals (chiefly skulls) of both sexes and all ages. In addition to these, Dr. Merriam had the good fortune to procure a full grown fœtus of the square flipper seal (*Erignathus barbatus*), which is supposed to be unique.

Whatever of value may attach to these specimens is insignificant by comparison with the importance of the very extended notes Dr. Merriam was enabled to make concerning the breeding habits of the hooded seal, and upon the structure and nature of their peculiar inflatible proboscis or "hood," which is wrongly figured and described in all the published accounts.

Greenland.—Previous reports make mention of the expectation of interesting collections in natural history and ethnology on the part of Lieutenant Greely and his Signal Service expedition to Lady Franklin Bay, as they took with them a very complete outfit of apparatus and supplies for natural history work. In the failure of the relief parties of 1882 and 1883 to reach them, we are, of course, unable to form any idea of what they have accomplished. It is to be hoped, however, that the measures about to be taken for their assistance will be successful, and that they will be found in the enjoyment of good health and with ample results of their explorations.

It is generally known, of course, that the steamer *Proteus* was chartered by the United States Signal Office to carry Lieutenant Garlington and his party to the north for the purpose of establishing connection with Lieutenant Greely and his companions, and of bringing them back to the United States. The Navy Department, at the request of the Secretary of War, furnished the steamer *Yantic*, under Commander Wilde, as convoy and aid. Two naval ensigns, Messrs. H. G. Dresel and A. Ackerman, who had been assigned to duty at the National Museum, volunteered their services to accompany the *Yantic*, and were ordered to her by the Navy Department as natural history assistants. They were placed somewhat under a disadvantage by the necessities of the service, but succeeded in making some very interesting and acceptable collections; Mr. Dresel devoting himself more particularly to natural history, and Mr. Ackerman to mineralogy and geology. A number of well-filled boxes were brought back, and their contents have been duly sorted and distributed in the collections.

Both these gentlemen were ordered again to the National Museum, where Mr. Dresel is still engaged. Mr. Ackerman, however, volunteered for duty with the *Albatross* in her proposed expedition to the Caribbean Sea, and is now on board that vessel.

Arctic Coast.—The most important exploration that has ever been prosecuted directly on the Arctic coast of the United States is that of the Point Barrow party, under Lieutenant Ray, sent up in 1881 by the Chief Signal Officer for the purpose of taking part in the international system of certain polar meteorological stations. Lieutenant Ray was accompanied by Messrs. J. E. Murdock and Middleton Smith, as civilian assistants in meteorology and magnetism, and also as collectors and observers in natural history.

The expedition was organized in San Francisco, the last member of the original party of ten reporting for duty on July 5, 1881, and it sailed from that city on the 18th of the same month, in the schooner *Golden Fleece.*

On September 8 the vessel arrived at Cape Smyth, 10 miles from Point Barrow, to the southwest, and it was decided to establish the station here, as the ground at Point Barrow itself was unsuitable for this purpose. The supplies of the party were accordingly landed with all possible speed, on account of the lateness of the season, and on September 16 the schooner returned.

The house was finished and occupied October 3, and the regular work of the station commenced October 17. The station received its official name, "Ooglaamie," from an Eskimo village of the same name, about half a mile distant. The expedition succeeded in obtaining a continuous series of hourly meteorological observations from October 17, 1881, to August 27, 1883, when the party was recalled and the station abandoned. Hourly magnetic observations began on December 1, 1881, and continued till the station was closed. The 1st and 15th of each month were observed as magnetic-term days, the observations being made every five minutes on these days. Numerous observations were also obtained of auroras, tides, temperature of the sea and earth, &c.

The zoölogical work was carried on assiduously when the season permitted, and resulted in the securing of 497 bird-skins, comprising about 50 species, and 177 sets of eggs, mostly of wading birds; a small collection of skins, skulls, and skeletons of mammals; 11 or 12 species of fishes, not yet identified; a very few insects; and some marine and fresh-water invertebrates. The plants of the region were carefully collected.

A considerable number of Eskimo vocabularies were obtained, together with a large collection of implements, clothing, &c.

The commanding officer made two expeditions into the interior, which resulted in the discovery and partial exploration of a large river flowing into the Arctic Ocean.

The Arctic whaling fleet visited the station, bringing mail, in the summers of 1882 and 1883; and in 1882 a relief expedition in the schooner *Leo* brought supplies and reënforcements.

The steam-whaler *North Star*, of New Bedford, was crushed in the ice near the station, July 8, 1882, and her crew were received at the station and cared for till they could be placed on board the other vessels.

The station was closed and abandoned August 27, 1883, and the expedition proceeded on the schooner *Leo* to San Francisco, where it was disbanded October 15, 1883.

Due report will be made by Lieutenant Ray to the Chief Signal Officer of the meteorological and physical researches of the party. The collections in natural history and ethnology just referred to are of the very greatest interest and value, including large numbers of birds, some plants, but principally rich in ethnological matter.

The National Museum has heretofore been much favored by ample illustrations of the life of the Eskimo of Greenland, of the Mackenzie River region, and of Northwestern River from Kotzbue Sound around to Cook's Inlet. The acquisition of very large collections from Northern Labrador, made by Mr. Turner, and from Point Barrow and its vicinity, by Lieutenant Ray and his party, nearly completes the series, and enables the Institution to claim for the National Museum the possession of by far the finest series in existence of illustrations of Eskimo life.

Among the choice ornithological treasures of the Point Barrow Expedition are over 50 skins of Ross's gull, a bird of which only a few specimens are elsewhere known.

Alaska.—Quite a number of interesting collections have been received from the different stations in Alaska, although not in such quantity as it has been sometimes our pleasing duty to record. From Saint Michael's nothing has come in 1883; the exhaustive work, however, at that point, first of Messrs. Kennicott, Dall, and Pease, of the Western Union Overland Telegraph Expedition of 1865, and then of Mr. Turner and Mr. Nelson, has left practically very little to be accomplished. It is expected, however, that something will soon come to hand from the Signal Service observers at that station.

It is with deep regret that I here record the death, by drowning, April 19 last, of Charles L. McKay, in charge of the United States Signal Service station at Nushagak, Fort Alexander, Alaska, and whose important collection has been the subject of notice in several of the previous reports.

He started on a tour of exploration to Cape Constantine on the breaking up of the ice in the river, and, returning, his boat was capsized and he was drowned. The body had not been recovered at the latest advices.

Mr. McKay had been in the service of the Signal Office about two years, having been nominated by the Smithsonian Institution, through the courtesy of General Hazen. He was not only an efficient meteorologist, but also an accomplished naturalist, trained under the direction of Professor Jordan.

All the collections made by Mr. McKay at the time of his death have been received, through the courtesy of the Alaska Commercial Company, and properly disposed of. They include some very rare forms of animal life, as also numerous ethnological specimens of much interest, showing that the people in the vicinity of Nushagak are essentially Eskimo, but somewhat aberrant in their habits from those in the more northern localities.

Mr. W. J. Fisher, stationed at Kodiak, in the service of the United States Coast Survey, has also continued his very valuable co-operation by sending many interesting specimens of natural history and ethnology.

Among his more recent transmissions are included a new species of petrel, which has been named in his honor. Mr. Fisher is contemplating an extended exploration of the interior of Alaska at some future day, and will doubtless make his mark, owing to his thorough preparation for the work.

A few collections of a miscellaneous character have been received from Sitka, although none of any particular importance.

Lieut. Commander H. E. Nicholls, in command of the United States Coast Survey steamer *Hassler*, in the course of his labors in Alaskan waters, during the year 1883, has utilized his opportunities, as heretofore, in the interest of the National Museum, by collecting a large number of objects of interest and transmitting them to Washington.

Among the localities in the North Pacific Ocean least known to naturalists are the Commander Islands (Bering and Copper), situated about 70 miles off the coast of Kamtschatka, and forming a connecting link between that mainland and the Aleutian Archipelago.

The chief interest of this group of islands lies in the fact that it was the home of the great northern sea-cow (*Rhytina gigas*), a marine mammal related to the manatee, and of enormous size, reaching a length of 30 feet and a weight of several thousand pounds.

This animal was only known by civilized man for a small number of years before its complete extermination, and more than one hundred years must have elapsed since the existence of the last survivor.

The Smithsonian Institution has for some time taken special interest in the Commander Islands in connection with the northern sea-cow; and also in the desire to determine what are the faunal and floral relationships between them and the Asiatic continent on the one side, and the American islands on the other.

In the Report for 1882 brief mention is made of the opportunity which presented itself for exploring the region in question through the courtesy of the Alaska Commercial Company in offering its most liberal aid in carrying out the undertaking.

The Signal Office also desired to have a station on the island and another on the adjacent mainland of Kamtschatka, so as the more readily to connect the observations of the Russian Government on the continent of Asia with those on the Aleutian Archipelago and circumpolar regions, partly under its own direction and partly under that of the Canadian Government.

Dr. L. Stejneger, an eminent Norwegian naturalist, at the time in Washington, accepted the invitation of the Smithsonian Institution to take charge of the proposed exploration; and, as stated in the last Report, he left Washington towards the end of March, 1882, expecting to sail from San Francisco on the 1st of April. He was, however, delayed for several days by snow on the line of the Union Pacific Railroad; the Alaska Commercial Company, with unexampled courtesy, holding their vessel until the doctor's arrival in San Francisco.

Leaving San Francisco April 5, the doctor landed on Bering Island on the 8th of May, and after starting work on the island proceeded to Petropaulowski, where he spent several weeks in establishing a second, class station, to work in connection with a first-class station on Bering Island.

Dr. Stejneger spent the summer on Bering Island; and on August 21 made a boat expedition around the island, especially for the purpose of collecting the bones of the *Rhytina*. This work occupied twelve days.

The winter was spent on Bering Island, during which time several expeditions were made in dog sledges into the interior.

In May Dr. Stejneger proceeded again to Petropaulovski to inspect the station, and made numerous collections and observations in the vicinity. In the summer he visited Copper Island, for the purpose of studying the habits of the fur-seals, of which there are large rookeries, worked by the Alaska Commercial Company.

Returning to Bering Island, Dr. Stejneger finished his work there, and left on the steamer *St. Paul* for San Francisco, where he arrived October 29, 1883, and shortly after reached Washington.

The most noteworthy results of Dr. Stejneger's expedition consisted—*first*, of 4 more or less complete series of vertebræ and long bone and about 18 skulls of the *Rhytina; second*, 1 skull of a bearded whale, and several skulls of three different genera of toothed whales, embracing forms of great rarity, and previously unknown in the North Pacific; *third*, three specimens of the Kamtschatkan mountain sheep; *fourth*, about 700 bird-skins, including 7 adults of the great Kamtschatkan sea-eagle, together with a large collection of birds of Kamtschatka and the Commander Islands, some of them new to science; *fifth*, collections of the fishes, marine invertebrates, &c.; and, finally, *sixth*, collections of Tertiary fossils.

A considerable number of the water birds and fishes of the Commander Islands are supposed to be identical with, or else very closely related to, those of Alaska on the one side and Kamtschatka on the other; the precise determination of this fact, however, depending upon a careful comparison of specimens.

No museum in the world has heretofore furnished the opportunity which is now presented in the National Museum for making final decision on these doubtful points.

Dr. Stejneger makes mention in his report of the most liberal and generous aid rendered by Messrs. Hutchinson, Kohl, Philippeus & Co., as well as by the Alaska Commercial Company and their employés, that was shown him in every possible way, including free passage to and from the islands and quarters during his stay.

He also especially mentions in the same connection Mr. N. Grebnitsky, manager on the part of the Russian Government of the Commander Islands, for valuable assistance and liberality in adding many of the most interesting specimens to his collection.

British Columbia, Washington, and Oregon.—Much the most important research prosecuted under the auspices of the Smithsonian Institution was that by Mr. James G. Swan in the Queen Charlotte Islands. The aid rendered by Mr. Swan to the Institution in its various enterprises is mentioned in many of the preceding annual reports; for more than a quarter of a century his contributions having been most noteworthy. To him we owe very extensive collections illustrating the life and work of the Indians of Puget Sound, as also everything relating to the fisheries of that region, whether prosecuted by the savage or the white man. The aboriginal fishery implements collected by Mr. Swan and exhibited by the United States at Berlin and London attracted very great attention.

During the past year the Institution was enabled, by the appropriation for the prosecution of ethnological researches, to send Mr. Swan on an extended exploration of the Queen Charlotte Islands—a region of which but little has hitherto been known. Such is the ease of communication with Alaska and the adjacent regions at the present time, and such the extent of travel in that direction, that objects of native manufacture, whether prehistoric or modern, are becoming extremely scarce and very costly. As these characteristics increase day by day, there is, of course, no time to be lost in securing that complete representation required for the service of the National Museum in Washington.

Fortunately for this object, the Queen Charlotte Islands have been more out of the way of travel, and much less well known; and Mr. Swan, with the hearty co-operation of officers of the Hudson's Bay Company, especially of Mr. George, was able, at reasonable rates, to secure a collection of extraordinary magnitude and interest. This, filling some thirty boxes, has reached Washington, and is now being catalogued and arranged. It includes a full series of everything relating to the life and customs of the Indians, and especially to the modes and results of their fishing, which of course constitute a very prominent feature in their life.

One of the most important results of Mr. Swan's work was the discovery of the use of a fish of great food value, known as the Beshowe, or black cod. This is the *Anoplopoma fimbria* of ichthyologists, and is in no way related to the cod, although improperly so called. It is an extremely abundant fish, easily caught, and when salted keeps well, and is very palatable. Specimens sent by the United States Fish Commission to Boston were smoked and pronounced to be superior to the halibut similarly treated. It is not improbable that an extensive eastern demand can be established for this fish.

Capt. Charles Bendire, whose official co-operation in the work of the Smithsonian Institution has been already referred to, has, during the year, made some interesting collections at Fort Klamath and forwarded them to the Institution.

California.—As usual, the collections from California have been of much importance, and furnish material not only for the reserve collections of the National Museum, but also for distribution and exchange.

The most important collection was furnished by Mr. Charles H. Townsend, an employé of the United States Fish Commission at the salmon hatchery on the McCloud River. Large collections of birds and their eggs, skins of mammals, specimens of reptiles and fishes, fossil remains, &c., have all been sent in large quantity, furnishing the means for an elaborate monograph of the animal productions of Shasta County. Mount Shasta itself was visited, and the distribution of animal life carefully noted. Mr. Livingston Stone, who has charge of the salmon hatchery, also made some important contributions.

From Mr. J. J. McLean, Signal Service observer at Cape Mendocino, were received some very desirable collections; and Mr. R. E. C. Stearns also furnished large numbers of antiquities, as well as of recent shells.

Lower California, Arizona, and New Mexico.—The explorations of this region by the several correspondents of the Institution have furnished some valuable matter, especially the gatherings of Mr. L. Belding in the vicinity of the Gulf of California.

Nearly a quarter of a century ago Mr. John Xantus, an accomplished naturalist and collector, prosecuted an extended exploration to Cape Saint Lucas and the southern end of the Gulf of California, in the interest of the Smithsonian Institution. The additions made by that gentleman to our knowledge were of the utmost interest and importance.

Since then almost nothing has been done in that region until in 1881, when, at the suggestion of the Institution, Mr. L. Belding, of California, undertook to revisit the same region, with a view of ascertaining what changes, if any, had occurred since the time of Mr. Xantus, and whether any additional facts or species could be obtained.

Starting on his mission in 1881, Mr. Belding was occupied at La Paz for about three months, from the middle of December to the middle of March, making side trips to Espiritu Santo and other points in the vicinity.

He then proceeded to Cape Saint Lucas by steamer, and from there to San José, where he remained until May 18, with occasional excursions to Miraflores, after which he returned to California.

During this time Mr. Belding gathered a great many extremely acceptable specimens, which were duly transmitted to the Smithsonian Institution. He ascertained that most of the species which were found by Mr. Xantus, and supposed to be peculiar to Cape Saint Lucas, had quite an extended distribution northward, although he was unable to define exactly their limitations.

His collections included all kinds of animals, even to the marine invertebrates, some plants, and some very interesting archæological objects.

During a good part of the time his hands were disabled by contact with the spines of the cactus, and he was consequently unable to use them in preparing skins of birds to the extent he desired.

Mr. Belding revisited Lower California in 1882–'83, arriving at Guaymas on December 7, during which time he collected extensively in the vicinity.

From La Paz he went to San José del Cabo, and then proceeded to Laguana for the purpose of making explorations in the Victoria Mountain.

On February 15, having been joined by Dr. Ten Cate, a naturalist acting in behalf of the museums of Leyden, Holland, and who had previously been in Washington, he proceeded to a point about 50 miles north of San José, in search of aboriginal ruins as well as of objects of natural history. They explored the region pretty thoroughly, and ascended the mountain, 4,500 feet in height.

In the beginning of March the two gentlemen again started from La Paz to various points on the coast, among them Ballena, Las Paritas, San Antonio, San Jacinto, &c. In the course of the expedition they found some aboriginal remains of much interest, of which series were collected and sent to Washington.

Among the aboriginal remains were some curiously-marked rock paintings, which attracted much interest.

On March 23 Mr. Belding returned to Guaymas, from which point he was obliged by illness to return home to California.

Mr. Emerich, of Guaymas, has also laid the Institution under obligations by transmitting a collection of stone implements of very remarkable character, and from some regions previously unrepresented.

Mr. H. H. Rusby has completed his proposed explorations in Arizona, especially in connection with its botany. A series of his collections has been furnished the National Museum, as also a collection of photographs representing the geological and archæological features of the country.

From the remaining portions of the United States, collections have been received from many points, and representing more or less valuable material in archæology, natural history, mineralogy, and geology. These will all be duly noted in the report of the assistant director, Mr. Goode.

Parties of the Geological Survey, under Major Powell, have secured an immense number of specimens—those of fossils and rocks by the ton. The extensive collections in anthropology made by Mr. James Stevenson in New Mexico have not yet been received.

A large collection of fossils, reptiles, and fishes has been furnished by Mr. George Stolley, of Austin, Tex.

Dr. Shufeldt, of the Army, while stationed at Jackson Barracks, near New Orleans, devoted himself to the complete exploration of the natural history of that region; his collections being especially rich in reptiles, fishes, and insects. He also secured some desirable objects from the mounds in the vicinity.

Mr. A. A. Robinson, chief engineer of the Atchison, Topeka and Santa Fé Railway, presented eighteen boxes of samples of the building stones found along the line of the railway mentioned, constituting a very important addition to the building stone department of the National Museum.

An almost equally valuable collection of building stones from North Carolina was presented by Professor Kerr.

Additional collections of fossils, bones, &c., were furnished by Mr. Crooks, of New Iberia, La.

The Atlantic seaboard.—From the Atlantic coast of the United States the most important collections have been those of the United States Fish Commission, and especially from the work of the steamer *Albatross.* These embrace a vast variety of animal species for the most part taken in depths down to 3,000 fathoms. Over thirty new species of deep-sea fishes, of remarkable character, were obtained during the season. It is, of course, understood that the main researches into the temperatures, depths, salinity of water, and other indications were carried on, as well as the collection of specimens.

A most important research into the natural history of the Atlantic coast of the United States has been carried on by the Institution with the co-operation of Mr. S. I. Kimball, Superintendent of the Life-Saving Service. In the early part of the year circulars from the Institution were distributed by Mr. Kimball, which asked for telegraphic notification of the occurrence or capture of any remarkable marine animal, and its careful preservation until word could be received from the Institution in regard to it.

The arrangement made by the Superintendent of the Life-Saving Service, early in the year, for the telegraphic announcement to the Smithsonian Institution, of the stranding of marine animals has already been productive of important results. The series of specimens thus far received is in every way remarkable, and should the system continue to be so productive it is impossible to say what good may not result to zoölogy. The first specimen received was that of a shark (*Pseudotriacis microdon*) from station No. 10, at Amagansett, N. Y., Mr. Joshua B. Edwards, keeper. This species had hitherto been captured only off the coast of Portugal, and its discovery in our waters was a matter of great interest to American ichthyologists. The only specimen known to be preserved besides this one is the type of the species.

Shortly after this shark was received a still more remarkable animal was announced from station No. 8, at Spring Lake, New Jersey, Mr. Henry S. Howland, keeper. This was a pigmy sperm whale, entirely new to the North Atlantic, and apparently new to science as well. It has been provisionally named *Kogia Goodei.*

Few specimens of this genus have ever been collected, and these from the most remote parts of the globe, some from New Zealand, and one from Mazatlan at the entrance of the Gulf of California. These animals resemble the great sperm whale, to which they are closely related, but do not seem to attain a length of more than nine or ten feet, and are truly the pygmies of their race. The New Jersey specimen was peculiarly interesting in that it was a female with young. In dissecting the animal a fœtus fully three feet long was found, which is probably the first ever seen by the naturalist.

The enthusiasm aroused by the arrival of this specimen had scarcely abated when the stranding of another cetacean was announced from station No. 17, at Barnegat City, N. J., Mr. J. H. Ridgway, keeper. This remarkable animal floated in upon the tide and was secured by Mr. Ridgway and his crew after considerable exertion. The curator of mammals and an assistant were dispatched from the National Museum, and a cast of the exterior was made and the skeleton prepared for shipment to Washington. As the huge animal lay upon the sand, the question of its identity proved quite a puzzling one to the zoölogist who viewed it, but when the skull was cut out, it was at once apparent that the animal belonged to the whales known as the Ziphioids, and probably to the species *Ziphius cavirostris*, an animal for which no common name exists, but which may be termed a bottle-nosed whale. It is probably the second specimen ever taken on the coast of the United States. Ziphioid whales have a most interesting history. In ages past they were very abundant, perhaps as much so as the common porpoises of to-day, but at present only stragglers are found in remote quarters of the globe. It would seem as if they were but the surviving relics of a great race which sprung into existence, reached the maximum of its abundance, and declined long ages before man appeared on earth.

From the station No. 25, at Fire Island, New York, Mr. Daniel S. Hubbard, keeper, and the station, No. 37, at Turtle Gut, New Jersey, Mr. Uriah Cresse, keeper, came two specimens of a porpoise, which, unlike the cetaceans which have been already referred to, is of common occurrence on our Atlantic coast and is probably also represented in European waters. The casts, however, which the National Museum was enabled to make are probably the first of the species in any museum in the country, and with the skeletons which were preserved form an excellent basis for comparison with other forms. The animal is commonly known as the bottle-nose dolphin, and is identical with or closely allied to the species *Tursiops truncatus*.

In addition to the shark previously mentioned, several peculiar and interesting fishes have been received. Among these is a fish known as the "star gazer" (*Astroscopus anoplus*) from station No. 6, at Deal's Island, North Carolina, Mr. Malachi Corbel, keeper. The "star gazer" is a southern species which occasionally strays northward as far as Cape Cod, but it is very rare in museums. A very closely allied species (*Astroscopus y-græcum*) is said to possess electrical powers in life.

From station No. 2, at Point Judith, Rhode Island, Mr. Herbert M. Knowles, keeper, was received a specimen of the "lumpfish." The "lumpfish" as a rule is an inhabitant of colder waters than that in which it was found. The "flute mouth" (*Fistularia serrata*), from the same station, is a very rare species on our coast. The angel-fish (*Pomacanthus aureus*) taken at Barnegat City, N. J., has not been known hitherto north of Florida.

In several cases, too, the keepers of the light-houses have rendered services similar to those of the officers of the life-saving stations, notably Mr. Burnham, of the Cape Canaveral light-house, who, at the request of General O. E. Babcock, light-house inspector, collected the skulls and bones of a large number of sperm whales, and transmitted them to the Institution. The keeper of the light-house at Monomoy Point, on Cape Cod, enabled the Institution to secure the first specimen recorded on the coast of the United States of the small fin-backed whale, *Balænoptera rostrata.*

Mexico.—Since the completion of the railway lines on the southern border of the United States, and extending into Mexico, access has been easy to an extremely interesting region hitherto more or less inaccessible, and several parties have asked and obtained assistance of the Smithsonian Institution in carrying on their researches. Among these Mr. H. H. Rusby, of New Jersey, with quite a large party, visited various parts of Mexico and Arizona, more particularly in search of botanical novelties. He made a large collection of photographs of the ancient ruins, of which a series has been presented to the National Museum. The facilities extended by the Institution consisted principally in the way of free passes, obtained especially for the occasion, and of transportation of specimens from various points to Washington.

Another expedition of a similar character has been arranged for during the year, under the direction of Mr. C. G. Pringle, of Charlotte, Vt. This gentleman, who is well known as a botanist, will visit Northern Mexico, and in return for the facilities extended him by the Institution will supply a series of his duplicates.

Yucatan.—Mr. George F. Gaumer, formerly of Santa Fé, N. Mex., but more recently of Kansas City, Mo., resided for a number of years in Yucatan, engaged for the most part in making collections of specimens of natural history. He returned to New York with a large collection, especially of birds, many of which proved to be of new species. Mr. Gaumer has recently been appointed United States consular agent at Campeche, to which point he will proceed early in the coming year, and it is hoped to secure his services in completing the collections of the natural history of Yucatan already in possession of the National Museum.

Central America.—By far the most important collections received from this region is the series of casts from squeezes taken by Mr. Charnay in the course of his explorations of Mexico and Central America, prosecuted largely at the expense of Mr. Pierre Lorillard, of New York. It is well known that Mexico and several States of Central America prohibit absolutely the removal from their borders of native antiquities, and it has, therefore, become almost impossible, even as a smuggling operation, to take away any but the smaller and more portable objects. Mr. Charnay, however, was permitted to copy what he pleased, and in the vicinity of the ruins of Palenque, Uxmal, and other localities he succeeded in obtaining the material with which, on his return to Paris, he made two sets of casts. Of these, one became the property of the French Government, and the other of Mr. Lorillard, who kindly transferred it to the National Museum, and paid the expenses of a suitable person to accompany the specimens from Paris to Washington, and to erect them in a room assigned for the purpose. This room has been made the depository of all other collections of a similar character from the same region. These include a large number of statues obtained along the line of the Costa Rica Railroad, and supplied by Mr. Minor C. Keith, engineer of the road. Statues obtained in the same region have also been supplied by Mr. Nutting and Mr. Harrington.

A very important exploration of Central America, carried on under the direction of the Institution, was conducted by Prof. Charles H. Gilbert and Mr. C. C. Nutting, both aided in every possible way, first by the issue of free passes on the part of the Pacific Mail Steamship Company, and then by the hearty co-operation of Capt. John M. Dow, the agent of that company at Panama. Mr. Gilbert devoted himself to the study of the ichthyology of the two shores of the isthmus, and collected a large number of species, including many new to science. These were by permission taken to the State University at Bloomington, Ind., where, unfortunately, they were nearly all destroyed by the disastrous fire in which the museum of the university was consumed.

Mr. Nutting's work was prosecuted mainly in Costa Rica, and he brought back a valuable collection of birds and other objects, as well as some extremely interesting antiquities. Among these was a large stone image, nearly perfect in its character. His most important acquisitions were made on the San Juan River, at which point six new species of birds were secured.

Mr. J. C. Zeledon, of San José, Costa Rica, also furnished a continuation of the results of his extensive explorations into the natural history of his native country.

A large collection of pottery, stone implements, and some of metal, made in Chiriqui, by Mr. James McNeill, was received by the Institution during the year.

The services of the United States Government were invoked by Guatemala in the selection of an astronomer to take charge of the running of a boundary line between that country and Mexico, and to represent it officially on that occasion. Prof. Miles Rock, of the Washington Observatory, was selected for the position in question, and kindly offered his services to the Institution in any practicable way that might be designated.

As it is believed that the region to be traversed by the commission contains many interesting archæological remains, Professor Rock was requested to secure photographs or drawings of as many of these as possible, as well as to obtain any portable specimens. To this he kindly assented, and on his departure, in mid-summer, he carried with him a photographic outfit, furnished by the Institution. Much is expected from Professor Rock's labors, as he is an accomplished specialist, as well as being versed in photographic manipulation.

South America.—Not much material of importance has come to hand from South America, with the exception of a large collection of rare and remarkable Peruvian pottery, presented by Mr. W. W. Evans. Lieutenant Very, of the Navy, also furnished some specimens from Patagonia.

Japan, China, and Corea.—In previous reports reference has been made to the important work prosecuted by Mr. P. L. Jouy in China, a region first visited by him in connection with the service of the United States steamer *Palos.* After the completion of his engagement on the *Palos*, Mr. Jouy remained in Japan, where, with the kind aid of Messrs. Owston, Snow & Co., he was enabled to prosecute his explorations in certain little-known portions of the empire. The collections sent by him relate to all branches of zoölogy as well as to archæology, and have proved to be of extreme interest. Through his exertions the National Museum now possesses very good collections of the birds of Japan, the fishes, in large part, having previously been received through the museum at Tokio.

On the opening of intercourse with Corea, Mr. Jouy accompanied Minister Foster, and was enabled to obtain facilities for further research, the results of which have not been received. Ensign Bernadou, one of the naval officers detailed by the Department for service in the National Museum, volunteered for service in Corea, and was ordered thither by the Department, to prosecute his explorations under the auspices of the Smithsonian Institution. Well trained in chemistry, mineralogy, and geology, Mr. Bernadou expects to make some important researches in those branches, as well as in anthropology and general natural history.

Other Countries.—The collections from the other parts of the globe have not been of much importance, in view of the fact that the Institution occupies itself but little in explorations in the Old World, believing that this is best done by agencies in Europe. Collections in materia medica have been received from the Government authorities in Calcutta and Madras, as also from the directors of the museum at Kurrachee, in India.

During the performance of his functions as Fishery Commissioner to the London Fishery Exhibition, Mr. Goode, Assistant Director of the National Museum, obtained a number of desirable collections in exchange, and these have added materially to our knowledge, especially of the ichthyology of Europe.

PUBLICATIONS.

Smithsonian Contributions to Knowledge.—During the past year a memoir was published belonging to the quarto series of Smithsonian publications, entitled "On the contents of a bone-cave in the island of Anguilla (West Indies)." By Edw. D. Cope. It gives a description of the fossil vertebrates, shells, and also of the indications of human occupation discovered during the excavation of a cave in the West Indian island of Anguilla.

The remains were first discovered in 1868, and brief notices of them made, but the publication of a full account was delayed in the hope that other objects might be added to the collection. The memoir was submitted to the Institution in 1878, but the other works in progress prevented its publication until last year.

The importance of the subject is shown by the fact that it is the first investigation of the life of the cave age in the West Indies; that it gives the first reliable indication of the period of submergence and hence of separation of the West Indian islands; that it furnishes the first evidence as to the antiquity of man in the West Indies, and that it describes some very peculiar forms of animal life not previously known.

The paper consists of 34 pages, and contains 5 plates, with 105 figures, the illustrations being made particularly full on account of the archæological interest attaching to those animals which were probably the contemporaries of the earliest men of tropical America.

Smithsonian Miscellaneous Collections.—For several years past the Institution has expended a considerable portion of its publishing fund in reproducing, in the Smithsonian Miscellaneous Collections, the Bulletins and Proceedings of the National Museum; as also the Proceedings of the Philosophical, Anthropological, and Biological Societies of Washington, this being considered strictly germane to the plan of the Institution and representing both divisions of its functions—the increase and the diffusion of knowledge. The stereotype plates are furnished free of cost, leaving only the press-work and paper to be provided for.

By publishing these works in the series of Smithsonian Miscellaneous Collections they are placed in all the principal libraries and establishments for research throughout the world; the cost to the Institution being simply that of press-work and paper. This is the only mode by which ample publication can be secured.

Four volumes of this series have been gathered and published during the year, some of the constituent papers of which (it is to be understood) had been previously issued separately.

Volume XXIV contains but one article, and comprises in all 1,081 pages. The article is entitled "Synopsis of the Fishes of North America." By David S. Jordan and Charles H. Gilbert. 1882. 8vo. 1074 pp.

Volume XXV contains five articles, comprising in all 786 pages. Article 1, "Bulletin of the Philosophical Society of Washington," Vol. IV, October 9, 1880, to June 11, 1881. 8vo. 1883. 189 pp. Article 2, "Bulletin of the Philosophical Society of Washington," Vol. V, October 8, 1881, to December 16, 1882. 8vo. 1883. 189 pp. Article 3, "Transactions of the Anthropological Society of Washington," Vol. I, February 10, 1879, to January 17, 1882. 8vo. 1882. 142 pp. Article 4, "Abstract of Transactions of the Anthropological Society of Washington," from March 4, 1879, to January 18, 1881. 8vo. 1883. 150 pp. Article 5, "Proceedings of the Biological Society of Washington (with the addresses read on the occasion of the Darwin Memorial Meeting, May 12, 1882)," Vol. I, November 19, 1880, to May 26, 1882. 8vo. 1883. 110 pp.

Volume XXVI contains four articles, comprising in all 867 pages, with 70 illustrations. Article 1, "The Toner Lecture, No. VII, Suggestions for the Sanitary Drainage of Washington City." By George E. Waring, jr. 8vo. June, 1880. 26 pp. Article 2, "List of Foreign Correspondents of the Smithsonian Institution, corrected to January, 1882." 8vo. April, 1882. 174 pp. Article 3, "Additions and Corrections to the List of Foreign Correspondents, to January, 1883." 8vo. 1883. 56 pp. Article 4, "Classification of the Coleoptera of North America." By John L. Le Conte and George H. Horn. 8vo. 1883. 605 pp.

Volume XXVII contains four articles, comprising in all 815 pages. Article 1, "The Constants of Nature, Part IV, Atomic Weight Determinations; a Digest of the Investigations published since 1814." By George F. Becker. 8vo. 1880. 152 pp. Article 2, "The Constants of Nature, Part V, a Recalculation of the Atomic Weights." By Frank Wigglesworth Clarke. 8vo. 1882. 293 pp. Article 3, "Catalogue of Publications of the Smithsonian Institution (1846–1882), with an Alphabetical Index of Articles in the Smithsonian Contributions to Knowledge, Miscellaneous Collections, Annual Reports, Bulletins and Proceedings of the U. S. National Museum, and Report of the Bureau of Ethnology." By William J. Rhees. 8vo. 1882. 342 pp.

The separate papers under this class published during the year are the following:

No. 479. The Report of the Secretary of the Smithsonian Institution, for the year 1881, to the Board of Regents of the Institution. This was not actually published till 1883. It is an octavo pamphlet of 53 pp.

No. 480. "Classified List of Publications of the Smithsonian Institution." 8vo. 24 pp.

No. 481. "Miscellaneous Papers relating to Anthropology," from the Annual Report for 1881. 8vo. 160 pp.

No. 482, also from the Report for 1881, on "Tuckahoe, or Indian Bread," by Prof. J. Howard Gore, was noticed in the Report for 1882 (pp. 23, 24), but was not actually issued till the spring of 1883 8vo. 15 pp.

Nos. 483, 484, 485, 486, 487, and 488. Accounts of Progress in Astronomy, Meteorology, Physics and Chemistry, Botany, Zoölogy, and Anthropology, for the year 1881, were not published till 1883.

No. 490. "Additions and Corrections to the List of Foreign Correspondents, to January, 1883." 8vo. 56 pp.

No. 491. "Report of the National Museum Building Commission, and of the Architects, January, 1882." 8 vo. 10 pp.

No. 498. "Bulletin of the Philosophical Society of Washington, Vol. IV, October 9, 1880, to June 11, 1881." 8vo. 189 pp. Illustrated with 1 map and 2 plates.

No. 499. "Proceedings of the Biological Society of Washington (with the addresses read on the occasion of the Darwin Memorial Meeting, May 12, 1882), Vol. I, November 19, 1880, to May 26, 1882." 8vo. 110 pp.

No. 502. "Abstract of Transactions of the Anthropological Society of Washington, from March 4, 1879, to January 18, 1881." 8vo. 150 pp.

No. 503. "Bulletin of the Philosophical Society of Washington, Vol. V, October 8, 1881, to December 16, 1882." 8vo. 189 pp. Illustrated with 2 maps.

No. 507. The "*Classification of Coleoptera* of North America," by Drs. J. L. Le Conte and George H. Horn (referred to in the last report), has been published during 1883. The first edition of this work was published in 1861–'62, and ended with the Cerambycidæ. Within the last twenty years not only have the collections of Coleoptera largely increased, but many new genera have been discovered. The authors have carefully examined all the new material, studied all the works by foreign authors, and now present this volume as combining all the literature of the subject. Its value is much increased by the addition of a bibliography prepared by Mr. Samuel Henshaw, of Boston. The introduction describes the peculiar characteristics of coleopterous insects, defines their classes, and is illustrated by 67 figures of antennæ, mouth parts, thoraxes, legs, claws, &c. It forms an octavo volume of 606 pages.

No. 520. The "Report of the Secretary of the Smithsonian Institution, for the year 1882, to the Board of Regents of the Institution," is an octavo pamphlet of 56 pp.

No. 524. "Report of the Assistant Director of the United States National Museum, G. Brown Goode, for the year 1882." Addressed to Prof. S. F. Baird. 8vo. 145 pp.

No. 525. "An Account of the Progress in Astronomy in the year 1882," By Prof. Edward S. Holden. 8vo. 48 pp.

No. 526. "An Account of the Progress in Geology in the years 1881–1882." By Dr. T. Sterry Hunt. 8vo. 21 pp.

No. 527. "An Account of the Progress in Geography in the year 1882." By Commander F. M. Green, U. S. N. 8vo. 18 pp.

No. 528. An Account of the Progress in Meteorology in the year 1882." By Prof. Cleveland Abbe. 8vo. 99 pp.

No. 529. "An Account of the Progress in Physics in the year 1882." By Prof. George F. Barker. 8vo. 50 pp.

No. 530. "An Account of the Progress in Chemistry in the year 1882." By Prof. H. Carrington Bolton. 8vo. 23 pp.

No. 531. "An Account of the Progress in Mineralogy in the year 1882." By Prof. Edward S. Dana. 8vo. 17 pp.

No. 532. "An Account of the Progress in Botany in the year 1882." By Prof. William G. Farlow. 8vo. 13 pp.

No. 533. "An Account of the Progress in Zoölogy in the year 1882." By Prof. Theodore Gill. 8vo. 68 pp.

No. 534. "An Account of the Progress in Anthropology in the year 1882." By Prof. Otis T. Mason. 8vo. 41 pp.

No. 535. "Miscellaneous Papers relating to Anthropology." Published in the Annual Smithsonian Report for 1882. By Don Leon Fernandez, R. T. Bron, George C. Van Allen, James M. Williamson, William McAdams, John G. Henderson, G. W. Homsher, J. P. MacLean, James M. Null, Benjamin W. Kent, J. Francis Le Baron, M. H. Simons, John P. Smith, H. E. Chase, and J. F. Bransford. Followed by brief abstracts from the anthropological correspondence of the Institution. Forming in all an octavo pamphlet of 155 pp., illustrated with 48 maps and figures.

No. 537. A sketch map of the District of Columbia (12 inches square), indicating the localities of aboriginal remains; by L. P. Kengla.

No. 543. "Bulletin of the Philosophical Society of Washington." Vol. VI. January 3, 1883, to December 19, 1883. 8vo. 168 pp.

No. 544. "Transactions of the Anthropological Society of Washington." Vol. II. February 1, 1882, to May 15, 1883. 8vo. 211 pp. Illustrated with 43 figures.

No. 560. "Report on the Pharmacopæias of all Nations." By Dr. James M. Flint, U. S. N. (Extracted from the report of the Surgeon-General of the U. S. Navy for 1882.) 8vo. 28 pp.

"*General Catalogue of Scientific Periodicals.*"—The publication of this work by Dr. H. Carrington Bolton, of Trinity College, Hartford, Conn., has been continued during the year, 344 pages having been printed and stereotyped. Extra proofs of each signature are printed and distributed to about 50 public libraries, with the request that they be returned with the titles checked of those works possessed by each library. Complete sets are marked with a "C," nearly complete sets with "Inc." written on the margin. In the appendix to the work it is proposed to give a list of all the libraries in which any of the periodicals cited may be found. This will add much to the value of the catalogue, and the prompt response and ready co-operation of librarians in this enterprise is very gratifying.

Professor Bolton's catalogue is intended to include independent journals in every branch of science, both pure and applied. Transactions of societies are generally excluded, as well as medical and art journals.

Physical and Meteorological Tables.—This work, published by the Institution in 1852 (212 pages), and revised in 1859 (638 pages), has been taken up by the author, Prof. A. Guyot, of Princeton, N. J., with the purpose of adding new and important tables and carefully revising the old ones. This has been a labor requiring much time, and has occupied several years. The manuscript was, however, completed and sent to press in 1883, and the printing has proceeded as rapidly as the nature of the work would permit.

The volume will be published during the year 1884, and will doubtless be in great demand, as very few of the publications of the Institution have met with such steady call as the former editions of these tables.

Bulletins of the National Museum.—An additional series of publications lately included in the Miscellaneous Collections consists of the Bulletins of the United States National Museum, primarily printed under the direction of the honorable Secretary of the Interior. This series was instituted for the purpose of furnishing a prompt publication of original descriptions of the specimens received by the Museum, many of which are new to science, as well as of presenting such other interesting information on subjects of biology as may be given by its collaborators. From the stereotyped plates thus produced a supplementary edition is printed off by the Institution, and distributed among its numerous correspondents in the same manner as its other publications. The following bulletins were published during the year:

Bulletin No. 16 (Smithsonian No. 492) contains a "Synopsis of the Fishes of North America." By David S. Jordan and Charles H. Gilbert. The table of contents of this elaborate work occupies 47 pages, and the work itself forms an octavo volume of 1018 pages.

Bulletin No. 20 (Smithsonian No. 508), the first of a proposed series of extended catalogues of the writings of American naturalists, comprises a bibliography of "The Published Writings of Spencer Fullerton Baird from 1843 to 1882." By George Brown Goode, Assistant Director of the National Museum. The work is prefaced by a biographical sketch of Professor Baird of 9 pages, and includes (1) a "Chronological Catalogue" of his published writings (forming the bulk of the volume); (2) a "Systematic Catalogue," in which the various species described or treated of are arranged in the order of biologic classification; (3) a "List of Species Discussed and Illustrated," similarly classified. The whole forms an octavo volume of 393 pages.

Bulletin No. 24 (Smithsonian No. 493) contains a "Check-List of North American Reptilia and Batrachia, with catalogue of specimens in the United States National Museum." By Dr. H. C. Yarrow. 8vo. 255 pp.

A brief abstract of the preceding (Smithsonian No. 517) is a "Check-List of North American Reptilia and Batrachia, based on specimens contained in the United States National Museum," by Dr. H. C. Yarrow. 8vo. 28 pp. For the convenience of collectors, this list has been printed on the right-hand page only.

Bulletin No. 26 (Smithsonian No. 500) is an "Avifauna Columbiana: being a list of birds ascertained to inhabit the District of Columbia, with the times of arrival and departure of such as are non-residents, and brief notices of habits, etc." By Drs. Elliott Coues and D. Webster Prentiss. This is the second edition, revised to date and much enlarged, of the Catalogue of the Birds of the District of Columbia, prepared by the same authors twenty years ago, and published in 1862 in the Annual Report of the Smithsonian Institution for 1861. The present edition has been entirely rewritten to embrace all the additions which have been made to the list during the interval between the two editions, together with a review of the changes the Avifauna has undergone, a sketch of the topography of the District with reference to the haunts and habits of its birds, and much other new matter; and is handsomely illustrated with wood-cuts or lithographs. It appears as one of the series of natural history monographs of the District, following the Flora recently published, and to be succeeded by articles upon other departments of the Fauna.

It forms an octavo of 138 pages, with a full-page illustration of rail shooting on the Anacostia marshes, District of Columbia, and folded colored maps of the Potomac River region, of the Rock Creek region, and of the Eastern Branch or Anacostia River region of the District of Columbia; also a large map of Washington and vicinity.

Proceedings of the National Museum.—This is an allied series of publications, designed to furnish to naturalists early announcements and descriptions of specimens received, more particularly when of new species.

Volume V of the Proceedings of the United States National Museum was completed during the year. It contains memoirs by numerous contributors, and comprises 714 octavo pages.

Proceedings No. 19 (Smithsonian No. 539) contains a "Classification of the Materia Medica collection of the U. S. National Museum and catalogue of specimens." By James M. Flint. 8vo. 45 pp.

Educational series (Smithsonian No. 516), "List of duplicate marine invertebrates distributed by the U. S. National Museum." Prepared by R. S. Tarr, under the direction of Richard Rathbun. 8vo. 5 pp.

Proceedings No. 20 (Smithsonian No. 541), a circular "Request for Specimens of Drugs and Information concerning them." 8vo. 1 p.

Smithsonian Annual Report.—The Annual Report of the Regents to Congress for 1881 was transmitted on the 1st of March, 1882, but copies were not received from the Public Printer until October, 1883.

Its contents were referred to in the last report.

The report for the year 1882 was sent to Congress on the 19th January, 1883, but copies have not yet been received for distribution.

It will include the Journal of Proceedings of the Board of Regents, with the reports of the Secretary and the Executive Committee. The "General Appendix" contains the continuation of the record of recent scientific progress commenced in the Annual Report for 1880, and consists of the following articles:

Account of recent progress in Astronomy, by Prof. E. S. Holden.

Account of recent progress in Geology, by Prof. T. S. Hunt.

Account of recent progress in Geography, by Commander F. M. Green.

Account of recent progress in Meteorology, by Prof. C. Abbe.

Account of recent progress in Physics, by Prof. G. F. Barker.

Account of recent progress in Chemistry, by Prof. H. C. Bolton.

Account of recent progress in Mineralogy, by Prof. E. S. Dana.

Account of recent progress in Botany, by Prof. W. G. Farlow.

Account of recent progress in Zoölogy, by Prof. Th. Gill.

Account of recent progress in Anthropology, by Prof. O. T. Mason.

Miscellaneous papers and extracts from correspondence on Anthropology.

ASTRONOMICAL ANNOUNCEMENTS BY TELEGRAPH.

During the past year an important change has been made in the directorship of the astronomical telegraphy so long undertaken by this Institution. It was stated in the last report that the "Science Observer" of Boston, under the editorship of John Ritchie, jr., of the Harvard College Observatory, had for some time past supplemented this work by issuing "special circulars" furnishing successive elements and ephemerides of observed comets, &c., and also by frequently telegraphing the same by cable dispatches in a peculiar phrase code adopted for this purpose.

On being informed that this enterprising agency was willing and prepared to take the entire charge of the system, the Smithsonian Institution, agreeably to its settled policy not to expend its energies on interests otherwise provided for, expressed its readiness to transfer the control of this useful service to the Harvard College Observatory, on the formal acceptance of the same by its director, Prof. Edward C. Pickering. The principal portion of the correspondence relative to this matter is presented in the appendix to this report. On the receipt of

Professor Pickering's reply the following circular was published and distributed to all our astronomical correspondents:

"SMITHSONIAN INSTITUTION,
"*Washington, D. C., January* 10, 1883.

"Arrangements having been completed with the director of the Harvard College Observatory for conducting the system of telegraphic announcements of astronomical discoveries, which was established by this Institution in 1873, you are hereby informed that from and after this date the American center of reception and distribution of such announcements will be 'The Harvard College Observatory, Cambridge, Mass.,' to which address all astronomical telegrams should in future be sent. It is hoped and believed that this transfer of a highly important service will prove beneficial to the interests of astronomical science."

Thus the work of receiving and distributing transatlantic announcements of astronomical discoveries, established and faithfully conducted by this Institution for the past ten years, has been committed to other, and we feel assured worthy, hands. It is believed that astronomical interests will be benefited by the transfer; and while retiring from its future charge, we shall always be ready to co-operate as far as practicable in this important field "for the diffusion of knowledge."

This notice will properly close with a copy of the circular prepared by Professor Pickering (dated February 14, 1883) on assuming the charge:

"*Circular relative to the collection and distribution of astronomical intelligence.*—The arrangements described in this circular have been made in order to render the transmission of astronomical intelligence more speedy and accurate.

"An association of about fifty European observatories has recently been formed, with its headquarters at the Royal Observatory, Kiel, Germany, directed by Professor Krueger, who has taken charge of the business of the association. Connections by cable have been established with South America, South Africa, and Australia, and the Harvard College Observatory has been requested to co-operate with it in the United States, by receiving and distributing in this country the telegraphic information sent from Kiel, and by forwarding to Kiel by telegraph any similar information of importance collected from American astronomers. By the courtesy of Professor Baird, Secretary of the Smithsonian Institution, the function hitherto performed by the Institution, of collecting and transmitting announcements of discovery, has been transferred to the Harvard College Observatory.

"In accepting this transfer it is right that a public acknowledgment should be made of the service rendered to science by the Smithsonian Institution in undertaking the labor from which it now retires. For many years its action has relieved a want generally recognized, although not otherwise provided for; while, as soon as astronomers were prepared to assume the task, the Smithsonian Institution courteously offered to facilitate the change which has just been made.

"The members of the European association above mentioned have agreed to contribute a fixed annual sum for the payment of its expenses, in return for which they are to receive from Kiel the dispatches which may be received at that place.

"In the absence of any similar action on the part of American astronomers, the dispatches sent from Kiel to this country will be immediately communicated to the Associated Press, and to the observatories and such other institutions and persons as may make special arrangements for obtaining them.

"The importance of the work thus begun requires that a special officer of the observatory should be intrusted with it. Mr. John Ritchie, jr., of Boston, has accordingly been appointed assistant in charge of this service, and the details of the proposed system are explained by him in the circular distributed with this.

"American astronomers are requested to send to the 'Harvard College Observatory, Cambridge, Mass.,' telegraphic information of discoveries of comets, asteroids, or phenomena of any kind requiring immediate attention. Arrangements will be made to refund the cost of such telegrams to the senders when their contents are of importance. It is very desirable that the messages should conform to the principles stated in Mr. Ritchie's circular.

"The success hitherto attained by Messrs. Chandler and Ritchie—both of whom are now connected with the observatory—in their project of improving the mode of transmitting astronomical telegrams encourages the belief that the system now adopted will prove expeditious and satisfactory. Mr. Chandler will continue his computations of cometary orbits, which will be distributed by telegraph, as heretofore, when that course seems to be desirable.

"EDWARD C. PICKERING,
"*Director of Harvard College Observatory.*

"CAMBRIDGE, MASS., *February* 14, 1883."

INTERNATIONAL EXCHANGES.

Among the subjects occupying more than any other the attention of the Smithsonian Institution is the system of international exchanges, as initiated about the year 1850, and carried on with constantly expanding scope to the present time. It was begun purely for the purpose of enabling the Institution to distribute its own publications and obtain exchanges in return, but gradually its sphere was extended first to scientific institutions and specialists of the United States, then to institutions and individuals of the remainder of the New World, and finally to the various Bureaus of the Government and the Congressional Library. The number of packages from foreign countries for distribution in the United States during 1883 was 8,262, and filled 232 boxes. Those received from institutions and individuals in America, including the United States Government, for transmission abroad consisted of 18,063 packages, and required 495 boxes for their accommodation, each box averaging contents of perhaps 8 cubic feet and weighing 78,647 pounds.

In the accompanying report of Mr. Boehmer, the officer in charge of this branch, will be found full details of this work—so important a factor in accomplishing the mission of the Smithsonian Institution.

From the 1st of July, 1883, by enactment of Congress, the disbursement of a specific appropriation for international exchanges (constituting the third) has been under the State Department, amounting to $7,500. This allowance has been a very important relief to the Institution, which originally was obliged to meet all the costs of this work, sometimes to the amount of $12,000 annually, out of its small income. The appropriation by Congress, first of $3,500, next of $5,000, and, next of $7,500, has enabled the Institution to meet the burden more easily and to greatly increase the efficiency and extent of the system, although the additional cost in 1883 met from the Smithsonian fund has been $6,192.34.

If the Institution were obliged to pay the full freight charges on its packages carried by ocean steamers, the cost would necessarily be increased by several thousands of dollars. Thanks, however, to the liberality of the principal steamship companies, no charges whatever are made for such transportation.

The principal companies making this concession are the following:

American Colonization Society, Washington, D. C.

Anchor Steamship Company (Henderson & Bro., agents), New York.

Atlas Steamship Company (Pim, Forwood & Co., agents), New York.

Bailey, H. B., & Co., New York.

Beadle, E. R., Philadelphia.

Bixby, Thomas & Co., Boston, Mass.

Bland, Thomas, New York.

Borland, B. R., New York.

Cameron, R. W., & Co., New York.

Compagnie Générale Transatlantique (L. de Bébian, agent), New York.

Cunard Royal Mail Steamship Line (Vernon Brown & Co., agents), New York.

Dallett, Boulton & Co., New York.

Dennison, Thomas, New York.

Hamburg American Packet Company (Kunhardt & Co., agents), New York.

Inman Steamship Company, New York.

Merchants' Line of Steamers, New York.

Monarch Line (Patton, Vickers & Co., agents), New York.

Muñoz y Espriella, New York.

Murray, Ferris & Co., New York.

Netherlands American Steam Navigation Company (H. Cazaux, agent), New York.

New York and Brazil Steamship Company, New York.

New York and Mexico Steamship Company, New York.

North German Lloyd (agents, Oelrichs & Co., New York; Schumacher & Co., Baltimore).

Pacific Mail Steamship Company, New York.

Panama Railroad Company, New York.

Red Star Line (Peter Wright & Sons, agents), New York.

Spinney, Joseph S., New York,

Steamship Lines for Brazil, Texas, Florida, and Nassau, N. P. (C. W. Mallory & Co., agents), New York.

White Cross Line of Antwerp (Funch, Edye & Co., agents), New York.

Wilson & Asmus, New York.

The Monarch Line, recently added to the list, running direct from New York to London, greatly facilitates the exchanges between the United States and Great Britain.

The Pennsylvania Railroad Company and the Baltimore and Ohio Company have continued their concessions of reduced fares, and the freight steamer lines between Washington and New York have also made liberal concessions, which have been of very great value.

Acknowledgments are also due to the foreign ministers and consuls of the various Governments for their assistance in taking charge of the packages intended for the countries which they respectively represent and transmitting them with care to their destination.

The following tables will give some particulars of the statistics of the distribution of packages thus made:

Receipts.

Purpose of and source of receipt.	In 1881.	In 1882.	In 1883.
1. For foreign distribution:			
From Government Departments (packages)	4,326	6,470	7,165
From Smithsonian Institution	5,436	7,056	6,218
From scientific societies	3,631	5,119	3,900
From individuals	768	647	780
	14,161	19 292	18,063
2. For home distribution	7,890	7,187	8,262
3. For Government exchanges	15,550	31,568	37,569
Total receipts, packages	37,551	58,047	63,894

Transmissions during the last eight years.

1. FOREIGN EXCHANGES.

Items.	1876.	1877.	1878.	1879	1880.	1881.	1882.	1883.
Number of boxes	323	397	309	311	268	407	422	495
Bulk, in cubic feet	2,261	2,779	2,160	2,177	1,976	2,800	2,950	3,2[illegible]8
Weight, in pounds	80,750	99,250	69,220	69,975	60,300	100,750	105,500	122,265

2. DOMESTIC EXCHANGES.

Total addresses to institutions	310	392	392	444	385	600	548	423
Total addresses to individuals	328	374	370	341	560	454	399	471
Total number of parcels to institutions	3,705	3,868	4,059	5,786	4,021	7,086	7,192	8,677
Total number of parcels to individuals	1,148	1,094	1,233	1,185	1,566	1,347	1,167	2,323
Total number of parcels	4,853	4,962	5,292	6,971	5,587	8,433	8,359	11,000

3. GOVERNMENT EXCHANGES.

Total number of boxes	122	73	73	67	35	98	122	76

Government Document Exchange.—The exchange of official publications of the United States Government for those of most other foreign nations has been continued, as in previous years, under the auspices of the Smithsonian Institution, in accordance with the law of Congress, and a large number of valuable publications have been sent to agencies designated by their respective countries.

Previous reports contain full details of the arrangement. The essential points consist in the receipt by the Joint Library Committee of Congress of fifty extra copies of all Government publications to be used in the distribution.

I regret to say that comparatively few of the nations, even of those which had formerly agreed to enter upon an exchange, have carried out their promises; and it is a somewhat serious question as to whether our own self-respect will permit us to continue all these transmissions without corresponding returns. We cannot, of course, ask for the equivalent in bulk, as no nation prints so large an amount of official matter as the United States does. It is, however, not too much to ask that whatever may be published, however small in quantity, shall be forwarded.

Some of the most important nations are conspicuous by their absence from this arrangement, notably Germany, with which we have found it impossible to make any arrangement. Great Britain, which, until 1883, has not been on our list, has, during the year, made the most satisfactory arrangements, and it is expected that a large number of works of important character will be received and transferred to the Library of Congress.

It is of course understood that this entire transaction was intended by Congress to be for the benefit of the Library of Congress, and all the publications when received are immediately transferred to Mr. Spofford's care.

LIBRARY.

The usual steady increase in the number of books reported by the library as received is indicated for 1883—12,675 pieces, as against 11,779 of 1882. These are, for the most part, obtained by exchanges; to a less extent by absolute donations, and still less by purchases. As heretofore, these books have been transferred on arrival to the Library of Congress, excepting where purchased expressly for the use of the National Museum, or needed for the service of that branch of the Institution; all serials, however, being regularly transferred.

In many cases we have been enabled to obtain a second series of many important journals and publications of societies, in exchange for the volumes of the Bulletins and Proceedings of the National Museum, which are eagerly sought after, and the acquisition of which is considered to be a matter of great importance.

In this latter establishment the same system as heretofore has been continued—namely, that of allowing all books on special subjects to be taken charge of by the curators of those branches, while mixed or general works are retained in the central library room. The librarian keeps, of course, an accurate record of the disposition of each book, so that any applicant can be referred at once to the place of deposit of such book in possession of the Museum that he may wish.

Attention is again called to the importance of an arrangement by which a card catalogue of all books in the libraries of the various Departments can be kept in charge of the Congressional Library, so that the actual depository, and the most convenient one, of any book may be indicated to an applicant.

The following is a statement of the books, maps, and charts received by the Smithsonian Institution during the year 1883, and transferred to the Library of Congress and the National Museum:

Description.	Octavo or smaller.	Quarto or larger.	Total.
Volumes	1,312	442	1,754
Parts of volumes	4,060	4,170	8,134
Pamphlets	2,200	368	2,568
Maps and charts			219
Total			12,675

RELATIONS OF THE SMITHSONIAN INSTITUTION TO OTHER BODIES.

The hearty co-operation of the various Departments of the Government in the scientific work of the Smithsonian Institution, whether relating more particularly to the National Museum or to the solution of scientific problems in general, has never been more strongly marked than during the past year; and it is with great pleasure that I take this occasion to make proper mention of the same.

The Navy Department.—Previous reports have referred to the experiment initiated by the Navy Department of detailing six ensigns for the service of the National Museum. The object of this measure of the Department was to impart to a body of young naval officers such training as might enlarge their sphere of mental activity, and enable them to utilize in the interests of the Department and of science the many opportunities of research and investigation presenting themselves in the course of their cruises and other duties.

The first detail of this kind was made in the autumn of 1881; the second in 1882, and the third in the autumn of 1883.

These gentlemen, as mentioned hereafter, have all been assigned to duty with the curators of the Museum and assistants of the United States Geological Survey, their own preferences being considered as far as possible.

I am very happy to say that the experiment has proved to be a decided success, the officers applying themselves to their work with great diligence, and obtaining a fair knowledge of the subjects upon which they are engaged in a reasonably short time. There is every reason to believe that from year to year, as this service is continued, the Navy will receive back a body of officers who will reflect luster on the Department and on the country.

The measure in question appears to be quite popular in the Navy, judging from the number of officers who have made application for participation in the benefits.

The details for the past three years have been as follows :

First year, 1881.

R. H. Miner, attached to *Albatross.*
E. E. Hayden, in hospital at Portland, Me.
J. B. Blish, attached to *Jamestown.*
H. S. Chase, National Museum.
L. M. Garrett, attached to *Albatross.*
C. C. Marsh, National Museum.

Second year, 1882.

H. G. Dresel, National Museum.
J. B. Bernadou, ordered to Corea.
A. A. Ackerman, attached to *Albatross.*
A. P. Niblack, National Museum.
E. Wilkinson, National Museum.
W. E. Safford, National Museum.

Third year, 1883.

H. M. Witzel, National Museum.
O. G. Dodge, National Museum.
J. H. Fillmore, National Museum.
C. S. McClain, National Museum.
H. S. Knapp, National Museum.
G. H. Harlow, National Museum.

Lieutenant Winslow, who was detailed for duty in securing statistics of the production, distribution, and varieties of the oyster industry of the United States for the census of 1880, has completed his report on that subject, and was subsequently occupied in collecting material of a similar character for the London Fisheries Exhibition, and also in arranging and labeling the collections made for that object. He is now devoting himself to the special investigation of a number of the useful mollusca of the country.

Dr. J. M. Flint, of the medical department of the Navy, still continues the efficient relationship to the National Museum referred to in the preceding report.

Among the special divisions of the National Museum a collection of the medicines of all nations has been receiving much consideration.

With the co-operation of the leading druggists, and by means of extended exchanges, a collection has been brought together superior to any other in the United States and scarcely excelled by any in Europe.

Dr. Flint has had supervision of this collection, and has brought it into admirable condition, the specimens being all neatly put up and properly labeled with the scientific and common names, and made available for study. Further reference to this collection will be found in another part of the report.

At the suggestion of the Institution, the Secretary of the Navy detailed Messrs. Dresel and Ackerman, two ensigns on duty at the Institution, to the *Yantic*—the naval vessel which convoyed the *Proteus* in her trip for the relief of Lieutenant Greely and his party at Lady Franklin Bay. These gentlemen made very valuable collections in zoology and mineralogy, which have been turned over to the National Museum, and have been absorbed in the general collections.

The Secretary also assigned Ensign Bernadou, at the suggestion of the Institution, for duty with the steamer *Alert*, about to proceed to Corea, with the understanding that he was to be detached from that vessel on reaching Corea, and permitted to devote himself to scientific research, under the direction of the Institution. He is specially interested in chemistry, mineralogy, and geology; but he hopes to make comprehensive collections in many other branches.

The Secretary of State also furnished Mr. Bernadou with a special passport to Corea, and a letter commending him to Mr. Foote, the United States minister to that country.

The *Pinta* being under orders for Alaska, Dr. Crawford, of the Navy, offered his services as collector, and applied for the necessary apparatus for making alcoholic collections. Suitable tanks filled with alcohol and other supplies were forwarded to the vessel; but as Dr. Crawford was detached from service on her, his successor, Dr. Willson, very kindly renewed the offer, and will doubtless make due report of his labors.

The War Department.—The United States Signal Service.—The close relationship existing between the objects of the Smithsonian Institution and the United States Signal Office, as established by the transfer to that Bureau of the entire meteorological organization, has continued to the present time. The most important connection is in the prosecution of scientific research in various parts of the country, as shown more particularly in the establishment of stations in northern or Arctic America. Many of the persons selected by the Signal Office for carrying on research in the interests of climatology, either for its own special purposes, or in co-operation with the international arrangements, have been nominated by the Smithsonian Institution, at the request, or by the permission of the Chief Signal Officer. Instructions as to the special desiderata have been issued, and the additional expenses needed in the way of outfit and supplies have been furnished by the Institution. The result has been to add a great amount of important information to what we previously knew of the natural history, geology, and anthropology of the regions north of the United States; while, of course, full provision has been made for the necessary physical research required by the Signal Office.

The Treasury Department.—A somewhat similar arrangement to that of the Signal Office has been made with the Life-Saving Service, under the direction of Superintendent Kimball, who instructed the keepers of stations to carry out the provisions of a circular issued by the Institution, requesting telegraphic announcement in regard to the stranding of cetaceans, strange fishes, and any other unusual inhabitants of the sea.

In another part of this report will be found a full statement of the very important results already accomplished.

The Light-House Board of the Treasury Department has also continued its co-operation by requiring observations of ocean temperatures at various light-ships and light-houses along the coast. The data accumulated in this way have been of the utmost importance in connection with the general problems of ocean physics, and have been used to very great advantage in solving many questions concerning the migrations of fishes along the coast.

The Interior Department.—Another extremely important addition to the exhibits of the National Museum results from the transfer of the entire collection of Washington relics from the Interior Department, where they had been until now in the custody of the Commissioner of Patents. In this was included not only the old collection that had been on view for so many years, but also a large number of objects purchased some years ago by Congressional appropriation from Colonel Lewis, and never unpacked after their arrival in the city. These articles have all been placed temporarily in large cases in the north hall, and will as soon as possible be transferred to more suitable depositories, where they can be more readily observed and appreciated. The utmost care is taken of this collection, which is justly prized as one of the most valuable properties of the National Museum.

Some other articles of historical interest were also received on the same occasion.

Relations to Foreign Governments.—Under the head of "Explorations in Labrador" will be found a reference to the researches of Mr. Lucien M. Turner. It became necessary in the earlier part of the year to renew the supplies of alcohol, ammunition, &c., to Mr. Turner; and as the vessel by which communication is effected starts for Montreal and Quebec, and not from any American port, the question of duties—on the alcohol especially—became one of some importance.

By the assistance of the Department of State, the intervention of Mr. Robbins, United States commercial agent at Ottawa, with the Canadian minister of finance was secured; and it was finally arranged that on the request of the Secretary of the Treasury to that effect small quantities of supplies for Mr. Turner or other agents of the Smithsonian Institution in the Provinces might be sent in by it to several ports of entry free of duty, the collectors of customs at Montreal, Quebec, and Victoria being notified to that effect. Use was made of this privilege, not only in connection with Mr. Turner's work, but also in the sending of alcohol to Mr. James G. Swan preliminary to his researches of the season in the Queen Charlotte Islands.

Transportation Facilities.—The occasion of having a large quantity of freight to forward to London, for the service of the International Fishery Exhibition in that city, made it of great importance to secure as low rates as possible, the quantity to be shipped representing an aggregate of about 24,000 cubic feet, or 600 measurement tons.

The Pennsylvania Railroad Company promptly responded to an appeal for aid by furnishing cars at most favorable rates, to be loaded by the Institution, and made very satisfactory arrangements in regard to lighterage of the packages and their transfer to the steamers.

An arrangement was also made with Messrs. Patton, Vickers & Co., agents of the Monarch Line of steamers, plying between New York and London direct, by which the goods were carried at reduced rates for the round trip.

The gentlemen just referred to also kindly agreed to carry the regular boxes of international exchanges system of the Institution free of charge, in this respect following out the liberal example of all the other lines between New York and the rest of the world.

Very favorable offers for freights between New York and Washington have also been made by the Inland and Seaboard Coasting Company, and accepted by the Institution.

International and State Exhibitions.—Since the International Exhibition in Philadelphia, in 1876, exhibitions of a somewhat similar character, although more limited, have been held in many of the cities of the United States, these usually opening in August or September and lasting till towards the end of the year. Application is usually made to the Institution by the directors of these organizations for the loan of specimens from the National Museum. In most cases, however, it has not been considered expedient to take any action, excepting in cases where important contributions to the National Museum could be expected in return, or where Congress definitely authorized a loan in the particular case. It is not generally understood that, excepting where the Museum is to be benefited, there is no authority for allowing any specimens to leave the walls of the Museum buildings, and it was only by direct authority of Congress that displays were made at Philadelphia and in the Fishery Exhibitions at Berlin and London.

Quite a large collection, however, of duplicate specimens was furnished for exhibition at the International Exposition held at Louisville during the year 1883, this consisting, in large part, of showy objects, such as an ethnological display from Alaska, the skeleton of a whale, some mounted mammals, &c. The stipulation in the Congressional enactment, that they were to be taken from and returned free of expense to the Institution, has been carried out, and the various objects have been returned with but a moderate amount of deterioration.

Earlier in the year similar action was taken in regard to the Chicago Railway Exposition, in the loan of one of the earliest locomotives used in Pennsylvania, and presented, at the Philadelphia Centennial, to the National Museum by the Pennsylvania Railroad Company.

Some collections were lent to the Foreign Exhibition which opened in Boston September 14 and continued to the end of the year. This was, however, on condition that a very valuable exhibit made by the Rajah of Lahore, and at the disposal of the authorities of the exhibition, be presented to the National Museum at the close.

Electric Light Accommodation.—The loan by the Brush-Swan Electric Company of a powerful dynamo machine of six 3,000-candle-power, and of a series of arc-lights for the purpose of experiment upon the lighting of the Museum building, as also for use in electric photography, has already been mentioned. A suitable engine for working the dynamo was obtained at the expense of the Museum, and the apparatus put in efficient running order. This has since been under the direction of Mr. A. A. Duly, the engineer of the building, and Mr. William J. Green, the electrician.

On several occasions the halls of the building have been lighted with this apparatus; and very constant use was made of it in the preparation of enlarged photographs of scenes connected with the fishery industries, to be used for exhibition at London. Several hundreds of these were enlarged from a size of 10 by 12 inches to that of 30 by 40; and, being finished up in crayon, constituted a very interesting and striking element of the international display at London.

In December, Mr. A. A. Hayes, representing the Brush Company, asked the privilege of making an exhibition, in the lecture room of the Museum, of the Brush storage battery system, which was readily granted. A battery was placed in the lecture room, connected with forty of the Swan incandescent lights, and was charged by the Brush dynamo machine referred to. The exhibition was continued several successive evenings, and was witnessed by a number of Government officials and prominent citizens of Washington who were present by invitation. The exhibition was reported to be entirely satisfactory.

The light was also used on the occasion of the lecture of Professor Powell, before the Biological and Anthropological Societies of Washington, as already mentioned.

The apparatus has been left in the lecture room for such additional use by the Institution as it may desire.

Forestry Inquiries.—At the request of the Biological Society of Washington, which is very much interested in the question of forest trees (either native or planted) in the District, the Institution issued a circular asking various persons informed on the subject, including superintendents of parks and grounds, for lists of the trees the existence of which in the District is known to them. The information thus obtained will be collated and presented in the form of a map, which will undoubtedly be of much interest.

Among the various courtesies extended, directly or indirectly, to the Institution, was an invitation to the Secretary to permit his name to be used as one of a committee on a bill providing for the protection of American forests. He was also asked to serve as a member of the jury in the International Horticultural Exposition, to be held at St. Petersburg on the 17th of May, under the auspices of the Imperial Horticultural Society of Russia.

NECROLOGY.

The usual melancholy task of recording some deaths during the year, of employés and collaborators of the Institution, again falls upon me. I shall follow the order in time of the respective dates of decease.

EDWARD H. KNIGHT, born in London, June 1, 1824, came to this country and settled in Cincinnati in 1845, at the age of twenty-one. He died at Bellefontaine, Ohio, January 22, 1883, at the age of fifty-nine years. In 1864 he was employed in the United States Patent Office as general editor of its publications. During his connection with this great institution, availing himself of his rare advantages, he compiled his "American Mechanical Dictionary," which was completed and published in 1873 in three large octavo volumes. In 1876 he was selected as the commissioner in charge of the Patent Office exhibit at the Centennial Exhibition at Philadelphia. As one result of his observations at that great international display he wrote "A Study of the Savage Weapons at the Centennial Exhibition," which was published in the Smithsonian Report for 1879, occupying 86 pages, and illustrated with 147 sketches of various weapons sketched by himself. In 1878 he was appointed a commissioner to the International Exposition held in Paris in that year; and in the following year supervised the publication of the official report of the United States commissioners to the Exposition, in five octavo volumes. He had undertaken for the Smithsonian Institution the preparation of an elaborate work on the "Development of the Mechanic Arts," a subject he was well qualified by his studies and tastes to discuss in a comprehensive manner, but a project he did not live to accomplish.

PAUL SCHUMACHER was born in Hungary April 10, 1843. In 1865, at the age of twenty-two, he came to the United States. He remained several years in New York, where he acquired the English language by his own efforts. He left New York on account of ill health, and went to San Francisco, where he remained until he was employed by the United States Coast Survey. In this service he made his first collection of Indian relics along the southern coast of California and on the neighboring islands. Afterward, in 1875, he was employed by the Smithsonian Institution to extend his explorations as far north as Oregon. In 1880 he went to Guaymas, Sonora, to pursue his vocation of civil engineering and surveying, and also with the intention of continuing his archæological researches. While there, he became interested in mines, and during a visit to the San Antonio copper mines he was taken with fever, and died, after an illness of three days, on the 22d of May, 1883.

HERMANN DIEBITSCH was born in Neustadt, Silesia, Germany, on the 16th of March, 1818. He died at his residence in Washington, September 30, 1883. In 1825 he entered the academy of his native town, at the age of seven years; and in 1831 he entered the University at Breslau, but left it in 1835 to enter the Military Academy in Berlin, where he was graduated as lieutenant in 1838, and soon gained high rank in the Prussian army. In 1850 he came to this country, became connected with the Smithsonian Institution as meteorological clerk and observer in 1853, and remained there with some interruptions (during which he was employed in mathematical work for the Naval Observatory) until his death. For a number of years preceding his death he had charge of the exchange system of the Institution, though for the last year or so incapacitated from active work by a partial paralysis. He was a man of scholarly attainments, and possessed a clear, critical, and analytic quality of mind.

JOHN LAWRENCE SMITH, M. D., was born near Charleston, S. C., December 16, 1818, and died at his residence in Louisville, Ky., October 12, 1883, in the sixty-fifth year of his age. He was a graduate of the University of Virginia, and subsequently of the Medical College of Charleston After receiving his medical diploma, he spent several years in Europe, pursuing his studies. In 1844 he was appointed assayer of the State of South Carolina. In 1847 he received an invitation from the Turkish Government to become its mining engineer and to investigate and report on the conditions of cotton-growing in that country. While pursuing these new duties, he made a careful study of the geological and mineralogical characteristics of the emery mines of Turkey, spending about four years in this service. His memoir on the subject was published in the *Mémoires des Savants étrangers*. He also examined chemically and published a report on the thermal waters of Asia Minor.

Dr. Smith also invented, in 1851, the "inverted microscope," by which liquids placed upon a horizontal stage of thin glass could be conveniently examined from beneath, the illuminating rays passing downward and being then reflected upward to the eye.

In 1854 he visited Washington City, and became for a year or two the chemist of the Smithsonian Institution, in the laboratory of which he found a congenial place for pursuing his analytical researches, From the study of mineralogy—in which field Dr. Smith made important original observations—he was led to a careful examination of meteorites, to which subject he devoted the greater portion of his later years, and in which he became a recognized authority. He had accumulated a very large and valuable collection of these interesting cosmical bodies, now in the possession of Harvard College. A volume of 400 octavo pages, comprising his principal scientific writings, was published in 1873. Fully one-fourth of this matter is occupied with his various papers on meteorites.

Dr. Smith filled successively several professorships; was a United States commissioner to the Universal Exposition of Paris in 1867, and to that of Vienna in 1872; was president of the American Association in 1872; and was a member of the National Academy of Sciences.

George Shoemaker, an efficient assistant in the department of birds, died October 12, 1883, at his parents' residence in Georgetown, D. C., after an illness of more than a year. He was born in 1842, and had passed his 21st birthday only 16 days. His disease was pulmonary consumption, which first developed itself about the middle of September, 1882. Soon after being taken ill he went to Philadelphia, where he spent two months, thinking the change might be of benefit. In the spring of 1883 he went to Florida, and, after remaining two months, returned without having derived any benefit from the journey, but, on the contrary, much reduced in weight and strength. Early in September, on the recommendation of his physician, he went to Loudoun County, Virginia, in order to try once more the effects of a change of atmosphere. There he continued to lose ground so rapidly that he decided to return at the end of two weeks. He reached home in a very much weakened condition, but managed to keep up until within a very few days of his death. Mr. Shoemaker was a young man of much promise; faithful and consciencious in the discharge of his duties, and possessed of many excellent traits of character. He death was no less a loss to the department than a sad bereavement to his friends.

Dr. Leonard Dunnell Gale was born at Millbury, Mass., in 1800. He was graduated from Union College, Schenectady, N. Y., in 1825, and devoting himself chiefly to the pursuit of chemistry became early a professor of that science in several institutions of learning. In 1833 he made a geological survey of Manhattan Island, and not long afterward was appointed professor of chemistry and mineralogy in the New York City University. In 1836 he there formed the acquaintance of Prof. S. F. B. Morse, and by his familiarity with the discoveries of Professor Henry was enabled to render his colleague's project of an electro-magnetic telegraph successful in operation. In 1846 he came to Washington, and for eleven years was an examiner in the Patent Office in charge of the department of chemical inventions. In 1857, having been removed from that office, he practiced in this city for some years as expert and attorney in chemical applications.

In 1871 Dr. Gale became connected with this Institution as chemist in the laboratory, where he continued for a year or two.

He became considerably enfeebled in his later years, and died in this city October 23, 1883, at the age of eighty-four.

Dr. JOHN LAWRENCE LE CONTE was born in New York May 13, 1825, and died in Philadelphia November 15, 1883, in the fifty-ninth year of his age. His father, Maj. John E. Le Conte, of the Engineer Corps, was a writer on botany and zoology. Dr. Le Conte was graduated in 1846 from the College of Physicians of New York. He wrote some early papers on mineralogy and palæontology, but his principal studies were in the department of entomology, and more especially in the class of Coleoptera, to which division he devoted the labor of many years, and in which he made a very large and valuable collection of specimens. In 1850 he published a "Monograph of Pselaphidæ," and not long afterward an "Attempt to classify the Longicorn Coleoptera of America north of Mexico."

In 1858 Dr. Le Conte was requested to prepare for the use of the Institution "Instructions for collecting Coleoptera," which paper was published in the Smithsonian report for that year, and was also separately printed and widely distributed (as a circular) to collectors. In 1859 a paper by him on "The Coleoptera of Kansas and Eastern New Mexico" was published in the Smithsonian Contributions, Volume XI, occupying 64 quarto pages, with two plates and one map. In 1862 the Institution published his "Classification of the Coleoptera of North America," Part I, in 312 octavo pages, with 49 wood-cuts. (This was included in Volume III of the "Miscellaneous Collections.") In 1866 appeared "List of the Coleoptera of North America," Part I, in 82 octavo pages. ("Mis. Coll.," Volume VI.) In the same year "New Species of North American Coleoptera," Part I, in 180 octavo pages. ("Mis. Coll.," Volume VI.) In 1873 "New Species of North American Coleoptera," Part II, in 74 octavo pages. ("Mis. Coll.," Volume XI.) In the same year Part II of his "Classification of the Coleoptera of North America" in 72 octavo pages. ("Mis. Coll.," Volume XI.)

These works remain incomplete, but their author, after years of preparation, decided upon an entire revision and complete presentation of his subject. Meanwhile he prepared an important contribution to entomology in a treatise devoted to the "Species of Rhyncophora," which was published in 1876 by the American Philosophical Society.

In 1882, assisted by his pupil and friend, Dr. George H. Horn, he had ready (after an interval of ten years from its first issue) the new and revised edition of his "Classification of the Coleoptera of North America" greatly extended. Early in 1883 this important and elaborate work, comprising the latest labor of his life, was published by the Institution. It occupies (including the introduction) 605 octavo pages.

Dr. Le Conte was president of the American Association in 1874. He was a member of the National Academy of Sciences, president of the

American Entomological Society, and a vice-president of the American Philosophical Society.

MISCELLANEOUS.

The Mercer Bequest.—Reference has been made in a previous report to the will of the Rev. Dr. Mercer, of Newport, R. I., by which the Smithsonian Institution was made an ultimate legatee with Harvard and Yale Colleges and one or two individuals to administer a certain sum of money intended for educational purposes.

It is not expected that the Institution will be called upon to take any action for many years, possibly not in the course of a generation. The estate, however, has proved to be much larger than was originally imagined, and amounts to over $1,000,000.

Friendly proceedings are now under way for the purpose of determining the precise status of the several legatees, and the action which the executrix, Mrs. Pell, should properly take in the premises.

Naval Museum of Hygiene.—The Navy Department has been engaged for several years past in bringing together an exhibit of sanitary apparatus and appliances, whether used in the Navy or elsewhere; and as this subject at present has no special assignment or place in the National Museum, it was thought expedient, as a method of carrying out proper reciprocity with the other Departments, to transfer all the apparatus of that character to the charge of the Naval Museum of Hygiene.

The principal objects consisted of articles of terra-cotta and metal, intended for sanitary uses, and obtained at the International Exhibition of 1876. The specimens furnished constitute a very acceptable addition to the Naval Museum.

Portrait of Darwin.—The picture gallery of the Smithsonian Institution during the year has been enriched by a life-size portrait of Darwin, painted by E. F. Andrews, of Washington, and given by the artist. This has been duly assigned and placed in the Museum, and attracts much interest.

Priestley Relics.—At the suggestion of Professor Leeds, of the Stevens Institute, Hoboken, N. J., I made application to Mrs. Priestley, of Northumberland, Pa., in behalf of the Institution for the collection of apparatus used by her husband's ancestor, Dr. Joseph Priestley, the eminent physicist, and brought by him to this country many years ago. As the discoverer of oxygen, and other important elements in chemical science, and as one of the first to carry on chemical research in the United States, the memory of Dr. Priestley is highly revered by American chemists, and it was with much gratification that they learned of Mrs. Priestley's willingness to make the transfer.

By the assistance of Professor Leeds the collection was securely put up in a number of crates and hogsheads, which were forwarded to Washington. Arrangements will now be made to unpack these articles and place them where they will be most accessible to all persons interested.

Memorial Objects in the Pension Building.—One of the largest and most imposing buildings in Washington is the one being erected under the direction of General Meigs, in Judiciary Square, for the use of the Pension Office. A part of the architectural effect of this building consists in a series of columns of enormous size, and the happy thought occurred to General Meigs of making each column the depository of the archives and documents relating to the history of a Department of the Government. The offer of a column to the Smithsonian Institution was promptly made use of by furnishing a series of documents giving some notice of the past history and present condition of the Smithsonian Institution and the National Museum.

Instructions for Cave Research.—The Smithsonian Institution has always taken much interest in the investigations of caves for the purpose of obtaining specimens of prehistoric man, and of extinct and recent vertebrated animals.

In addition to the large collections made by myself at various times in this direction, and now forming part of the collections of the National Museum, the proceeds of the Hamilton bequest have been devoted for several years to this purpose. So far, however, the caves of the United States have not been as productive in collections as those of Europe. Having received very valuable collections of bones and relics from the celebrated Kent's Cavern in England, made under the direction of Mr. William Pengelly, that gentleman was asked to prepare a special treatise on cave research, to be published by the Smithsonian Institution in its Miscellaneous Collections. This offer has been kindly accepted, and it is hoped that the manuscript will soon be received and put to press.

Abert Collection of Minerals.—Among the most important single contributions to the National Museum during the year was that of four cases of minerals, presented by Col. James T. Abert, of Washington City, and constituting a large portion of the collection of his father, the late Colonel Abert, of the Topographical Bureau. This collection, although somewhat antiquated, from representing the condition of mineralogy more than twenty years ago, embraces a large number of very rare and interesting minerals, the localities of which have for the most part been exhausted, and which are now only procurable with great difficulty.

Obsequies of John Howard Payne.—Mr. John Howard Payne, so well known as the author of "Home, Sweet Home," died many years ago in Tunis, during his incumbency of the office of United States consul at that place.

Desirous of rendering proper tribute to his memory, Mr. W. W. Corcoran, the eminent philanthropist of Washington, undertook to have these remains transferred to the United States and placed under a suitable monument in the Oak Hill Cemetery near Washington.

The reinterment took place on the 9th of June; and in the appointment of pall-bearers, the Smithsonian Institution, among other literary and scientific establishments of the city, was recognized by the selection of its Secretary, to act in the above-mentioned capacity. The services on that occasion were very impressive, and attracted a large gathering of people.

UNITED STATES NATIONAL MUSEUM.

During the year the officers of the Museum have continued the work of rearranging the materials under their charge on the greatly extended space afforded by the completion of the new building. It will be remembered that this building was first occupied late in 1881, and that therefore 1883 is really only the second year of systematic effort. Some experiments in installation were made in 1881, but the chief thing accomplished was the accumulation in some of the inner courts of the building of the great mass of unassorted material which had been gathering for many years in the various store-rooms of the Smithsonian building and elsewhere, and which, on account of lack of space, had been allowed for the most part to remain in the original packing cases.

After a struggle of twenty-four months with this mass of unassorted material, the floors of the Museum have at length been cleared, and only three of the seventeen exhibition halls are now occupied for storage purposes.

A provisional classification of the departments of the Museum was adopted early in 1882, and during the past two years has been practically applied. Twenty-two scientific departments were provided for and grouped in five divisions, namely, anthropology, zoology, botany, geology, and exploration and experiment. There are also eleven executive departments, grouped together in the division of administration.

A brief review of what has been accomplished in each department up to the present time, and especially during the past year, will perhaps be the most satisfactory mode of bringing before the Board the present methods and tendencies of the work in the Museum. I shall not, however, attempt to discuss the additions of the year to the Museum, as those will be treated of in detail in the reports of the several executive officers, and of which a complete list, arranged alphabetically by donors, will be found in the Appendix to the Report of the Assistant Director.

Department of Art and Industry.—In the department of art and industry is included for the present all ethnological material except that belonging to prehistoric archæology. Under the head of ethnological material are included the products of the arts and industries of civilized as well as of semi-civilized and barbarous races. These collections are being arranged in accordance with a teleological rather than a geographical plan of classification, objects of a similar nature being placed side by side—musical instruments together, weapons together, &c.—and arranged in such a manner as to show the evolution of each idea from the most primitive type. In discarding the ethnographic method of arrangement, almost universal among museums, special care has been taken not to sacrifice the possibility of bringing together the objects belonging to any particular locality or race, if this shall at any time be required for purposes of study.

The department of art and industry must in time necessarily be subdivided into a number of special departments. At present, and until the material now on hand is properly assorted, such subdivision is not particularly to be desired. There have grown up, however, a number of sections in this department, the result of the accumulation of large quantities of material requiring the care of a special officer.

Section of materia medica.—This section is already thoroughly under control, the specimens beirg installed in exhibition cases in systematic order, and a large number of labels being attached. This department has been for two years under the care of Dr. James M. Flint, surgeon, U. S. N., who has been detailed for this service by the Surgeon-General of the Navy, and to whose skill the Museum is indebted for the development of a collection of medicinal substances probably unequaled elsewhere.

Section of methods of transportation.—The collection of models of boats and vessels now includes between two and three hundred specimens. This collection has been developed in connection with the fisheries collection, and is especially complete in representation of American forms, both aboriginal and modern. The series of primitive types is particularly full, and the collection, which will be installed in the room adjoining the fisheries collection, will, when arranged upon the evolutionary plan, be thoroughly unique.

Section of foods and textiles.—The Museum is very rich in the textile products and food substances of the North American aborigines and a number of foreign countries, acquired at the close of the Philadelphia Exhibition. Prof. W. O. Atwater, of the Wesleyan University, Middletown, Conn., has been acting as honorary curator of the section of foods, and has carried on extensive operations in the analysis of food products for the benefit of this collection and of the Fish Commission. Mr. Romyn Hitchcock, of New York, an experienced microscopist and chemist, has recently been designated acting curator of the department of textiles and acting assistant curator of the department of foods.

Section of Aboriginal pottery.—Mr. W. H. Holmes has been detailed by the Director of the Bureau of Ethnology of the Institution to prepare a report upon American aboriginal pottery, and the entire collections of the Museum have been placed in his hands for that purpose. This collection is very rich, and after its arrangement has been completed will be one of the most impressive in the whole Museum.

Section of historical relics.—The relics of George Washington and other distinguished persons, for many years displayed in the Patent Office, and the Lewis collection of Washington relics, purchased by Congress, and stored in the Patent Office, but kept in the original packing boxes, have during the year been given into the charge of the National Museum by the Commissioner of Patents. These have been placed on exhibition in temporary cases, together with many articles of similar nature already in the possession of the Museum.

Section of costumes, architecture, &c.—The wealth of the Museum in articles of costumes derived from the North American aborigines is very great, as well as in objects of all the classes of implements and other articles which usually make up the bulk of ethnological collections. The mass of unassorted material is still very large, and is being increased every week by the arrival of new collections.

The Catlin collection of Indian paintings, presented in 1881 by Mrs. Joseph Harrison, of Philadelphia, have been unpacked and placed on exhibition in the lecture-room.

The collection of musical instruments is deserving of mention, since it is, up to the present time, the only one, excepting the fisheries collection, which has been thoroughly arranged and labeled in accordance with the accepted plan of installation.

Department of Antiquities.—The department of prehistoric antiquities, under the charge of Dr. Charles Rau, has advanced with its usual steps of progress during the year. The present somewhat unsettled condition of the upper main hall of the Smithsonian building, in which these collections are stored, is due to the fact that the art and industry collections, formerly exhibited here, have been only in part removed, owing to the lack of exhibition cases in the new building.

Department of Mammals.—The accessions of the year have been numerous and important. The curator of mammals has devoted a considerable portion of his time during the year to the reorganization of the collection of skeletons, which is exceedingly rich in North American material. The cases for their reception not having been finished, the mounted preparations still remain in the Smithsonian building. The articulated skeletons have all been systematically arranged in the osteological gallery.

Department of Birds.—In the department of birds, under the care of Mr. Robert Ridgway, the work of the year has necessarily been confined to the laboratory, all the space in the ornithological galleries outside of the cases having been occupied by the offices of the Smithsonian Institution during the reconstruction of the eastern end of the building. There has been, however, very much important work accomplished in the rearrangement of the study series, and valuable collections have been received, especially from Dr. Stejneger and from others already mentioned in another part of this report under the head of "Geographical Explorations."

Department of Reptiles and Batrachians.—Under the charge of Dr. H. C. Yarrow, honorary curator, the usual administrative work has been accomplished, and an annotated catalogue of the American specimens belonging to the Museum has been published.

Department of Fishes.—This department is perhaps one of the most unwieldy in the Museum, its material being for the most part alcoholic. From 1865, when it was thoroughly disorganized by the fire in the Smithsonian building, up to 1871 this department was without a curator, though subsequently to 1881 the bulk of the collection was largely increased every year by the work of the United States Fish Commission. For two years Dr. Tarleton H. Bean, the curator, assisted by Messrs. Parker, Dresel, Miner, and Bean, has been engaged in re-arranging the entire collection and preparing a card catalogue, a task which has been doubly difficult owing to the lack of sufficient room in which to work. The collection is, however, now very well under control, and several thousand bottles have been set aside for the exhibition series. From June to October of this year Dr. Bean, was detailed for special service in connection with the International Fisheries Exhibition, and devoted a considerable portion of this period to the study of the ichthyological collections in London, Paris, Genoa, Vienna, Berlin, and Liverpool, establishing additional relations of exchange in those cities. This department has been, as usual, enriched by the work of the United States Fish Commisson, whereby many new species and genera have been added to the fauna of North America.

Department of Mollusks.—This department continues under the charge of Mr. William H. Dall as honorary curator, Mr. R. E. C. Stearns acting during a portion of the year as non-resident assistant curator. The collection has been greatly enriched by the acquisition of Mr. Stearns's collection of American mollusks and the very rich collections of J. Gwyn Jeffreys, esq., F. G. S., &c., of London.

Department of Insects.—The Museum is still unfortunately without a collection of entomological specimens worthy of the name, the valuable collections accumulated by the Government service having years ago suffered destruction in the hands of the Department of Agriculture, with whom they were deposited. Prof. C. V. Riley, who is acting as honorary curator of this department, has deposited his extensive collection of American insects in the Museum, and it is hoped that in time this may become the property of the United States.

Department of Marine Invertebrates.—The collections of crustaceans, radiates, worms, and protozoans are administered in charge of Mr. Richard Rathbun, being grouped together under the general heading of "Marine Invertebrates." The west hall of the Smithsonian building has been assigned to this department for exhibition purposes, but is still occupied in large part by collections belonging to other departments, so that the curator has had but little opportunity for perfecting the exhibition series. Very extensive progress, however, has been made during the year by the curator, assisted by Ensign W. E. Safford, Ensign C. S. McClain, and Mr. R. S. Tarr, in the way of assorting the material already on hand, and the distribution of duplicates. A card catalogue of the collection is nearly completed, and a number of important exchanges with several European museums have been made during the year.

Department of Invertebrate Fossils.—This department is now divided into two sections, Dr. C. A. White, honorary curator of the department, retaining charge of all except the Paleozoic fossils which are in the hands of Mr. C. D. Walcott, honorary curator of that department.

Department of Recent Plants.—The collection of recent plants, for many years in the custody of Dr. John Torrey, of New York, and afterwards deposited in the Department of Agriculture, have been kept in excellent condition by Dr. Vasey, curator of the department.

Department of Fossil Plants.—This department is administered by Prof Lester F. Ward, honorary curator, who, like the curators of fossil invertebrates, is an officer of the Geological Survey.

Department of Lithology and Physical Geology.—The collection of building stones under the charge of Mr. George P. Merrill, assistant, acting as curator, presents each month a more imposing appearance in the exhibition gallery. The space assigned to it has been considerably increased during the year. Owing to the expense of preparing the specimens, little has been done towards getting ready for exhibition the great hoard of material which lies at present unutilized, in the southwest court.

The curator of this department has recently undertaken the development of the collections in physical geology, but has not yet had opportunity to seriously begin work.

Department of Minerals.—Since the death of Dr. George W. Hawes, curator of this department, Mr. W. S. Yates, aid in the Museum, has had charge of the mineral collections, and has nearly completed the task of rearranging and classifying the material. Prof. F. W. Clarke, chemist of the United States Geological Survey, was appointed honorary curator on December 3.

Department of Metallurgy and Economic Geology—Mr. Frederick P. Dewey has been appointed full curator in this department. Until within a few weeks nothing had been done towards developing the exhibition series, the time of the curator and his assistant having been devoted to the overhauling and cataloguing a portion of the great mass of unassorted metallurgical material acquired by the Museum at the close of the Philadelphia Exhibition. There is still an immense quantity of ores and metallurgical products stored away in the original packing boxes within the Museum building, and also in a temporary shed attached to the armory building. This latter was obtained by Mr. Thomas Donaldson at the close of the so-called "permanent exhibition" on the Centennial grounds in Philadelphia.

During the absence of the Assistant Director in Europe, Mr. Frederick W. True, curator of mammals, rendered most efficient service.

BUREAU OF ETHNOLOGY.

The appropriation made by Congress for the prosecution of ethnological researches among the North American Indians was increased at the last session from $35,000 to $40,000. The work has remained in charge of Maj. J. W. Powell, who has furnished the following account of operations during the past year:

Mound Exploration.—The work of exploring the mounds and other ancient monuments of our country, begun in 1882, was carried on during the year 1883 under the charge of Prof. Cyrus Thomas.

The same persons, to wit, Col. P. W. Norris, Mr. James D. Middleton, and Dr. Edward Palmer, who were engaged during the previous year, were retained as the regular field assistants through 1883.

Colonel Norris spent the latter part of the winter and early spring in Arkansas and Mississippi, and made, in the months of June and July, a trip to Upper Wisconsin, Northern Minnesota, and Dakota in order to ascertain the character of the new earthworks found in that northwestern region. The remainder of the year he was engaged in opening mounds in the Kanawha Valley in West Virginia.

Mr. Middleton's field of operation for the latter half of the winter and the spring was confined to the northern parts of Georgia and Alabama. During the last part of the year he has been carrying on mound explorations in Wisconsin and southward as far as Northern Arkansas.

Dr. Palmer has confined his operations during most of the year to Central and Southern Arkansas and Northern Louisiana. He was engaged a short time in examining interesting cave deposits in Central Alabama.

Besides these regular assistants, Mr. John P. Ragan, Mr. John K. Emmert and Mr. L. H. Thing were engaged for short periods as temporary assistants.

In June Mr. Ragan explored certain mounds in Caldwell County, North Carolina, which had been reported by Dr. J. M. Spainhour, of Lenoir, who also rendered very great aid in this work. Afterwards Mr. Ragan was sent to the southern part of Georgia and into Florida. Mr. Emmert was temporarily employed in opening mounds and graves in East Tennessee, and in investigating the maufactnure of imitations of ancint relics in Western North Carolina. Mr. Thing devoted a short time to the exploration of the earthworks and ancient cemeteries of Southern Illinois and Southeast Missouri.

The number of specimens collected during the fiscal year ending June 30, 1883, as shown by the catalogue prepared for the bureau, is 4,110. It is believed that about one-half, or 2,000, of these specimens were obtained in the first six months of 1883. The number collected during the latter half of the year has not been accurately ascertained, but is supposed to be 1,500, making in all for the calendar year 1883 about 3,500 specimens. They embrace almost every type of articles hitherto found in the mounds and other ancient works of that portion of the United States to which the operations of the year have been confined, as well as quite a number of new types.

Among the more interesting finds are a remarkably fine series of polished celts, a large number of steatite pipes with handles, three winged pipes of green chlorite slate finely worked, two very large stone image pipes, gorgets, plummets, and boat-shaped ornaments.

A very fine collection of mound pottery has been obtained, containing many whole pieces, presenting almost every type, both as to form and ornamentation, heretofore discovered in these earthworks, also a few that are unique as to shape and decoration. Quite a number of shell and bone ornaments and implements were obtained, among which are some of the finest specimens of engraved shells so far discovered.

The collection also includes a number of copper implements and ornaments, some of which are very fine and unique.

Among the articles obtained indicating contact with European civilization are some iron implements from a North Carolina mound and fragments of copper plate from several localities bearing the impress of machinery.

The most important results of these explorations to the students of American archæology are the facts brought to light concerning the manners and customs of the mound-builders and the purposes for which these mounds and other ancient works of our country were erected. They clearly demonstrate that a large portion of those in the Southern section were built for domiciliary purposes or as foundations for houses, and that these houses were plastered with clay, the plastering often being stamped with an implement made of split reeds, and frequently painted, and that the houses were usually thatched with grass or straw.

A new class of mounds, so far as the internal structure is concerned, has been discovered, bringing to light a different mode of sepulture from any previously observed.

The number of mounds opened during the year was large, reaching several hundreds, but cannot be definitely stated.

These explorations have been specially successful in the light they have thrown upon the question often asked, "Who were the mound-builders?"

Explorations in the Southwest.—In continuing the investigations of the preceding year, excursions were made by Mr. James Stevenson in the summer and fall of 1883 through sections of the Southwest not heretofore carefully examined, for the purpose of obtaining their archæologic value and to determine to what extent future explorations would be required. These observations resulted in the discovery of several more ruined cave and cliff cities differing in some respects from any before examined. The most remarkable was a village of sixty-two underground dwellings, situated near the summit of one of the volcanic foot-hills of the San Francisco Mountains in Arizona. The surface stratum of the hill had by exposure become hardened, and formed the common roof for the entire community. The dwellings were excavated after a common pattern, and a description of one will convey an idea of the whole. They had no communication beneath the surface, and were only accessible by means of square holes leading from the surface by a vertical shaft to the main room of the dwelling. Foot-rests—holes at convenient distances along the sides of the shaft—served the purposes of a stairway. At the bottom of the shaft was found an oval-shaped arched-roofed room, about twenty feet in its smallest diameter. At the ends and on the sides opposite the entrance low doorways connected the main room with smaller rooms, the whole suite of rooms or dwelling consisting of four apartments. One of the smaller rooms had its floor excavated to a depth of two or three feet below the floors of the other rooms, and is supposed to have served the purpose of a store-room or cellar for the ancient occupant. The other small rooms may have been sleeping rooms. A groove 18 inches deep by 15 in width, extending from the floor of the main room up one side of the shaft to the surface of the hill, its bottom filled with ashes and its sides blackened by smoke, formed the fire-place and chimney of the establishment. Around the mouth of the shaft a stone wall was found, forming by its inclosure a kind of door-yard to the dwelling below. Considerable *débris* was found in these dwellings, an examination of which led to the discovery of many curious objects, illustrating some of the social and domestic customs of the inhabitants.

Stone mauls and axes, the implements used in excavating the dwellings; pottery bearing a great variety of ornamentation; bone awls, and needles of delicate workmanship; the metate or family grinding-stone for grain, its well-worn surface indicating long use; shell and obsidian ornaments and implements of wood, the uses of which were undiscoverable, were among the trophies of the exploration. Search was made for a water-course or spring, but no appearance of the existence of water in the neighborhood was discovered.

There were signs of intercommunication between this village and a cliff-city some 15 miles distant, which indicated the contemporaneous inhabitancy of the two.

This city, or rather cluster of villages, also a new discovery, occupied the sides of a cañon which has recently been christened Walnut Cañon. The sides have been gullied by storms and torrents, leaving shallow, cave-like places of great length at different heights, along the bottoms of which, wherever the ledge furnishes a sufficient area, dwellings in groups or singly were built. The season was well advanced when the place was reached, and only little time was spent in its exploration.

All the ancient methods of approach have been long worn away, and access to the nearest of the groups of houses was a work of difficulty.

The group or village which was most narrowly examined was about half a mile in length, and consisted of a single row of houses, the common rear wall being the lining-rock, while the sides and front were made of large squared stones laid in clay. A narrow street or pathway extended along the entire front. Other and similar villages could be seen along the cañon for some distance.

Among the relics found here was a wooden spindle whorl similar to those in use by the Pueblos of the present time, but unlike them in the apparent manner of its manufacture. Nothing indicating the use of metallic tools of any description was discovered. The surface of the wood of which the whorl was formed had apparently been charred and then ground down to the required size and shape by rubbing it upon sandstone. A shaft of reed resembling bamboo still remained in the whorl. It had been broken by the maker and neatly mended by winding about it a piece of fine twine. The ends of this twine being examined under the microscope disclosed the fact that its fiber was made of very fine human hair.

Articles of wood, corn-cobs, and even the perfect grains of corn; walnuts, bones of elk, antelope, and wolf; portions of wearing material of a fabric resembling the mummy cloth of Egypt, but made from material unfamiliar to the explorers, and other perishable articles, were found in abundance buried in the piles of *débris* which partially fill these deserted homes, and would, at first thought, seem to indicate somewhat recent inhabitancy. On the other hand, however, the preservative qualities of the atmosphere of this region are remarkable, and it is the belief that centuries have elapsed since the last of the departed race or races occupied these old cities and villages as homes.

Explorations in Arizona and New Mexico.—Mr. Victor Mindeleff, aided by Messrs. Cushing and Atkins, proceeded, in the early part of the year, to the Moki towns for the purpose of making ethnologic collections.

O-rai-be, the most distant of the villages, was the first visited, but much opposition was encountered, in that a large majority of the natives were found to be inimical to Americans.

In consequence of this the O-rai-be collection was small, numbering only about one hundred and fifty pieces, which had been secretly offered in trade, despite the strict injunctions to the contrary of those in authority. A catalogue of this material was prepared by Mr. Cushing from notes made in the field.

After leaving O-rai-be, camp was established at a point convenient to the remaining villages, near Ma-shong-i-ni-vi, of the "middle mesa." Here a large collection was secured, principally from the villages of the middle mesa, of modern pottery, basket ware, dance paraphernalia, and stone implements, as well as a valuable collection of well-preserved ancient pottery, embracing a variety of forms and decorations.

During the intervals of collecting at Moki, several visits were made to Mr. Thomas V. Keam's place, near by, where drawings, notes, and photographs were made of his extensive collection of ancient pottery.

On August 15, Mr. Mindeleff again took the field for exploration among the cliff ruins of Cañon de Chelley, but on reaching the fitting-out point an anticipated outbreak among the Navajos and the unsettled condition of the Indians compelled a temporary postponement of work in that region, during which time a visit was made to the extensive ancient pueblo ruin known among the Navajos as "Kin-tiel." This ruin is situated near the eastern border of Arizona, about 25 miles south of Pueblo, Colorado.

Small subordinate ruins occur on various prominent points, bordering the long narrow valley that extends north from the main ruins which from their position, overlooking arable land, may have served as farming habitations occupied only during the summer season, as Nutica and Pescado, near Zuñi, are at the present day. This large and compactly built pueblo is on two sloping hillsides which come together in an "arroyo," or wash. A large part of the northern half, where the walls follow a broad curve, is still standing to a height of from 10 to 15 feet. The masonry shows a high degree of skill and is in a good state of preservation. The external curved wall is nearly 3 feet thick in many places on the lower floor, and usually 6 inches less above. A noticeable feature is the occurrence of small square loop-holes pierced obliquely through the external wall. The walls of the lowest story were usually several inches thicker than those above, thus forming a projecting ledge upon which the floor beams rested. Several beams were found in place. Architectural plans of the ruin were made, together with a contour map of the ground to illustrate its relation to the topography. Sketches and photographs were also made.

In excavating on the bank of the "arroyo" a short distance from the ruin, a nearly complete skeleton was found lying on its right side. From the grave were taken two bowls of ancient ware, but no trace of textile fabric was discovered. At a point within the ruins the bank of the "arroyo," having been partly washed away, had caved in, exposing to view a complete vertical section of two rooms. On clearing away the *débris*, broken pieces of pottery and fragments of a pierced round stone disk were found.

Digging at a number of places resulted in the exposure, at the eastern end of the ruin, of a large room in which many objects of interest were found, among them an unbroken circular stone slab, with a hole large enough to admit the body of a man, solidly built into a partition wall and serving as a doorway.

The same room contained a well-preserved fireplace, large, smooth, baking stones, metates, mortars, broken pottery, and bone implements.

The manner in which these objects were scattered about the room indicated a sudden abandonment. While here, Indians brought in reports of remains farther south, extending into the neighborhood of Zuñi. These reports were confirmed by statements of Mormons from that vicinity. These men also gave accounts of numerous pueblo remains in the region southwest of Zuñi, near the headwaters of the Little Colorado, in and about Round Valley.

November 1, Mr. Mindeleff reached Cañon de Chelley. A closely detailed meander survey was made of the cañon, with its network of branches, as also of a small neighboring cañon containing ruins, not heretofore visited. This plot was made on a large scale to admit of showing the relation of the position of the ruins to the arable land and other topographic features.

The lateness of the season and short supplies (for one month's stay) made it necessary to devote nearly all of the time to exploring, mapping and securing plans and sketches of the ruins. Some excavations, however, were made, and interesting textile remains, such as rugs, sandals, and cordage of yucca fiber and cedar bark, were found.

The number of ruins found was far beyond what was expected, about one hundred and thirty-five ruin-sites having been noted.

In exploring branch cañons many ruins of large extent were observed, some of them containing several large circular chambers with very thick massive walls beautifully finished inside with smooth coats of cement, and sometimes with a decorative band near the floor. In one case the drawing was very skillfully executed in red paint on a white ground, very similar in character to designs found on ancient pottery. These larger ruins are not nearly so well preserved as the small ones. They have evidently been the principal dwellings of the ancient people of this region, and seem to have been visited with a destruction which the more insignificant cliff outlooks have escaped.

On finishing the work in Cañon de Chelley, a trip was made to the pueblo of Acoma. A representative collection of modern ware was secured, composed principally of large jars, small vessels being comparatively rare at this pueblo. Very few specimens of ancient pottery were found here.

During intervals of collecting, a survey and a plan of Acoma were made for the preparation of a model similar to those of Zuñi and the Moki villages.

Explorations at Zuñi.—In August, 1882, Mr. F. H. Cushing proceeded to the Seneca Iroquois Reserve, in Western New York, with the Zuñi Indians who had accompanied him on his Eastern trip. Here he visited the Senecas of Tonawanda, learning important and obscure facts relative to their social and more especially their "Medicine" organizations. In the latter he found evidence of a society of "medicine priests" functionally identical with a similar organization among the Zuñis, the latter being that of the *Kâ′-kâ-thla na Kwe* or "Grand-Medicine-Dance Society."

Proceeding thence, he arrived at Zuñi, N. M., on the 23d of September. Here, during the month of October, he resumed note-taking, sketching of Zuñi dances and ceremonials as they happened to occur, adding to his vocabularies and memoranda on the sociologic system of the tribe, their ceramic-art decorations, and mythology. On the 5th of November he went to the Moki towns to assist, in concert with J. Stanly Brown, esq., in the collecting of ethnologic specimens therefrom. On nearing Keam's Cañon, the point of rendezvous, it was determined advisable that he should make a visit of reconnaissance to Oraibe. Nearing Walpi, he was driven in by a severe snow-storm, but he had the good fortune to meet there a visiting chief from Oraibe. With him he consulted and negotiated, making him the messenger of his arrangements for trading with the tribe in question. He then returned to Keam's Cañon.

Pending the arrival of goods at Moki, Mr. Cushing returned across the country to Zuñi, for the purpose of observing more minutely than on former occasions the annual sun ceremonials. *En route* he discovered two ruins, apparently before unvisited.

One of these was the outlying structure of *K'n'-i-K'él*, called by the Navajos *Zĭnni-jin'ne*, and by the Zuñis *He'-sho'ta pathl-tâĭe*, both, according to Zuñi tradition, belonging to the *Thlé-e-tâ-kwe*, the name given to the traditional northwestern migration of the Bear, Crane, Frog, Deer, Yellow-wood, and other gentes of the ancestral pueblos.

It is a two-story structure, of selected red sandstone slabs, around the base and over the summit of a huge outcropping bowlder, and is nearly intact, most of the floor of the second story, roof, lintels, etc., still being in good state of preservation. It is situated in the mouth of one of the arms of K'ĭn-i-kéel, or "Dead Run" Cañon, 25 miles northwest of the station of Navajo Springs, on the Atlantic and Pacific Railroad. In the ground-room of this structure, leaning against a trap opening in the floor of the second story, were found the poles of a primitive ladder, notched with stone instruments at regular intervals on the corresponding sides. To the lower portion of the poles was bound with yucca fiber a much-decayed round, still complete, but too feebly attached to allow of disturbance. The structure details of the rooms of the second story were noteworthy features, indicating the relationship of the building with the ruin of K'ĭn-i-kéel, and thus, in a measure, confirming the Zuñi tradition.

As soon as the ceremonials of the sun had been completed, Mr. Cushing again set out, with Nánahe (a Zuñi of Moki nativity) as interpreter, for Moki, via Holbrook, Ariz., and proceeded with Victor Mindeleff, esq., and his expedition to Oraibe on the 19th of December. On account of the unfavorable attitude of the natives, it was determined that further efforts would prove comparatively fruitless of results; hence the expedition proceeded from Oraibe to an encampment near the mesa of the two Moki towns, Mi-shong-i-ni-vi and Shĭpau-i-li-vi. Here Mr. Cushing superintended the collecting of more than twelve hundred specimens, at the same time noting several examples of Moki folk-lore and tradition, and studying the considerable collections of antique pottery gathered, some of the results of which latter studies will appear in forthcoming reports.

On the 19th of January, 1883, Mr. Cushing returned to Zuñi and continued his investigations relative to the sociologic system of the Zuñis. He added during the months of March and April more than five hundred pages to his notes on Zuñi folk-lore. He also made a brief trip to the ruin sections of Zuñi tradition, lying toward the southwest, accompanied by an artist, W. L. Metcalf, as a volunteer assistant, and two Indians. His discoveries near the Escudilla and farther north, in Eastern Arizona, were more important, archæologically, than he had before made.

Linguistic Field Work.—Mrs. Erminnie Smith, whose former work had been devoted to the Iroquoian tribes of New York and Upper Canada, was this year engaged among those of Lower Canada, principally Mohawks. The isolation of these Indians for nearly two hundred years from the other Iroquois has afforded interesting comparisons regarding dialect and customs. A large amount of literature, consisting of sermons, catechisms, vocabularies and dictionaries, the most important of which was in manuscript, the work of French Catholic missionaries, was obtained. By this means the Mohawk synonyms for many words before collected by Mrs. Smith in the Tuscarora, Onondaga, and Seneca dialects, were ascertained.

Mr. Jeremiah Curtin visited the Indians on the Seneca Reservation, New York, and collected a large body of linguistic and mythologic material, and afterwards proceeded to Indian Territory with the same object.

Mr. H. W. Henshaw, in the latter part of the year, was occupied in Nevada and California. He procured a very complete vocabulary of the Washo language from the members of that tribe, about 300, in the neighborhood of Carson, establishing the former supposition that the Washo language is the sole known representative of a linguistic stock. A similar vocabulary of the Panamint language, hitherto unknown, was obtained, showing it to belong to the Shoshone stock. The Panamint tribe was found not to be so near extinction as had been popularly supposed, there remaining about 150 individuals.

Dr. W. J. Hoffman visited the Ottawa, Ojibwa, and Pottawatomie Indians of Northern Michigan, and the Sisseton and Mdewakantannawn bands of Dakota, in Minnesota and Dakota, with special reference to the study of pictographs and gesture language.

Rev. J. Owen Dorsey, during January and February, was on the Kansas and Osage Reservations, in the Indian Territory, where he gained considerable linguistic and ethnologic material from the Indians, who speak dialects related to that of the Ponkas and Omahas. Among this material may be specified two dictionaries, of fully three thousand words each, grammatical notes in each dialect, native texts, including myths, historical papers, and epistles and sociologic notes.

Office Work.—Col. Garrick Mallery, United States Army, has been engaged in further researches and extensive correspondence for the completion of a monograph on sign language, and in the preparation of an introduction to the study of pictographs, with the requisite illustrations. In this work he has been assisted by Dr. W. J. Hoffman.

Dr. H. C. Yarrow has continued the preparation of his monographs on mortuary customs, and also has been occupied in obtaining data for a work upon the medicine practices of the North American Indians.

Mr. H. W. Henshaw was engaged in preparing a report upon Indian industries, both from historical data and from the returns of the Indian census.

Prof. O. T. Mason has prepared a report upon Indian education, based upon material obtained from the office of the Commissioner of Indian Affairs, from correspondence with every school and college in the United States, from the reports of the Indians, and from the general census. This has been arranged with reference to the name, location, and linguistic stock of every tribe, detailing the school facilities, attendance, and literacy.

During the year Mr. W. H. Holmes had general charge of the collections of the Bureau outside of those from the mound district, and has made the necessary classification and catalogue thereof. He has also been acting as honorary curator of pottery in the National Museum, and has spent much time in classifying and arranging the very large collections in that department. In connection with this work he has made some interesting investigations relating to ancient American ceramics. The most important of these were studies of the use of textile fabrics in the manufacture of pottery by the ancient tribes of the Atlantic slope, and of the art of "coiling" for the same purposes by all the American people. Exhaustive papers have been prepared upon these subjects.

Mr. Holmes has also had charge of the department of illustration of the Bureau conjointly with that of the Geological Survey.

Mrs. Erminnie Smith was engaged in translating into English the manuscript French-Mohawk dictionary of Rev. Father Marcoux, procured by her, in which the spelling of the Indian words was changed to that adopted by the Bureau of Ethnology. She also prepared a chrestomathy of the Mohawk dialect, and a table containing a large number of words in use among the isolated Mohawks, with their synonyms as used by the Mohawks on the "Six Nation Reserve."

During the year the Bibliography of North American Linguistics, by Mr. J. C. Pilling, was slowly put in type, only 350 pages having been added. To this work Mr. Pilling has only been able to give such time as could be spared from other more pressing official duties. In the spring he made a trip to the west coast of the United States for the purpose of inspecting the books in certain libraries in California, and in the fall a visit of a few weeks to some of the principal libraries of the East, notably the Lenox Library and the Astor Library of New York, and the valuable private libraries of Dr. J. Hammond Trumbull, of Hartford, and Dr. D. G. Brinton, of Media, Pa. There are now 900 pages of the Bibliography in type.

Mr. Jeremiah Curtin prepared, in part from material in the office, vocabularies of the Muskoki, Caddo, and Seneca languages, and of the Chinook jargon, also a collection of Seneca folk-lore.

Mr. C. C. Royce resumed the preparation of a historical atlas of Indian affairs.

This work will indicate upon a series of charts the boundaries of all cessions of land made to the United States by the several Indian tribes, the location of present and former Indian villages, and all points or places of historical interest, reciting briefly the location, character, and condition of each tribe in its earliest relations with the whites; its migration, wars, and diplomacy to the formation of the Federal Government, and a particular account of the various treaties with the United States, together with the causes and results thereof. The progress of the year covers the cessions in all the States and Territories between the Mississippi River and the Pacific slope; also the greater part of Wisconsin, Michigan, and much in Tennessee, North Carolina, and Georgia, as well as the collection of a large amount of historical data relating to the different tribes.

Mr. Albert S. Gatschet was engaged in revising the items composing his English-Klamath Dictionary and putting them in shape so as to be ready for the press.

Many of the longer items had to be rewritten entirely from the materials on hand.

In the middle of May type-setting began on the work, and it was completed and stereotyped by the latter part of August. Including the preface, this second part of the dictionary now contains 205 quarto pages, with about 4,400 items.

Mr. Gatschet also undertook the revision of the manuscript of his grammar, part of which had to be rewritten.

The Dakota-English portion of the Dakota Dictionary of Rev. S. R. Riggs, D. D., being 655 pages of proof, was finally corrected in April, 1883. The death of this distinguished missionary and scholar in August, 1883, required the transfer of the preparation of the English-Dakota part of the dictionary to Rev. John P. Williamson, who has since been engaged upon it.

From March to December, inclusive, Rev. J. Owen Dorsey was occupied in the preparation of a Kwapa vocabulary of several hundred words, and the Kansas and Osage dictionaries, from the material collected by him in Indian Territory, as well as in the transliteration of part of the Ponka dictionary, to make it conform to the last alphabet of the

Bureau. This last work will form Part II of "Contributions to North American Ethnology, Volume VI, The Ȼegiha Language."

Prof. Cyrus Thomas, who had charge of the explorations of mounds, has taken the precaution to have all the specimens carefully and properly labeled and numbered, from the time they were discovered in the field until they received the Museum catalogue number. He has also prepared a corresponding catalogue, in which are carefully noted the locality where each specimen was found, the name of the collector, and whether found in a mound, grave, or on the surface, so that archæologists can ascertain the history of any specimen by reference to the specimen itself.

In addition to this, a catalogue of the collection of the fiscal year ending June 30, 1883, with numerous illustrations, has been prepared for the Bureau and is now awaiting publication. Each assistant has made a full report of his work up to June 30, 1883, which will be brought together in the general report now in course of preparation by Professor Thomas. A large number of plates and illustrations of mound groups, ancient works, and mound sections accompany these reports, which will be used to illustrate the general report.

Mr. Victor Mindeleff was engaged during part of the year in making a series of large models in papier-maché of the Moki villages from the plans and measurements taken by him on the ground.

The Third Annual Report has been prepared and delivered to the Government Printer, its contents being as follows:

Manuscript Troano, by Prof. Cyrus Thomas.

Masks of the Northwest, by William H. Dall.

Omaha Sociology, by Rev. J. O. Dorsey.

Navajo Weavers, by Dr. Washington Matthews.

Catalogue of a portion of the ethnological and archæological collections made by the Bureau, etc., by William H. Holmes.

Textile Fabrics of the Mound Builders, derived from impressions on pottery, by William H. Holmes.

Illustrated catalogue of the collections from New Mexico in 1882, by James Stevenson.

During the year many linguistic manuscripts of value were received from collectors to whom the "Introduction to the Study of Indian Languages" had been furnished.

UNITED STATES GEOLOGICAL SURVEY.

It has been customary for the Secretary of the Institution to present each year a condensed account of the work performed by the Government Survey; and accordingly the following summary of its operations is given, kindly furnished by Major J. W. Powell, Director of the Survey:

In the act making appropriations for the fiscal year 1882–'83 Congress required the Geological Survey to make a geologic map of the

United States, thereby giving the Survey authority to extend its operations over the entire country in so far as necessary to effect that purpose. Inasmuch as the preparation of a geologic map requires a correct topographic map as its basis, it became necessary to adopt a scale for a general map of the United States, and also a method of graphic representation. The experience of the various geologic surveys carried on by the General Government and by the several States has shown that the smallest scale that can ordinarily be used on a map for general geologic purposes is 4 miles to the inch, and that vertical relief is best indicated by contours with intervals of 25 feet or 200 feet, according as the country represented is plain or rugged in its topographic features. Certain districts in which the geology is complex may require elaborate maps on larger scales, but for the general map the scale of 4 miles to the inch has been adopted as best suited for the purpose of geologic representation.

It is proposed to publish this general map in atlas sheets, each to include one degree of longitude by one of latitude.

To accomplish this topographic work in the shortest possible time and with the greatest economy, it was decided to take advantage of all work previously done, whether by the General Government, by the several States, by counties, townships, or by industrial corporations and individuals. In order to compile and adjust the material obtained from these various sources, a topographic division was organized, under the charge of Mr. Henry Gannett, who, in addition to the work of compilation and adjustment above referred to, began field operations, carried on to a limited extent in 1882, but extended and systematized in 1883.

Topographic Work.

The plans for the topographic field work for the season of 1883 contemplated a large increase of work in the Southern Appalachian region, the commencement of work in Massachusetts, the further prosecution of work in New Mexico and Arizona, in Northern California, and the commencement of a detailed map of the Yellowstone National Park. It was further proposed to extend the map of the Elk Mountains in Colorado, which was made by the survey under Dr. F. V. Hayden in 1874, besides numerous detailed maps in different sections of the country. Field work in the Arizona and New Mexico district, known as the "Wingate division," was commenced in the latter part of May, under the direction of Prof. A. H. Thompson. The division was organized first with one party for carrying on triangulation and two for topographic work, which organization was continued until the 1st of July, when another topographic party was added. The character of the country, which consists essentially of rolling plateaus commanded by buttes of no great height, was such as to permit of very rapid topographic work. The weather also was favorable during the entire season, and the result was that this division covered a very large area, estimated at 22,000 square miles, comprising the region lying between the parallels of 35° and 37°, and the meridians of 109° and 111°, and with an additional rectangle on the southeast, comprised between the parallels of 35° and 36° and the meridians of 107° and 109°. A small portion of the latter had been surveyed during the previous year. While this region was, as stated before, in the highest degree favorable to the rapid prosecution of topographic work, it was decidedly unfavorable for triangulation, requiring almost everywhere the use of artificial signals and much cutting away of timber. The area covered includes much that has been hitherto a *terra incognita*, partly on account of its aridity and barren condition, and partly on account of the difficulty of traversing it. So little has been known of it that within the area surveyed by Mr. H. M. Wilson (in charge of one of the topographic parties) a small mountain range has been indicated as occupying two places on the same map. Mr. Wilson is also the first white man to ascend Navajo Mountain, a dome-shaped mass that rises 4,000 feet above the general level of the country, between the San Juan and the Colorado Rivers, near the mouth of the former. At the close of the field season, Professor Thompson determined by astronomic methods the geographic position of Fort Wingate.

The field work of the California division was, as during the previous year, intrusted to the charge of Mr. Gilbert Thompson. The division was organized and took the field early in July. It consisted of two parties, one under the immediate supervision of Mr. Thompson and the other under Mr. Mark B. Kerr. The season proved to be exceptionally unfavorable. Not only was the work seriously interfered with by storms, but during nearly the whole season smoke and haze obstructed the view. In spite of these difficulties the topographers surveyed an area estimated at between 4,000 and 5,000 square miles, lying in the northern part of the State, about Mount Shasta, and extending westward therefrom into the Coast Range.

The work of preparing a detailed map of Yellowstone Park upon a scale of 1 mile to an inch was intrusted to Mr. J. H. Renshawe. Outfitting his party at Bozeman, Mont., he reached the Park and commenced work on the 7th of August, prosecuting work as late as the season would admit. Early in October, however, severe snow-storms caused a cessation of field operations, and he was obliged to withdraw to lower altitudes. The area covered by his party during the season was about 1,500 square miles, lying in the northwestern corner of the Park, and embracing the southern end of the Gallatin Range, and a considerable area of plateau country, extending hence southward down to the Geyser basins. Upon the return of the party to Bozeman, in October, a remeasurement with compensated bars was made of the base line at that place laid out and surveyed by the "Geographical Surveys West of the One Hundredth Meridian" in 1877.

During the year 1874 the Geological Survey of the Territories, under Dr. F. V. Hayden, made a somewhat detailed topographic map of the Elk Mountain region, in Western Colorado. This region, comprising one of the finest bodies of mountains in the country, has recently acquired prominence as a mining district both of the precious metals and coal. The extension of this work on the southwest, in order to include within its limits all of the mining district as now constituted, was intrusted to Mr. Anton Karl. It was commenced during the month of July, and carried on nearly to completion when Mr. Karl was called away for the purpose of verifying the survey of the Maxwell grant, in Northern New Mexico. Mr. Karl performed this latter duty to the satisfaction of the Department, and, upon its completion, the season being far advanced, field operations in the Elk Mountain Region were postponed until the following year.

The revision for the survey of the Southern Appalachians was organized upon a considerably enlarged scale, five topographic and two triangulation parties being put into the field. Three of the former, under Messrs. Yeates, Bien, and Pearson, took the field during the month of June, and at the same time one of the triangulation parties, under Prof. W. C. Kerr, commenced work. The area assigned to Mr. Yeates comprised the southwestern part of the mountain region of North Carolina; that to Mr. Bien, the northeastern part of this area, the southwestern corner of Virginia, and McDowell County, in West Virginia; that to Mr. Pearson, the valley of East Tennessee, with instructions to work from the boundary line of Virginia down the valley as far as the season would permit. The triangulation party was instructed to cover the area assigned to these three parties with a scheme of triangulation of sufficient accuracy to control their work. Early in July, topographic party No. 4, under Mr. W. A. Shumway, was put into the field, with instructions to survey the area lying between the Kanawha and Big Sandy Rivers, in West Virginia. Triangulation party No. 2, under Prof. J. Howard Gore, also took the field about this time, with instructions to connect the Coast Survey transcontinental belt, which follows generally the Kanawha River, with the work of the other party under Professor Kerr. At the same time, topographic party No. 5, under Mr. S. H. Bodfish, was put into the field, with instructions to survey the western part of Maryland and the adjacent portions of Northern West Virginia. Shortly after Mr. Bodfish took the field his health failed and it became necessary for him to relinquish charge of the party. Mr. W. T. Griswold was intrusted with the further prosecution of the work.

The weather throughout this region was unfavorable. The journals of the parties show that fully one-half of the days were so stormy as to preclude field work; furthermore, the character of the country, especially the density of its forests, makes field work at all times slow and difficult. Nevertheless, an area of fully 2,200 square miles was surveyed, a result attained only by great energy and ingenuity in overcoming and circumventing obstacles.

The survey of Massachusetts was intrusted to Prof. H. F. Walling, so long well known as the compiler of maps of the Northeastern States, and latterly by his topographic work upon the United States Coast and Geodetic Survey. Work was commenced among the Berkshire Hills in Massachusetts in July, and carried on until the close of the year, an area of 1,500 square miles having been surveyed, upon a scale of 2 miles to an inch. In carrying on this work very material assistance has been derived from surveys, either by the United States or State authority, or by private corporations or individuals.

In the Mono Basin, Mr. Willard D. Johnson spent the summer in topographic work, under the immediate supervision of the geologist in charge of the division of the Great Basin. He was occupied the greater part of the season upon a map of the hydrographic basin of Mono Lake, including an area of about 2,000 square miles, and executed on a scale of 1¾ miles to the square inch. About half the area is mountainous and difficult, including the western slope of a portion of the Sierra Nevada. Local maps were made of the Mount Lyell glaciers, and of a group of ancient moraines at the mouth of Parker Cañon.

The total area covered by the topographic work of the season amounts to about 53,000 square miles.

Geologic Work.

District of the South Atlantic.—Prof. H. R. Geiger was detailed to investigate the geology of certain portions of Virginia. He spent the early part of July in the eastern part of the State. During that month and August he studied all the formations from the Greenbrier River to the east of Alleghany Station, West Virginia.

In September he packed and shipped to Washington specimens from the Devonian formations, in Greenbrier County, and transferred his work to Alleghany County, Virginia. He there made a study of the formations, which are well exposed in that section, and procured some excellent geologic specimens. In October he extended his work from Alleghany County to Rockingham County, Virginia, where he studied the limestone fossils and made a special study of the foldings between the Blue Ridge and North Mountain. He made a careful comparative examination of the limestones of Alleghany and Rockbridge Counties, and at the end of the month came to Washington. The thanks of the Survey are due to Professor Campbell, of Washington and Lee University, who rendered great service to Professor Geiger.

Prof. Ira Sayles spent the early part of July in the examination of caves near Clinch River, Virginia, and the general features of the surrounding region. He then studied the coal beds of Big Yellow Creek, in Bell County, Kentucky, and the dyestone iron deposits a few miles down Poor Valley. In August he continued his work near the Clinch River, especially with the object of ascertaining the extent and direction of the faulting which was displayed there, and also examined the upper Coal Measures of the region, and made a running field chart of the county. Later in the season he discovered, in Hawkins County, Tennessee, some very interesting cave deposits, which he carefully studied and from which large collections were sent to the office in Washington. From this point, in October, he went southeastwardly through Hawkins County, studying the formations on the way, and by the last of the month was at Knoxville, where he examined the rocks of the Potsdam deposits, to supplement Mr. C. D. Walcott's work. The work in the vicinity of Knoxville and Centerville was continued through the latter part of the year, although bad weather interfered considerably with his work.

District of the Rocky Mountains.—Work in this district, under the charge of Mr. S. F. Emmons, was begun early in July. Mr. Whitman Cross was assigned to work in the Silver Cliff region. The report on this region will be of value from the fact that it is a camp of abortive processes, a true history of which will serve as warning by pointing out the errors which caused the failures there. Work was continued in this region through July, August, and part of September. Mr. S. S. Sackett was detailed to gather statistics as to reduction works in the district. A short trip was made to the Sangre de Cristo Range, on the opposite side of the valley from Silver Cliff, to determine the geologic relations of the rocks of this range to the Silver Cliff deposits. Work in the Denver coal basin was begun, but had to be stopped before the end of the season. Some attention was paid to the subject of artesian wells, and the material obtained will be embodied in the report on the Denver basin. In the office the notes on the ten-mile district were worked up, a geologic map and sections were prepared, and lithological determinations were made preliminary to final elaboration and publication. Messrs. Cross and Chapman have been engaged in the preparation of geologic maps, and some field work was done by Mr. Cross in the vicinity of Golden and Morrison, on the Mesozoic rocks which are exposed in this region.

Yellowstone National Park.—Mr. Hague began field-work in the Yellowstone Park in the latter part of July. His investigations were mainly confined to a preliminary examination to ascertain what the geologic problems really are. The Upper and Lower Geyser Basins were visited in August, and a geologic reconnaissance was made from the Upper Basin to Shoshone Lake of the Heart Lake Basin, for the purpose of comparing them with the Upper Basins of the Firehole, and to ascertain what thermal and other changes have occurred since 1878. Mr. Hague thinks that Mount Sheridan is a volcanic crater, so modified by glacial action as to practically obscure its true origin. A collection of 200 specimens of geyserites was carefully made for the educational rock series. In September permanent camp was established near the Great Valley of the Yellowstone, and short trips were made into the adjacent region. The Mount Washburne group was examined, and the headwaters of the Gardiner and Gibbon Rivers and the region of the Grand Cañon were visited. The bottom of the Grand Cañon was reached at four different points. A reconnaissance was made to Steamboat Point on Yellowstone Lake, and Mount Chittenden, one of the highest peaks in the vicinity, was ascended. During this time a study of the geysers in the Upper Geyser Basin was continued by Mr. Hague's assistant until September 25, when the camp there was broken up and a new camp was established at Mammoth Hot Springs. From this a trip was made to the western limits of the Park over the summit of the Great Plateau and back via Madison Cañon, where a fine section of rhyolitic rocks is exposed. The region north of Mount Holmes, on the west side of the Park, was also examined, but the results were meager on account of the severity of the storms. A geologic reconnaissance was also made via the East Fork of the Yellowstone to the headwaters of Soda Butte Creek and the Clark's Fork mines. Although the country was covered with snow, the work accomplished was of great value for general geologic purposes, and especially as suggesting plans of operation for next season. About the middle of October the weather became so inclement that the parties were obliged to leave the field. Mr. Iddings was sent to Eureka, Nev., to make collections of rocks for the educational series. He secured sufficient material for 200 cabinet specimens of five characteristic rocks. Three of these illustrate igneous rocks from the Great Basin, and two belong to the supplementary series. "All will be described in the Geology of the Eureka district."

District of the Pacific—Survey of the Quicksilver District.—Mr. G. F. Becker, who is in charge of the division of the Pacific, has been engaged in the examination of the quicksilver deposits of California. During the early part of the season he carried on an investigation in the vicinity of the Sulphur Bank, California. A trip was made to the North Fork of Cache Creek and Tulare Lake, the only localities in this section where fossiliferous strata occur. The early part of September was spent on the North Fork of Cache Creek, and the map of the Clear Lake region was completed. Returning to Sulphur Bank, soundings of the lake were taken, and careful examinations made of the mines. The party then proceeded to San Francisco to prepare for the winter's work, which consists of the revision of Mr. Curtis's memoir of the Eureka mines, the arranging of the Clear Lake and Sulphur Bank collections, and analyses of the minerals, rocks, and waters collected, and the general routine of office duties.

Work was undertaken during the season by Mr. Turner, in the region of Knoxville, but was interfered with by his sickness, which obliged him to enter the hospital at San Francisco.

Volcanic rocks.—Capt. C. E. Dutton, who has charge of the investigation of the volcanic rocks of the division of the Pacific, has been busy most of the year with the completion and preparation for publication of his memoir on the Hawaiian volcanoes, which were visited by him for the purpose of studying the features and processes of volcanoes in action, that the practical knowledge thus obtained might be used in the study of the extinct volcanoes of our western coast. His assistant, Mr. Diller, took the field at Red Bluff, Cal., early in July, and immediately began the study of Lassen's Butte. The plain around Red Bluff is volcanic conglomerate of andesitic fragments, which formation extends for 25 miles eastward. During the latter part of the month he was engaged in the examination of the region surrounding Mount Shasta. Later, he made a geologic reconnaissance of the Cascade range. Interesting studies were made of the faults on the eastward side of the range, near Klamath Lake. In September he visited Union Peak, Mount Thielson, Crescent and Summit Lakes, and Diamond Peak. Mount Thielson proved to be a very interesting ruined crater of large proportions. From Diamond Peak he proceeded to the group of volcanic cones known as the "Three Sisters." Here both Mr. Diller and his assistant, Mr. Hayden, met with an accident which obliged them to suspend work. Later in the season the reconnaissance was resumed and the west side of the range examined from Portland, Oregon, to Red Bluff, California.

District of the Great Basin.—The work in this division has consisted for several years in the investigation of the system of lakes which in Quaternary time occupied so many of the valleys. This work is now so far advanced that it is believed the most important generalizations have been reached; and the Director decided to close it as a means of enabling him to increase the working force on the Atlantic coast. The corps was therefore reduced early in the year, and those who remained were instructed to devote the season to supplementing the material already gathered so as to put it in the best shape for publication. The office at Salt Lake City, which had been the base of operations for the division, was closed in June.

Mr. G. K. Gilbert, geologist in charge, took the field soon after, visiting in Northern Utah, Northern Nevada, and the Mono Basin of California, localities necessary to complement his earlier notes.

He was accompanied in Utah and Nevada by Mr. R. Ellsworth Call, who is temporarily attached to the survey for the purpose of studying the molluscan faunas of the Quaternary lakes. The Quaternary shells are all of existing fresh-water species, but are depauperate as compared with their modern representatives in the same region; and the problem undertaken by Mr. Call is to determine the climatic conditions indicated by this depauperization.

Mr. Israel C. Russell has had immediate charge of the investigation of Lake Lahontan, the Quaternary ancestor of Pyramid, Carson, and Walker Lakes, and also of the investigation of the Quaternary history of the Mono Lake Basin. He devoted the summer to the completion of his field examinations. The six Quaternary glaciers which debouched into Mono Valley were studied in detail and traced to their common source in the great névé of the Sierra Nevada. Within the area of that névé are a number of small modern glaciers which were included in the investigation.

Messrs. Gilbert and Russell have devoted the time not consumed by field-work to the preparation of reports, preliminary and final, on the Quaternary lakes. The final reports will include monographs on Lake Bonneville, Lake Lahontan, and the Mono Basin.

Study of Metamorphic rocks.—Prof. R. D. Irving had five parties in the field continuing the investigation of the copper-bearing rocks. The examination of the Huronian rocks, in the vicinity of Sault Ste. Marie, Mich., was completed, and the field of investigation was extended north of Lake Superior to the National boundary, and along the latter westward to Rove Lake, Michigan. Special investigations were made in the vicinity of Sault Ste. Marie and at various other points in the neighborhood of Lake Superior. A study was made of the crystalline rocks of Morrison and Todd Counties, Minnesota, and a study of the Huronian quartzites of the Minnesota Valley. Professor Todd's report on the "Copper-bearing Rocks" is in type and awaiting the completion of the illustrations before publication. Early in September the Animikie group was examined along a route which gave two complete sections of the series from the junction with the Keweenawan, on the islands near Pigeon Point, along the boundary line to the underlying granite of Sanaga Lake, and along the west side of Thunder Bay to Port Arthur. The examination of the Minnesota Valley, begun in the latter part of August, was continued until the middle of September, when field work was stopped for the season. Considerable microscopic work has been done by Professor Todd and his assistants. Since the beginning of their study of the metamorphic rocks in 1882 thin sections of 500 rocks have been made, of which number written descriptions of 300 have been prepared. They include rocks from the original Huronian, the Huronian of the Marquette and Menominee regions, the Animikie group of the National boundary, the folded schists of the same region, and the crystalline rocks of the Minnesota and Mississippi Valleys. Professor Irving, in October, made a personal examination of the quartzites of Nicollet and Cottonwood Counties, Minnesota. A comparative study of the greenstones, etc., of Huronian age will be carried on. Office work has developed some interesting results in relation to the structure of the quartzites of the Huronian of Lake Huron and of the Marquette and concerning their relations to each other.

Yellowstone and Missouri Rivers.—The region between the Missouri River at Bismarck, Dak., and the Yellowstone Valley at Glendive, Mont., and along the Yellowstone River from Glendive to Livingston, Mont., with a portion of Montana in the vicinity of Bozeman, was the field of a geological reconnaissance by Dr. F. V. Hayden, who was assisted by Dr. A. C. Peale. Sections were made at various points along the line of the Northern Pacific Railroad with especial relation to the line of division between the Laramie group and the beds that lie beneath it. Collections were made at various points, mainly of fossils from strata of the Laramie group, and the numerous coal outcrops in the vicinity of the railroad were examined, as were also the borings for artesian wells at Bismarck in Dakota, and at Billings in Montana.

Quaternary geology.—An investigation of the glacial and associated formations of the interior basin has been in progress under charge of Prof. T. C. Chamberlin. In the early part of June he made a brief re-examination of the stony clays bordering Lake Michigan, with a view to discriminations between true glacial deposits and those produced by floating ice. Later in the month he made a cursory examination of some points on the southern border of the newer drift in Central Iowa, and on the loess and drift of Northeastern Nebraska, carrying a reconnaissance as far west as Fort Niobrara. In July he studied the outer border of the drift in Dakota, adjacent to and west of the Missouri River. In August a reconnaissance of the drift margin in the Ohio Basin in Southern Illinois, Indiana, and Southwestern Ohio was undertaken. September and the remainder of the available field season, reaching into the early part of December, were devoted to a supplementary examination of the border of the later drift and of its moraines in the plaine region, stretching from the Scioto to the Illinois Valley, in which the ridging of the drift is least conspicuous.

Prof. J. E. Todd, as assistant, devoted the main portion of the field season to an investigation of the moraines and associated drift deposits of the Territory lying between the James and Missouri Valleys and south of the Northern Pacific Railway in Dakota. Subordinately he made brief supplementary studies of the glacial phenomena of the southeastern corner of Dakota and the northeastern border of Nebraska.

The chief subject assigned Prof. R. D. Salisbury, assistant, was the character, quantity, and topographical associations of the residuary clays and other disintegration products of the driftless region of Wisconsin, Minnesota, Iowa, and Illinois. In connection with this study he traced out the limits of some portions of the driftless area that had not been determined with accuracy, and examined the character of the drift border with a view to comparison with the observations on the outer drift margin above indicated. He also gave attention to the loess-like loams of the western and southern portions of the district and to the valley drift. In November he was temporarily diverted from these studies to assist in glacial examinations in the Wabash Valley. In the latter part of November he transferred his field to Eastern Missouri, and began an investigation of the residuary clays, loess, and drift border analogous to that previously undertaken in the driftless region, and with the object, among others, of intercomparison. This work was continued until interrupted by snow-fall, about the middle of December.

The surface geology of the District of Columbia.—The superficial deposits of Washington, D. C., and vicinity have been made the subject of casual study during the past summer by Mr. W J McGee, whose reports may be summarized as follows:

The uppermost deposit consists of a unipartite but heterogeneous layer of gravel and loam, reposing unconformably upon the several older rocks of the region up to an altitude of 200 feet or more above tide. In general, the layer thickens toward waterways and is attenuated toward highlands, and the coarser materials predominate toward its base. The gravels are in part quartzitic, small, and well rounded, and in part of various sublocal rocks of all sizes up to fully four feet in diameter, and little worn; while the loam is sometimes of such fineness and local homogeneity as to simulate the coarser varieties of loess. The whole deposit is unfossiliferous, but is probably quaternary.

Below these superficial gravels and above the crystalline schists and gneisses of the easternmost Appalachian belt occur laminated sands and plastic clays, unfossiliferous within the District so far as known, but presumably of Cretaceous or Jurassic age. The series includes one or more pebble-beds, consisting mainly of small and well-rounded quartzitic pebbles, which dip seaward with the arenaceous and argillaceous strata, and soon disappear beneath the surface. Most of the eminences of the region are outliers of these obdurate beds, isolated by erosion; and from each such eminence is a talus, derived from and more or less closely resembling the undisturbed deposit, which descends the slopes, and ranges, perhaps by imperceptible degrees, into the gravels of supposed Quaternary age. This intermingling of similar deposits of widely different ages is most puzzling, and greatly increases the difficulty of the investigation.

East of the District richly fossiliferous eocene rocks overlie the Cretaceous, but thus far they have been only partially examined.

Beneath the superficial gravels sometimes occurs a ferriferous and lignitiferous subaerial deposit, in some cases of age manifestly approaching that of the Cretaceous or Jurassic rocks upon which it reposes, and in other cases of so recent aspect as to be generally mistaken for post-Quaternary accumulations. Local exposures of this discontinuous stratum may represent any portion, and the totality of exposure apparently represents the whole of the period intervening between the Jurassic and the Quaternary. Its iron ores are sometimes of economic importance.

Connected with the deposits is a complex system of terraces, both fluviatile and littoral. Preparatory to the exhaustive study of these terraces in their relations to the deposits with which they are associated, and to the orographic movements which they attest, a topographic map delineating the terraces in contours has been begun by Mr. S. H. Bodfish.

Geologic map of the United States.—Pending the accumulation of adequate material for the construction of the large-scale geologic map, a small-scale map of the United States, embodying our present knowledge of the distribution of American rocks, is now being colored geologically. The base is that employed in the atlas accompanying the final reports of the Tenth Census, which corresponds in size to the double atlas-sheets of the survey. Since the minor divisions of the geologic column cannot be indicated upon so small a scale, and since, moveover, our information respecting the rocks of various regions is insufficient for nice discriminations, only the general divisions will be represented on this map. These divisions are indicated by symbols and colors. The following is the scheme adopted:

Group.	System.	Symbol.	Color.
Era of Man	Quaternary	Q	
Cenozoic	Pliocene, Miocene	M	
	Oligocene, Eocene	E	
Mesozoic	Cretaceous	K	
	Jurassic, Triassic	T	
Paleozoic	Permian, Carboniferous	P	
	Devonian	D	
	Silurian	S	
	Cambrian	C	
Azoic	Archæan	A	

To an extent, the map is an experimental one; and the method of geologic cartography and the system of geologic classification to be ultimately adopted by the Survey are being developed as the map progresses. At the same time, since the sources of information drawn upon in its preparation embrace not only the latest publications (both official and unofficial), but also much unpublished material in the hands of different attachés of this Survey, of several State geologists, and of various amateur geologists, the map may properly be regarded, when completed, as the most satisfactory representation of American rocks extant. It is essentially complete in manuscript, and will probably be published within a few months. It is the present intention, indeed, to lay it before the Congrès Géologique Internationale at the approaching Berlin meeting, as an illustration of the system of cartography and classification finally adopted by the Survey.

The work is in the hands of Mr. W J McGee, who has had for a time the collaboration of Prof. C. H. Hitchcock.

Paleontologic Work.

Work of Prof. O. C. Marsh.—The search for extinct vertebrate remains and their study has been assigned to Prof. O. C. Marsh. During the season of 1883 he has had field parties at work in Colorado, Wyoming, and Oregon. Professor Marsh himself spent the month of August in Colorado clearing up some doubtful points on the Sauropoda, on which he is preparing a volume. Interesting collections were made of mammals from the Jurassic of Wyoming, and some important specimens were secured from the Tertiary of Oregon. Field work was brought to a close in Oregon in October, but in Wyoming and Colorado it was continued until late in the year.

Work of Mr. C. D. Walcott.—Mr. Walcott's studies have been devoted mainly to the invertebrate fossils of the Paleozoic age. During the summer, he made an examination of the Potsdam and Calciferous formations in New York, for the purpose of comparison. He also examined the Phillipsburg section of the Canadian Geological Survey, situated 2 miles north of the Vermont State line. The Cambrian strata of Franklin County, New York, were also investigated, and the outcrop of limestone at Greenfield, N. Y., was visited. Large collections were made and full notes taken in regard to the complicated geological structure of the regions examined. His office work has been mainly the study of the Paleozoic fossils from near Eureka, Nev., and the preparation of a map and section illustrative of the geology of the Grand Cañon of the Colorado east of the Kaibab Plateau in Arizona. He has also prepared the paleontologic portion of the Report on the Eureka district, which will be published as Part II of Mr. Hague's report. It will include the data obtained from the White Pine district.

Work of Dr. C. A. White.—Dr. C. A. White is in charge of the study of the invertebrate fossils from the Mesozoic and Tertiary formations. He began field work, with Mr. J. B. Marcou as assistant, early in July, making Fort Benton, in Montana, his outfitting point. Thence he proceeded eastward down the Missouri River to the mouth of Judith River, where a special examination was made of the Judith River group. Attention was given also to the structure of the mountains in the vicinity and to drift phenomena. The central and principal mass of the mountains was found to be a trap rock different in structure from that found in the Rocky Mountains in Colorado. Moccasin Mountain and Square Butte were found to be trachytic with stratified rocks flexed against them. Bear Paw Mountain was found to be essentially the same. The northern drift was found near the latter. Returning to Fort Benton, Dr. White was joined by Prof. L. F. Ward, and after an examination of several localities in that neighborhood, including the Great Falls of the Missouri, they together descended the Missouri River in a boat from Fort Benton, Mont., to Bismarck, Dakota. Only the Laramie group was noted in this distance, and large collections were made. Later in the season the Cretaceous strata near Sioux City were examined.

Office work has been confined mainly to the study of the collections and the revision of the text and illustration of a memoir on the "Ostreidæ of North America." Progress was made also in the preparation of paleontologic bibliography. Mr. Marcou has devoted considerable time to the arrangement and cataloguing of the Jurassic fossils for study and revision, and has also prepared for publication a catalogue of maps.

Work of Prof. Lester F. Ward.—Prof. Lester F. Ward, paleobotanist of the Survey, spent the months of July and August making large and valuable collections of fossil plants in the vicinity of Glendive, Montana. In September he proceeded to Fort Benton, Mont., where he joined Dr. White and accompanied him down the Missouri River, adding largely to his collections of fossil plants. Since his return to Washington the latter have been carefully arranged for study. This study is facilitated by the acquisition of the fossil plants described by Professor Lesquereux in his quarto report made to the Survey of the Territories. Professor Ward has prepared a catalogue of fossil plants, with their geologic horizons indicated.

Work of Prof. H. S. Williams.—Prof. H. S. Williams, assigned to the study of the Devonian section of Western New York, has reached some interesting conclusions as the result of this study during the season. He worked southward across Allegany County, New York, into Pennsylvania, and thence across McKean County, in the latter State. Two months' work furnished data for the construction of a continuous section (geographic and geologic) in a nearly direct line from Batavia, Genesee County, New York, to Alton, McKean County, Pennsylvania, passing from the base of the Devonian to the Coal Measures of the Carboniferous. He also prepared a meridional section, starting in Oneida County, New York, crossing Madison County, and terminating in Delaware County. This section passes geologically from the Carboniferous limestone to the red rocks referred to the Catskill formation. A preliminary report on the faunas of the Upper Devonian along the meridian from Cayuga Lake southward through Tompkins, Tioga, and Chemung Counties, in New York, and Bradford, in Pennsylvania, has been prepared for publication and will be issued as a bulletin of the Survey.

Work of Mr. L. C. Johnson.—In the district of the South Atlantic Mr. L. C. Johnson has been carrying on palæontologic work, preparatory to a more careful survey of the structural geology to be undertaken hereafter. He has made extensive collections from the Tertiary and Mesozoic formation in the Gulf States, especially in Alabama. The greater part of July was spent in Tuscaloosa, from which point 19 boxes of specimens were sent to Washington. During the early part of August he was investigating the boundary line between the Cretaceous and the Carboniferous, and between the rotten limestone of Greene County, Alabama, and the Eutaw group of the Cretaceous. Later he made a reconnaissance of the Tombigbee and Alabama Rivers. The section constructed by Mr. Johnson will go far towards defining the line between the Cretaceous and Tertiary. October and November were mainly devoted to the study of the Tertiary near Bridgeport, Ala., and the Cretaceous in Autauga County, Alabama. December was devoted to the investigation of the Tertiary. Large collections were made and many interesting facts developed. One of the results of the work will be to extend the boundary line of the Tertiary from 6 to 10 miles farther north than is usually shown on the geologic maps of this region.

Work of Prof. W. M. Fontaine.—Prof. W. M. Fontaine during the summer examined the Tertiary strata of Eastern Virginia, especially near Richmond, making collections of fossil plants. He has prepared drawings of many of the specimens collected. He is also engaged in the preparation of a memoir on the older Mesozoic plants of Virginia.

Chemic Work.

Prior to the fall of 1883 the chemical work of the Survey was done at various laboratories scattered through the country, and at the field laboratories in Denver, Salt Lake, and San Francisco. With the removal of the headquarters of the division of the Great Basin to Washington the field laboratory at Salt Lake City was abandoned, but work is still carried on at the others. With the appointment of Prof. F. W. Clarke as chief chemist of the Survey a laboratory was organized at Washington, in rooms furnished by the United States National Museum, where work has been begun on analyses of waters and various specimens brought in by the various field parties.

Professor Clarke, during the summer, made several mineralogical field trips and secured abundant material for future investigation.

In the laboratory at Denver Mr. Hillebrand has been making analyses of a number of minerals new to Colorado, and has been examining the various igneous rocks collected during the summer in the district of the Rocky Mountains. Dr. Melville, at San Francisco, has been doing similar work for the division of the Pacific.

A laboratory for physical research will probably be established in connection with the chemical division at Washington. This work has been carried on at the physical laboratory at New Haven by Dr. Carl Barus and Dr. William Hallock, who have been conducting experiments as to the exact measurement of exceedingly high temperatures.

Economic Work.

Statistics of Mineral Resources.—In accordance with an act passed by the Forty-seventh Congress, the Geological Survey was charged with the duty of reporting upon the present condition of the mining industries other than those of gold and silver. This work is in the charge of Mr. Albert Williams, jr., chief of the division of mining statistics and technology, whose first report, entitled the "Mineral Resources of the United States," an octavo of some 800 pages, was issued in October. This report contains the statistics of the metallic and mineral production of the country for 1882 and the first six months of 1883, besides the figures for preceding years, descriptions of localities, metallurgical papers, and such information as seems important from a practical and industrial point of view. The statistical work of the Survey thus supplements its purely scientific investigations, and, while it is the first attempt of the kind, has met with a gratifying public interest. Mr. Williams has been so fortunate as to secure the co-operation of a strong array of contributors among the engineers, metallurgists, and authorities on trade statistics, and has thus been enabled to conduct operations on a much more comprehensive plan than would be possible with a force limited to regular employés.

Forestry of West Virginia.—Mr. George W. Shutt, during the field season of 1883, examined the State of West Virginia, especially the southern and eastern portions, with especial reference to the distribution of timber, its economic value, and the facilities of transportation to market via the streams of the State. He traveled more than a thousand miles by wagon, and two hundred on horseback, and expresses the opinion that nearly one-half of the State is covered with a virgin forest, the value of which, if rendered marketable, would amount to billions of dollars.

Publications.

During the year the following publications were issued, viz:

Bulletin No. 1. On Hypersthene-Andesite and on Triclinic Pyroxene in Augitic Rocks, by Whitman Cross; with a geological sketch of Buffalo Peaks, Colorado, by S. F. Emmons. 1883. 8vo. 40 pp.

Bulletin No. 2. Gold and Silver. Conversion tables, giving the coining value of Troy ounces of fine metal, &c., by Albert Williams, jr. 1883. 8vo. 8 pp.

Mineral Resources of the United States, by Albert Williams, jr. 1883. 8vo. 813 pp.

The reprint of the Second Annual Report for the use of the survey, was also issued during the year; and 50 copies of the Third Annual Report were issued without the complete set of illustrations. Dr. C. A. White's paper on "The Non-Marine Fossil Mollusca of North America," from the Third Annual Report, was also issued as a separate publication early in the year.

Although the monographs of Captain Dutton and Mr. George F. Becker ("The Tertiary History of the Grand Cañon" and the "Geology of the Comstock lode and Washoe district," both accompanied by atlases) bear the imprint of 1882, they were not furnished to the survey for distribution until 1883.

The papers prepared for publication are numerous, and a number are in type and will soon be issued; among them are the Third and Fourth Annual Reports, two bulletins, and several monographs.

Collections.

About 200 boxes of fossils, rocks, and minerals were sent on to the main office of the Survey during the season by the various field parties.

UNITED STATES FISH COMMISSION.

As exercising the double function of Secretary of the Smithsonian Institution and of United States Commissioner of Fish and Fisheries, I have been in the habit of giving in the Smithsonian Annual Report some account of the work accomplished in the last-mentioned capacity; and I take great pleasure in saying that the workings of the Commission have continued to show the usual ratio of increase in extent and apparent practical value.

The difference in extent between the work of 1871 and that of 1883 is very great, each year showing some extension of the scheme, and more and more important measures instituted for investigation into the conditions of the fisheries, and for increasing the fisheries supply.

The full details of operations of the Commission will be found in its very voluminous reports year by year; these embracing not only the general history of the Commission, but also a report of what is done in the same direction by other establishments throughout the world.

The most important fact in this connection is the completion of the steamer *Albatross*, of which mention was made in the last report, and the result of her investigations in regard to the physics and natural history of the various parts of the ocean. Many regions were surveyed and important facts ascertained respecting the existence and extent of new fishing banks, while the amount of material gathered, new to science, has been enormous. Many undescribed species of deep-sea fishes were secured, some of these from a depth of more than three miles.

As in previous years, the summer station of the Commission was at Wood's Holl, Mass., where the arrangements for making a permanent establishment, principally for the purpose of hatching sea-fish in very large numbers, were actively prosecuted. The construction of buildings was commenced and well advanced before the close of the year. The Government pier, for which appropriation was made in the River and Harbor bill, was already begun, but will not be sufficiently completed to promise much service before 1885.

The work of propagation of food-fishes generally, was conducted on a larger scale than before, especially in connection with the whitefish of the lakes, of which about one hundred millions of eggs were secured and placed in the hatching houses at Northville and Alpena, Mich., for development.

The number of eggs of the shad obtained was not as large as the year before, owing to the meteorological conditions, which interfered with the free influx of the fish from the ocean.

About the average of work was accomplished in connection with the Penobscot and the land-locked salmon.

An increase was effected in regard to the California trout.

Beyond a few millions of eggs taken of the California salmon, not much was accomplished, in consequence of the interruption to the upward migration of the fish in the Sacramento River, caused by the blasting of rocks along the shores for the purpose of railroad construction.

Perhaps the greatest success of the Commission has been with the carp, for which the demand continues to a degree that it is impossible to meet. Every Congressional district in the United States, and in fact nearly every county, has made application to receive a supply of fish, and large numbers of persons were left unsupplied at the close of the season from exhaustion of the stock. It is proposed to extend considerably the area of these ponds in Washington, so as to meet the still increasing demand.

Numerous researches have been prosecuted in regard to the oyster and other fishes, for the purpose of securing a proper basis of practical work. These investigations have been carried on principally by Mr. John A. Ryder, the biologist of the Commission, and have added greatly to his deserved reputation.

Bulletin of the Fish Commission.—Reference has been made in preceding reports to the authorization by Congress of the printing of a bulletin to contain current news of interesting facts in regard to fish culture and the fisheries. Most of such matter has been furnished from the correspondence of the Commission, although some articles have been introduced from other sources.

The work is printed signature by signature as the matter is ready, and distributed in this form to fish commissioners and specialists who desire it, this requiring about 200 copies. The remainder of the edition is bound and supplied in that form.

Of this work the House of Representatives receives 2,500 copies and the Senate 1,000, all of which are eagerly sought for.

International Fisheries Exhibition, 1883.—In the spring of 1882 Congress authorized the United States Fish Commission to participate in the International Fisheries Exhibition to be held in London in 1883, and work was soon after begun and pushed forward with great activity. A preliminary exhibition of such of the material as could conveniently be displayed was held in the National Museum February 26, and the work of packing the collections for transmission to London was begun the following day. Mr. Thomas Donaldson made a satisfactory arrangement with the Pennsylvania Railroad Company for shipping the collections to New York, and Messrs. Patton, Vickers & Co., agents for the Monarch line of steamships, billed the goods to London at greatly reduced rates.

Being myself unable to go to London, I designated Mr. G. Brown Goode to the President as special commissioner. He was assisted by Dr. T. H. Bean and Messrs. R. E. Earll, J. W. Collins, A. H. Clark, W. V. Cox, H. C. Chester, and Reuben Wood. In addition to these gentlemen, Lieut. C. H. McLellan, U. S. R. M., was detailed by the Life-Saving Service, Mr. Max Hansman by the Light-House Board, and Sergeant James Mitchell, U. S. A., by the Signal Office. Mr. R. I. Geare accompanied the party as secretary.

The collections arrived in London in excellent condition, but it was found that the space asked for by the United States was entirely inadequate. Arrangements were, however, subsequently made for additional space in various parts of the reservation.

The exhibition, which was held in the grounds of the Royal Horticultural Society, was the largest special one ever held, and was participated in by 31 nations and colonies. The area occupied was 21 acres.

The formal opening of the exposition was made by the Prince of Wales on the 12th of May, in the presence of the Court, and by June 1, everything was in perfect order. The American section was generally admitted to be the most important division of the entire exhibition, both on account of its contents and the manner in which they were arranged and displayed.

A series of catalogues—numbering seven—illustrative of the United States exhibits, was prepared and published, and will form Bulletin of the National Museum No. 27. The series is as follows:

A.—"Preliminary Catalogue and Synopsis of the Collections exhibited by the United States Fish Commission, and by special exhibitors. (With a concordance to the official classification of the Exhibition.)" Prepared by G. Brown Goode. 8vo. 107 pp.

B.—"Collection of Economic Crustaceans, Worms, Echinoderms, and Sponges." By Richard Rathbun. 8vo. 31 pp.

C.—"Catalogue of the Aquatic and Fish-eating Birds, exhibited by the United States National Museum." By Robert Ridgway. 8vo. 46 pp.

D.—"Catalogue of the Economic Mollusca, and the Apparatus and Appliances used for their capture and preparation for market, exhibited by the United States National Museum." By Francis Winslow. 8vo. 86 pp.

E.—"The Whale Fishery, and its Appliances." By James Temple Brown. 8vo. 116 pp.

F.—"Catalogue of the Collections of Fishes exhibited by the United States National Museum." By Tarleton H. Bean. 8vo. 124 pp.

G.—"Descriptive Catalogue of the Collection illustrating the scientific investigation of the Sea and Fresh Waters." By Richard Rathbun. 8vo. 109 pp.

Mr. Goode expresses himself as much gratified by the courtesy and aid which the members of his party received from the managers of the exhibition, particularly from Mr. Edward Birkbeck, Professor Huxley, Sir Philip Cunliffe Owen, Mr. A. J. R. Trendell, literary superintendent, Surgeon-General Francis Day, Mr. Fell-Woods, Mr. W. Oldham Chambers, and Sir James G. Maitland. From the opening of the exhibition to its close the buildings and grounds were thronged with visitors, not only in the daytime, but at night, when they were illuminated by electric lights. The total number of visitors was 2,690,000, an average of 18,545 a day.

After the exhibition had got fairly under way the fishery conferences began, the opening address being made by Professor Huxley. These meetings continued three months, and the reading of papers was usually followed by a general discussion. About fifty papers were read and discussed, all being of great importance, and many dealing with subjects never before discussed. One of the most important papers was read by Mr. Goode, and treated of "The Fishery Industries of the United States, and the work of the United States Commission." Professor Huxley, in responding, held up the action of the United States as a worthy example for other nations to follow. He said that, with all respect to the efforts of Sweden, Germany, Holland, &c., he did not think any nation had "comprehended the question of dealing with the fisheries in so thorough, excellent, and scientific a spirit as the United States." The conference papers, with the discussions, have all been printed, and, together with a series of illustrated popular hand-books, the reports of the juries, and the prize essays, will form a very important contribution to the literature of fish and fisheries, making about twelve volumes octavo. The catalogue of the exhibition is in itself a cyclopædia of the fisheries, the account of the exhibit of each country being prefaced by a description of its fisheries by some expert. The establishment of a literary bureau, in charge of Mr. Trendell, was an important advance in exhibition administration.

The efficiency of the American exhibit was rendered more perfect by the fact that the employés were experts in their several departments, and were constantly in attendance and ready to explain the collections. The assistance of these gentlemen will also be of great importance in preparing the official report. This report will embrace, in addition to the narrative and descriptive part by Mr. Goode, special reports upon the European fisheries and fish-culture, the herring and sardine fisheries, the mackerel fisheries, the English fish-trade, life-saving appliances, &c.

In compliance with my request, Mr. Goode devoted a great deal of time to studying the methods of managing museums in the great establishments of England. He made a short visit to Paris also, to study museum methods there, having previously, in 1880, visited the establishments in Germany and Italy.

The exhibition was formally closed October 30, and by the end of the year the entire collection—of a bulk of over 500 tons—had been returned to Washington, where a force was at once put to work in setting it up for permanent exhibition in the National Museum.

Many important accessions to our collections were received during the exhibition. Most of these came by exchange. Prominent among them were exhibits from Greece, Spain, India, Sweden, and China. The Marquis of Hamilton presented an Irish coracle; Mr. W. B. Segetmeier furnished illustrations of the net-maker's art; Mr. Arthur Feddersen, of Viborg, presented a model of a Danish vessel, &c. A considerable collection of fish-cultural appliances was given to the new National Fisheries Museum at South Kensington, in exchange for objects from India and China.

As far as prizes are concerned the United States has been eminently successful. The number of awards made to this country is far greater than was expected. Eighteen gold and four silver medals were given to the Fish Commission and one gold medal to the National Museum. The total number of awards that came to this country was one hundred and fifty-one.

Fishery branch of Census of 1880.—The reports for several years past have contained detailed reference to the work prosecuted under the direction of the United States Fish Commission, and with the assistance of funds from the census of 1880 in connection with the preparation of an exhaustive series of reports upon the present condition and past history of the fisheries of the United States.

Most of the special reports of the fishery experts have been completed, and the force, with the exception of that permanently connected with the Institution and the Fish Commission, has been disbanded. Although there is still much work to be done, in the absence of an appropriation for the purpose, this must be accomplished by the Fish Commission at its leisure. A number of reports have been published, and large quantities of the manuscript are now in the hands of the Superintendent of the Census. A summary of the statistical results of the inquiry was printed in the Compendium of the Tenth Census, pp. 1402, 1403.

In view of the vast material to be printed directly by the Census Office, application was made to Congress for authority to print the more purely natural history and biological articles in a separate series under the auspices of the Fish Commission, and the first volume of this series, relating to the natural history of the useful animals of the sea, especially of fishes, cetaceans, and invertebrates, has all been put in type during the year, and it is hoped that it will be published early in 1884.

This volume forms Part I of the proposed work, and contains 900 pages of text and 270 plates. It will be followed by other parts approximately in the order below:

Part II. Fishing Grounds and the Geographical Distribution of Food Fishes.

Part III. A Geographical Review of the Fisheries.

Part IV. The Apparatus of the Fisheries.

Part V. Fishery Vessels and Boats.

Part VI. The Methods and History of the Fishery Industry.

Part VII. The Preparation of Fishery Products.

Part VIII. Commerce in Fishery Products.

Part IX. Fish Culture and Fishery Legislation.

Part X. A Dictionary of American Fish and Fisheries.

Respectfully submitted.

SPENCER F. BAIRD,
Secretary of the Smithsonian Institution.

APPENDIX TO THE SECRETARY'S REPORT.

CORRESPONDENCE RELATIVE TO THE TRANSFER OF ASTRONOMICAL ANNOUNCEMENTS BY TELEGRAPH.

Letter from Harvard College Observatory, May 2, 1882, to Smithsonian Institution.

DEAR SIR: The suggestion has been made to me that discoveries of comets should occasionally be telegraphed from this observatory to Europe by means of the "Science Observer" cipher system.

I am desirous to avoid any possibility of interference with the work of the Smithsonian Institution, and for this reason I have hitherto avoided making any such announcements of discoveries. The dispatches have been confined to statements of elements, ephemerides, and the first accurate positions obtained of comets, which would of course be subsequent to the original discovery. If, however, you see no objection to a similar announcement of discoveries in cases where it may be requested, there will be no difficulty in making it. I should be very glad to have your opinion on the subject.

Yours respectfully,
EDWARD C. PICKERING.

Letter from Smithsonian Institution, May 4, 1882, to Prof. E. C. Pickering, Harvard College Observatory.

DEAR SIR: The Smithsonian Institution does not possess any monopoly of transmitting astronomical information abroad, and it will not interfere in any way with its plans to have you make any communications you may desire in the cipher of the "Science Observer."

I have not felt at liberty to change the general system of communicating astronomical data, as arranged by Professor Peters, to whom the suggestion of this transmission is primarily due.

Whenever the astronomers of this country agree upon a change of system, it will give me great pleasure to carry it out.

Very truly yours,
SPENCER F. BAIRD.

Letter from the Science Observer, Boston, December 15, 1882, to the Smithsonian Institution.

DEAR SIR: In the matter of comet telegrams, I have the following report to make, I think ought to be made to you. You remember, without doubt, that when at Wood's Holl this fall you told me to go ahead with my system, and I have done it. You are doubtless aware that an organization of observatories has been effected in Europe, including Greenwich, Kiel, Vienna, Berlin, Paris, and over thirty others, and the organization proposes to use the Science Observer Code with transmission of astronomical information. Regarding their arrangements with each other, or their relations to the former system, with Vienna as a center, I am not informed. Dr. A. Krueger, of Kiel, has written to me in this matter, desiring the necessary publications, &c., and in one of his letters states: "I wish that you and Mr. Chandler or Harvard College Observatory would be the center for the United States." This letter seems to have been followed by a circular of which a copy has not been received here, but concerning which very definite information has been received from other sources, to the effect that Harvard College Observatory *was established* as a center for (presumably) the collection and diffusion of discovery announcements in astronomy.

The letter from which the quotation is made, was dated in Kiel November 11, and the circular November 14, hence it is evident that no answer could have been received at Kiel from here. What I did reply under date of December 2 was to the effect that under the existing arrangements the Smithsonian was deputed to secure and forward to Europe the earliest announcements of discoveries, &c., and that so long as these arrangements remained in force it would not be courteous to attempt the collection of precisely the same data. I wrote that whatever information was received here would be gladly forwarded to Kiel, and that second positions would in all cases be sent (as per our present agreements with Lord Crawford and Berlin), also elements and ephemerides, if desired. I further stated to him that messages received here would be distributed here as have been all previous ones, viz, by special circular, by telegram, and by Associated Press. And thus the matter rests. I have always felt, as I expressed to you, a desire not to trench upon the grounds of another, but at the same time I have "gone ahead," and trust the same will meet your approval.

I am sincerely yours,
J. RITCHIE, JR.

Letter from the Smithsonian Institution, December 22, 1882, to Mr. J. Ritchie, jr., of the Science Observer.

DEAR SIR: In reply to your favor of December 15 I may say that I am gratified to learn that your system of astronomical telegraphy has been so successful, and that so many foreign observatories are prepared to adopt the "Science Observer Code."

It has never been the policy of this Institution to occupy a position of rivalry in any scientific enterprise, but the moment it appears that any work can be as well or better performed by other agencies, we cheerfully extend our encouragement to such, and are always ready either to co-operate therewith, or to transfer thereto, the special field of activity. I do not doubt that you are well prepared to conduct this important branch of international exchange of discovery and research, and probably with better facilities than this Institution. If therefore you desire to take the entire charge of this field, so far from feeling any dissatisfaction, I shall very gladly resign the matter to your hands; and on receiving direct announcement of your wish and ability to conduct the service, I shall cordially lend assistance to your purpose by preparing a circular addressed to our correspondents, giving them a formal notification of the transfer.

Yours, very respectfully,
SPENCER F. BAIRD.

Letter from the Science Observer, December 28, 1882, to the Smithsonian Institution.

DEAR SIR: Your favor of 22d instant, with reference to the matter of notification of astronomical discovery, &c., is at hand, for which, many thanks. I have delayed answer a few hours that the subject might be discussed with Professor Pickering, of Harvard Observatory, and his opinion incorporated with mine. As to ability to conduct the "service," I think nothing further need be necessary in evidence than what is shown by the work of the past two years, during which we have sent such data to Europe, as did not lie within the province of the Smithsonian, and which was somewhat more complicated, including as it did the collection of observations in this country, the performance of the necessary computations, and the forwarding of the results.

Since the whole matter of collection and reduction of data will be best accomplished at the Observatory, where, as well night or day, there are always present persons prepared for action without delay, and no loss of time will ensue should Mr. Chandler, Professor Pickering, or myself be absent, it seems advisable to have all telegrams sent to the Observatory (as are all messages from Europe under the existing arrangements). Further than this, an impersonal address can best be remembered, and is not liable to change through death of any particular individual, it seems best to have the address simply:

"Harvard College Observatory, Cambridge, Mass."

All necessary arrangements are now in force, and whenever it seems to you advisable to make the transfer it may be done. It will, however, be necessary to receive from the Smithsonian Institution a list of those to whom messages of announcement are now being sent. Further than this there seems to be nothing necessary, save the circular to which you refer.

With many thanks for your interest in the matter,

I am, sincerely, yours,
J. RITCHIE, JR.

Letter from the Smithsonian Institution, January 3, 1883, to Prof. E. C. Pickering, of Harvard College Observatory.

DEAR SIR: From correspondence with Mr. J. Ritchie, jr., of the "Science Observer," relative to the transfer of telegraphic announcements of astronomical discoveries (heretofore conducted by this Institution), I learn that you are prepared to co-operate with him in the reception and distribution of such telegraphic message between this and foreign countries. As it will be necessary to send circulars to each of our correspondents, notifying them of the change, it seems proper that before requesting them to send dispatches to the "Harvard College Observatory" (as indicated by Mr. Ritchie), we should have your formal request or authorization to that effect. Will you kindly inform me of your wishes in the matter, at your earliest convenience?

Yours, very respectfully,
S. F. BAIRD.

Letter from the Harvard College Observatory, January 6, 1883, *to the Smithsonian Institution.*

DEAR SIR: Your letter of January 3 is at hand. The Harvard College Observatory is now prepared to undertake the reception and distribution of telegraphic announcements of astronomical discovery in this country, and to transmit by telegraph to Europe similar information of discoveries made in this country.

The Observatory is also prepared to transmit by telegraph the results of early observations of newly discovered objects, when these results appear to be of sufficient importance to require early distribution among astronomers.

You will greatly oblige me by sending this intelligence to any of your correspondents who would be interested in knowing it.

Yours, respectfully,
EDWARD C. PICKERING.

Letter from the Smithsonian Institution, January 24, 1883, *to Prof. E. C. Pickering, of Harvard College Observatory.*

DEAR SIR: I send you herewith a few copies of the circular of this Institution about to be distributed to all our astronomical correspondents, giving formal notice of the transfer to the Harvard College Observatory of the system of telegraphic announcements.

Yours, very respectfully,
S. F. BAIRD.

Letter from the Harvard College Observatory, January 27, 1883, *to the Smithsonian Institution.*

MY DEAR SIR: The copies of your circular announcing the transfer of the American center for transmitting astronomical information from the Smithsonian Institution to the Harvard College Observatory are duly received. I take this occasion to thank you for allowing no other considerations to interfere with those of a purely scientific character. Hoping that the new system may lead to a highly efficient distribution of astronomical information, I remain.

Very respectfully, yours,
EDWARD C. PICKERING.

REPORT ON SMITHSONIAN EXCHANGES FOR 1883.

BY GEORGE H. BOEHMER.

The delays resulting from the removal of the exchange office into temporary quarters pending the restoration and fire-proofing of the eastern portion of the Smithsonian building and in obtaining the Congressional appropriation made for the Bureau, considerably retarded operations during the past year.

The work of reorganization of the service, begun in 1880, has been continued during the past year, and the service now represents four distinct divisions, viz, the Record, Foreign Exchange, Domestic Exchange, and Government Document Exchange divisions, each of which is in charge of a competent assistant, whose duties are confined to his special department.

The Record Division.—Mention was made in the reports for 1881 and an illustration given in that for 1882 of a system of card catalogues, on the debit and credit system, with the corresponding societies in Austria, France, Germany, and Great Britain and Ireland. This system has been extended to comprise all establishments enumerated in the list of foreign correspondents, and now numbers about 1,000 cards. Over 18,000 entries were made on these cards during the year, and from them the invoices prepared which accompany every sending. In addition to this work, the assistant in charge of this division is required to credit the correspondents with the acknowledgments made by them of the parcels received, and to keep a daily record of the incoming letters. All the files are kept in this division.

Foreign Exchange Division.—The duties of the assistant in charge of this branch also included the domestic exchanges until the 1st of March, when these were placed in charge of a new assistant. This had become necessary on account of the constantly increasing work in both departments.

A full description of the work of receiving and preparing for transmission the packages of foreign exchanges was given in the report for 1882, and a repetition of it is superfluous; it may only be stated that the receipts for this branch were 18,063 packages, which were sent abroad in 419 boxes. A detailed statement is appended in the general statistics.

The work connected with the Government document exchanges is still performed by the foreign exchange department, but, both branches increasing so very rapidly, the suggestion made in the report for 1882, of placing this work in the hands of one assistant, is now renewed.

Domestic Exchange Division.—This separate branch was established on the 1st of March, and of the work performed, Mr. N. P. Scudder, the assistant in charge reports as follows:

"Eleven thousand parcels have been distributed in the United States and Canada. Of these I have classed as *individuals* 2,323, because they were addressed to individuals, though a very large portion were probably intended for societies, public libraries, &c., and have doubtless been turned over to their proper destination by the persons to whom they were addressed. The remaining 8,677 parcels have been sent to the institutions, &c., for which they were intended, 8,450 being distributed in the United States and 227 in Canada.

"During the year several improvements have been introduced in the method of keeping the records of the domestic exchanges. One of these is a *card catalogue of addresses.* The address of the society or individual is taken from *returned receipts* and the date of the signing of the receipt is noted. If any address is doubtful or incomplete, the following blank is sent to the party for full information:

(Slip to be returned.)

Please write your *full* address on the other side of this slip, as it will facilitate the prompt delivery of parcels sent to you by the Smithsonian Institution.

(over.)

Name____________________
Street and No. ____________________
P. O. box____________________
City or town____________________
County____________________
State____________________

(over.)

"By this method the address of the party is obtained directly and the date is noted.

"Another improvement has been introduced at your suggestion, *i. e.*, a card ledger of all the parcels sent out. A sample card is inclosed (it is unnecessary to reproduce this sample card, being in general the same form as adopted for the foreign exchange and illustrated in the report for 1882). By means of this ledger a glance will show what has been sent to any institution or individual. The ledger has been carried back to the beginning of the year 1883."

Government Exchange Division.—This portion of the service is still dependent for the performance of the necessary work on the force of the foreign exchange branch, though its constant increase would justify the employment of one assistant, and, though not quite to the exclusion of any other duties, he might be utilized in general office work when not employed in receiving, distributing, recording, cataloguing, or transmitting these exchanges and assuming all the necessary correspondence connected with this branch. Thus far the work in this department has generally been most pressing just at times when the force of the foreign department could be least spared for this purpose.

The receipts in this division were 37,569 packages, weighing 27,395 pounds, which were transmitted to foreign Governments as specified in the appended statistics.

I. RECEIPTS.

1. *For foreign distribution.*

Whence received.	1883.	
	Packages.	Weight.
(*a*) From Government Departments:	*Number.*	*Pounds.*
Adjutant-General's Office, U. S. A.	1	1
Agricultural Department	400	1,279
Bureau of Education	2	9
Bureau of Engraving and Printing	1	1
Bureau of Ethnology	8	70
Bureau of Military Justice	1	1
Bureau of the Mint	20	34
Bureau of Statistics	6	43
Coast and Geodetic Survey	3	42
Comptroller of Currency	1,000	1,062
Department of Justice	3	3
Engineer Bureau	382	2,803
Fish Commission	170	847
General Land Office	1	1
Geological Survey	676	13,137
Hydrographic Office	18	8
Interior Department	3	56
Internal Revenue	2	2
National Museum	67	3,193
Nautical Almanac	8	45
Naval Observatory	1,110	3,105
Ordnance Bureau, U. S. A	3	68
Pension Office	1	1
Post-Office Department	1	1
Second Comptroller	2	1
Signal Office	3,244	18,502
Surgeon-General's Office	15	250
Treasury Department	9	63
War Department	8	59
Total	7,165	44,637
(*b*) From Smithsonian Institution	6,218	22,566
(*c*) From scientific societies:		
American Association for the Advancement of Science	138	410
American Geographical Society	2	39
American Journal of Arts and Sciences	203	85
American Medical Association	53	132
American Philosophical Society	672	843
American Statistical Association	13	72
Boston Academy of Arts and Sciences	298	500
Boston Society of Natural History	295	1,007
Cambridge Entomological Club	2	4
Canadian Institute	1	2
Canadian Journal	114	25
Cincinnati Society of Natural History	1	5
Essex Institute, Salem	172	275
Johns Hopkins University	4	49
New Jersey Geological Survey	6	5
New York Academy of Sciences	273	90
New York State Cabinet	93	563

I. RECEIPTS—Continued.

1. *For foreign distribution*—Continued.

Whence received.	1883.	
	Packages.	Weight.
(c) From scientific societies—Continued.	*Number.*	*Pounds.*
New York State Library	129	3,025
Numismatic and Antiquarian Society	8	6
Ohio Mechanics' Institute	245	83
Peabody Institute, Baltimore	35	215
Pennsylvania Historical Society	58	41
Philadelphia Academy of Natural Sciences	270	629
School of Mines, New York	19	94
Second Geological Survey of Pennsylvania	38	620
Secretary of state, Illinois	1	5
Washburn Observatory	2	7
Washington Anthropological Society	66	53
Washington Philosophical Society	99	122
Western Bank Note and Engraving Company	1	31
Wisconsin Academy of Sciences	114	150
Wisconsin Geological Survey	288	1,710
Miscellaneous societies	186	76
Total	3,900	11,003
(*d*) From individuals:	780	441
Grand total	18,063	78 648

2. *For domestic distribution.*

From—	1883.		
	Boxes.	Parcels.	Weight.
	No.	*No.*	*Pounds.*
Argentine Confederation	3	134	506
Belgium	11	574	3,057
Central America	10	10	950
Costa Rica	7	35	4,035
Cuba	1	5	107
Denmark	4	124	137
England	73	1,629	14,209
France	29	1,489	9,050
Germany	53	2,249	10,212
Holland	5	117	708
India	2	2	100
Italy	7	521	2,361
Jamaica	1	1	10
Mexico	4	420	680
New South Wales	3	34	21
Norway	5	219	1,025
Portugal	1	56	676
Russia	7	468	1,401
South Australia	1	23	90
Sweden	1	1	9
Switzerland	1	112	100
Tasmania	1	27	50
Trinidad	1	9	5
Victoria	1	3	9
Total	232	8,262	49,608

To these 8,262 packages received from abroad for domestic transmission 3,200 should be added, received from home institutions for this purpose; but being partly included in the general invoices, the labor of separating them from the sum total received would have been an unreasonably complicated one. It was therefore concluded to leave this additional number in the sum total of parcels for foreign transmission. About 450 parcels remain on hand at the end of the year.

3. *For Government exchanges.*

For what and whence received.	1883.		
	Boxes.	Packages.	Weight.
	No.	*No.*	*Pounds.*
(*a*) For Library of Congress from—			
Austria	1	751	770
England	18	18	3,470
France	2	522	1,820
Sweden	2	27	90
Victoria	1	1	180
(*b*) For foreign Governments from—			
Public Printer	....	36,250	21,065
Total	24	37,569	27,395

RECAPITULATION.

For what and whence received.	1882.		1883.	
	Packages.	Weight.	Packages.	Weight.
	No.	*Pounds.*	*No.*	*Pounds.*
1. For foreign distribution from—				
(*a*) Government Departments.	6,470	60,118	7,165	44,637
(*b*) Smithsonian Institution..	7,056	13,447	6,218	22,566
(*c*) Scientific societies........	5,119	8,101	3,900	11,003
(*d*) Individuals	647	2,054	780	441
	19,292	83,720	18,063	78,647
2. For domestic distribution	7,187	30,904	8,263	49,608
3. For Government exchanges	31,568	28,750	37,569	27,395
Total	58,047	143,374	63,894	155,650

II. TRANSMISSIONS.

1. *Foreign transmissions.*

The total number of boxes sent during the year is 495, an excess of 73 boxes over last year; but, notwithstanding this marked increase, enough material remains on hand to fill at least 50 additional boxes. It was much desired to dispose of all books and parcels on hand, a policy adopted and executed during the past few years, never to allow any accumulations which might be worked off, but the difficulties above mentioned made it impossible to obtain this desired end.

The transmissions for the year compare with those of former years as follows:

Items.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.
Boxes	323	397	309	311	268	407	422	495
Bulk in cubic feet	1,503	2,779	2,160	2,177	1,976	2,800	2,950	3,288
Weight in pounds	80,750	99,250	69,220	69,975	60,300	100,750	105,500	122,265

These figures include in all cases the boxes sent under the system of Government document exchange to the various Governments specified in the appended report. The distribution was made as follows:

Country.	Government boxes.	Smithsonian boxes.	Total.
AFRICA.			
Algeria	....	7	7
Egypt, etc	....	3	3
Total	....	10	10
AMERICA.			
British America	4	10	14
Mexico	2	12	14
Central America:			
Costa Rica	....	1	1
Guatemala	....	1	1
Nicaragua	....	1	1
West Indies:			
Bahamas	....	1	1
Barbadoes	....	1	1
Cuba	....	2	2
Guadeloupe	....	1	1
Hayti and Dominica	2	2	4
Jamaica	....	1	1
Porto Rico	....	1	1
St. Thomas	....	1	1
Trinidad	....	1	1
Turk's Island	....	1	1
South America:			
Argentine Confederation	4	5	9
Bolivia	....	1	1
Brazil	2	9	11
British Guiana	....	1	1
Chili	2	3	5
Dutch Guiana	....	2	2
Ecuador	....	1	1
Peru	....	1	1
Uruguay	....	1	1
United States of Colombia	2	2	4
Venezuela	2	1	3
Total	20	64	84

Country.	Government boxes.	Smithsonian boxes.	Total.
ASIA.			
China	....	4	4
India	2	9	11
Japan	2	1	3
Total	4	14	18
AUSTRALASIA.			
New South Wales	2	....	2
New Zealand	2	....	2
Queensland	2	....	2
South Australia	2	....	2
Tasmania	2	....	2
Victoria	2	....	2
Total	12	....	12
EUROPE.			
Austria-Hungary	2	15	17
Bavaria *	2	1	3
Belgium	2	3	5
Denmark	2	4	6
England	2	103	105
Finland	....	1	1
France	2	54	56
Germany	2	72	74
Greece	2	....	2
Holland	2	9	11
Italy	2	17	19
Norway	2	3	5
Portugal	2	4	6
Prussia *	2	....	2
Russia	2	21	23
Saxony *	2	1	3
Spain	2	4	6
Sweden	2	8	10
Switzerland	2	8	10
Turkey	2	3	5
Würtemberg *	2	....	2
Total	40	331	371

* The Smithsonian exchanges are included in the 72 cases for Germany.

RECAPITULATION.

Countries.	Government boxes.	Smithsonian boxes.	Total.
Africa	....	10	10
America	20	64	84
Asia	4	14	18
Australasia	12	....	12
Europe	40	331	371
Total	76	419	495

Transportation Companies.—The liberality of transportation companies and parties interested in shipping hitherto extended to the Smithsonian Institution in aid to the scientific exchanges, and thus far granted by thirty-three companies and foreign consuls in the United States, has, during the past year, again been demonstrated by the addition of nineteen new firms, all desirous to further the object in question. These new additions now open channels for free transmissions to the following-named countries: Bahamas, Bolivia, Brazil, Colombia, Costa Rica, Denmark, Dutch Guiana, England (and all its colonies through their respective agents in London), Liberia, Nicaragua, Paraguay, Peru, Polynesia, San Domingo, Siam, Syria, Turk's Island, Uruguay, and West Indies.

These companies, granting free freight on all cases and parcels of exchanges bearing the Smithsonian stamp, are:

American Colonization Society, Washington, D. C.

Anchor Steamship Company (Henderson & Bro., agents), New York.

Atlas Steamship Company (Pim, Forwood & Co., agents), New York.

Bailey, H. B., & Co., New York.

Biddle, E. R., Philadelphia.

Bixby, Thomas, & Co., Boston, Mass.

Bland, Thomas, New York.

Borland, B. R., New York.

Cameron, R. W., & Co., New York.

Compagnie Générale Transatlantique (L. de Bébian, agent), New York.

Cunard Royal Mail Steamship Line (Vernon, Brown & Co., agents), New York.

Dallet, Boulton & Co., New York.

Dennison, Thomas, New York.

Hamburg American Packet Company (Kunhardt & Co., agents), New York.

Inman Steamship Company, New York.

Merchants' Line of Steamers, New York.

Monarch Line (Patton, Vickers & Co., agents), New York.

Muñoz y Espriella, New York.

Murray, Ferris & Co., New York.

Netherlands-American Steam Navigation Company (H. Cazaux, agent), New York.

New York and Brazil Steamship Company, New York.

New York and Mexico Steamship Company, New York.

North German Lloyd (Oelrichs & Co., New York, Schumacher & Co., Baltimore, agents).

Pacific Mail Steamship Company, New York.

Panama Railroad Company, New York.

Red Star Line (Peter Wright & Sons, agents), New York.

Spinney, Joseph S., New York.

Steamship Line for Brazil, Texas, Florida, and Nassau, N. P. (C. W. Mallory & Co., agents), New York.

White Cross Line (Funch, Edye & Co., agents), New York.

Wilson & Asmus, New York.

In addition, the following-named foreign consuls have consented to receive and transmit Smithsonian exchanges for their respective countries, as follows:

Carlos Carranza, New York, to Argentine Republic.

Charles Mackall, Baltimore, to Brazil.

D. de Castro, New York, to Chili.

Hipolito de Uriarte, New York, to Cuba and Spain.

Melchor Obarrio, New York, to Bolivia.

Lino de Pombo, New York, to United States of Colombia.

Henrik Braem, New York, to Denmark.

Thomas Schmidt, New York, to Denmark.

Francis Spies, New York, to Ecuador.

D. W. Botassi, New York, to Greece.

M. Raffo, New York, to Italy.

Samro Takaki, New York, to Japan.

Juan N. Navarro, New York, to Mexico.

Alex. I. Cotheal, New York, to Nicaragua.

Christian Börs, New York, to Norway and Sweden.

M. Severance, San Francisco, to Polynesia.

Gustav Amsink, New York, to Portugal.

John Stewart, Washington, D. C., to Paraguay.

Isaac T. Smith, New York, to Siam.

Enrique Estrázulas, New York, to Uruguay.

Shipping List.—The following is the shipping list at present used in the transmission of the Smithsonian exchanges:

Country.	Shipping agent.
Algeria	Compagnie Générale Transatlantique, New York. Transfer made by the French Commission of Exchanges, in Paris.
Argentine Confederation	Consul-General Carlos Carranza, New York. Shipments to the United States are made through either Lewis & Co., Portland, Me., or George F. Brown, New York, representing Samuel B. Hale & Co., of Buenos Ayres.
Antigua	Thomas Dennison, New York.
Austria-Hungary	North German Lloyd, Baltimore. Transfer made by Dr. Felix Flügel, Leipsic.
Bahamas	Murray, Ferris & Co., New York.
Belgium	Red Star Line, New York. White Cross Line, New York.
Bolivia	Consul-General Melchor Obarrio, New York.
Brazil	Consul Charles Mackall, Baltimore. R. B. Borland, New York.
British America	Baltimore and Ohio Express Company. Adams Express Company.
British Guiana	Monarch Line, New York. Transfer made by W. Wesley, London, England.
Cape colonies	Monarch Line, New York. Transfer made by agent-general for Cape colonies in London, England.
Chili	Consul D. de Castro, New York.

Country.	Shipping agent.
China	Salter & Livermore, New York, direct to Shanghai.
	Monarch Line, New York. Transfer made through Crown agents for the colonies, London, England.
Colombia, United States of.	Consul-General Lino de Pombo, New York.
Costa Rica	Muñoz y Esprilla, New York.
	Pacific Mail Steamship Company, New York.
Cuba	Consul-General Hipolito de Uriarte, New York.
Denmark	Consul-General Henrik Braem, New York.
	Consul Thomas Schmidt, New York.
Dutch Guiana	Thomas Bixby & Co., Boston, Mass.
Ecuador	Consul Francis Spies.
Egypt	S. L. Merchant & Co., New York.
Finland	North German Lloyd, Baltimore. Transfer made by T. A. Brockhaus, Leipsic, Germany.
France	Compagnie Générale Transatlantique, New York.
Germany	North German Lloyd, New York or Baltimore.
	Hamburg-American Packet Company, New York.
Great Britain	Monarch Line of Steamers, New York.
	North German Lloyd, New York or Baltimore.
	Cunard Royal Mail Steamship Company.
	Inman Steamship Company.
Greece	Consul D. W. Botassi, New York.
Guatemala	Consul Jacob Baez, New York.
Hayti	Atlas Steamship Company, New York.
Iceland	Consul Henrik Braem, New York. Transfer made by K. Danske Videnskabernes Selskab, Copenhagen.
India	Monarch Line, New York. Transfer made by Secretary of State for India, India Office, London, England.
Italy	Consul-General M. Raffo, New York.
Japan	Consul Samro Takaki, New York.
Liberia	American Colonization Association, Washington, D. C.
Madeira Malta Mauritius Mozambique	Monarch Line to Smithsonian agent, London.
Mexico	Consul Juan N. Navarro, New York.
Netherlands Netherlands India	Consul R. C. Burlage, New York.
New Caledonia	Monarch Line, New York. Transfer made by Gordon & Gotch, London, England.
New South Wales	R. W. Cameron & Co., New York.
New Zealand	R. W. Cameron & Co., New York.
Nicaragua	Consul-General Alex. I. Cotheal, New York.
Norway	Consul Christian Bórs, New York.
Paraguay	Consul John Stewart, Washington, D. C.
Peru	Joseph S. Spinney, New York.
Philippine Islands	Spanish consul, San Francisco.
Polynesia	Consul Severance, San Francisco.
Portugal	Consul Gustav Amsink, New York.
Queensland	Monarch Line, New York. Transfer made by Queensland department, London, England.
Russia	Hamburg-American Packet Company, New York. Transfer made by Russian consul-general, Hamburg, Germany.
St. Helena	Monarch Line, New York. Transfer made by William Wesley, London, England.
Siam	Consul Isaac T. Smith, New York.
South Australia	R. W. Cameron & Co., New York.
Spain	Consul-General Hipolita de Uriarte, New York.
Straits Settlements	Monarch Line, New York. Transfer made by William Wesley, London, England.
Sweden	Consul Christian Bórs, New York.
Switzerland	North German Lloyd, Baltimore. Transfer made by Consul von Heyman, Bremen.
Syria	Presbyterian Rooms, New York.

.Country.	Shipping agent.
Tasmania	Monarch Line, New York. Transfer made by Crown agents for the colonies, London, or by G. W. Wheatley & Co., 156 Leadenhall street, London, England.
Turkey	Ottoman legation, Washington, D. C.
Turk's Island	Wilson & Asmus, New York.
Uruguay	Chargé d'Affaires Enrique Estrázulas, Brooklyn, New York.
Venezuela	Dallet, Boulton & Co., New York.
Victoria	R. W. Cameron & Co., New York.
West Indies	H. B. Bailey & Co., New York.

CENTERS OF DISTRIBUTION.

Countries.	Agencies.
Algeria	M. Carette, chef d'état major du génie, service météorologique, Algiers.
Argentine Confederation	Museo Público, Buenos Ayres.
Antigua	
Austria Hungary	Dr. Felix Flügel, Leipsic, Germany.
Bahamas	
Belgium	Commission Belge d'Échange Internationaux, Brussels.
Bolivia	
Brazil	Commissão Central Brazileira de Permutações Internacionaes, Rio Janeiro.
British America	McGill College, Montreal; Geological Survey, Ottawa.
British Guiana	Observatory, Georgetown.
Cape colonies	Agent General for Cape Colony, London, England.
Chili	Universidad, Santiago.
China	Crown agents for the colonies, London, England. United States consul-general, Shanghai.
Colombia, United States of.	Central Commission of Exchanges, National Library, Bogota.
Costa Rica	Universidad, San José.
Denmark	K. D. Videnskabernes Selskab, Copenhagen.
Dutch Guiana	Surinaamsche Koloniaale Bibliotheek, Paramaribo.
Ecuador	Observatorio del Colegio Nacional, Quito.
Egypt	Institut Egyptien, Cairo.
Finland	Kejserliga Alexanders Universitet, Helsingfors.
France	Commission Française des Échanges Internationaux, Paris.
Germany	Dr. Felix Flügel, Leipsic.
Great Britain	William Wesley, London.
Greece	National Library, Athens.
Guatemala	Sociedad Economica de Amigos del Pais, Guatemala.
Iceland	Islands Stiptisbokasafn, Reykjavik.
India	Secretary to Government of India, Home Department, Calcutta.
Italy	Biblioteca Nazionale Vittorio Emanuele, Rome.
Japan	Minister for foreign affairs, Tokio.
Liberia	Liberia College, Monrovia.
Madeira	William Wesley, London, England.
Malta	William Wesley, London, England.
Mauritius	Agent-general for Cape Colony, London, England.
Mozambique	Agent-general for Cape Colony, London, England.
Mexico	Señor Ministro de Justicia y Istruccion Publica, Mexico.
Netherlands / Netherlands India	Bureau Scientifique Central Neérlandais, Harlem.
New Caledonia	Gordon & Gotch, London.
New South Wales	Royal Society of New South Wales, Sydney.
New Zealand	Parliamentary Library, Wellington, New Zealand.
Nicaragua	Government of Nicaragua, Managua.
Norway	K. N. Frederiks Universitet, Christiania.

Countries.	Agencies.
Paraguay	Government of Paraguay.
Peru	Biblioteca Nacional, Lima.
Philippine Islands	Royal Economic Society, Manila.
Polynesia	Royal Hawaiian Agricultural Society, Honolulu.
Portugal	Escola Polytechnica, Lisbon.
Queensland	Government Meteorological Observatory, Brisbane.
Russia	Commission Russe des Échanges Internationaux (Bibliothèque Impériale Publique), St. Petersbourg.
St. Helena	Crown agents for the colonies, London, England.
Siam	
South Australia	Astronomical Observatory, Adelaide.
Spain	R. Academia de Ciencias, Madrid.
Straits Settlements	Crown agents for the colonies, London, England.
Sweden	K. S. Vetenskaps Akademien, Stockholm.
Switzerland	Eidgenosseusche Bundes Kanzlei, Berne.
Syria	
Tasmania	Royal Society of Tasmania, Hobarton.
Turkey	
Turk's Island	Public Library, Grand Turk.
Uruguay	Bureau de Statistique, Montevideo.
Venezuela	University, Caracas.
Victoria	Public Library, Melbourne.
West Indies	
Cuba	R. Universidad, Havana.
Hayti	Sécrétaire d'État des Relations Extérieures, Port-au-Prince.
Trinidad	Scientific Association, Port of Spain.

2. *Domestic transmissions.*

Packages received by the Smithsonian Institution from abroad, and distributed to the following-named institutions and individuals in the United States and British America:

	Number of packages.
(*a*) Societies:	
Alabama	1
Arkansas	4
California	78
Colorado	1
Connecticut	318
District of Columbia	3,845
Georgia	7
Illinois	82
Indiana	29
Iowa	130
Kansas	13
Kentucky	4
Louisiana	39
Maine	50
Maryland	106
Massachusetts	1,205
Michigan	56
Minnesota	30
Missouri	200
New Hampshire	17
New Jersey	41
New York	702

	Number of packages.
(*a*) Societies—Continued.	
Ohio	407
Pennsylvania	662
Rhode Island	31
South Carolina	14
Tennessee	1
Texas	2
Vermont	26
Virginia	16
Wisconsin	133
Total in United States	8,450
British America	227
Total for societies	8,677
(*b*) Individuals	2,323
Grand total	11,000

In analyzing the operations of the exchange office in regard to domestic transmissions, it will be observed that on an average 400 parcels have been added annually for the past ten years. During the past year (1883) this average was largely exceeded, the increase amounting to 32 per cent. of the entire number of packages sent out in 1882, and this was the result of the year entirely, all accumulations having been worked off before the close of 1882. Furthermore, nearly 450 packages remain on hand yet, thus swelling the increase considerably above 32 per cent.

The total number of packages transmitted compares with the preceding seven years, as follows:

Items.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.
Total addresses of institutions	316	392	292	444	385	600	548	423
Total addresses of individuals	328	374	370	341	560	454	399	471
Total number of parcels to institutions	3,705	3,868	4,059	5,786	4,021	7,086	7,192	8,677
Total number of parcels to individuals	1,148	1,094	1,233	1,185	1,566	1,347	1,167	2,323
Total number of parcels	4,853	4,962	5,292	6,971	5,587	8,433	8,359	11,000

The history and condition of domestic exchanges, from their commencement to the present time, are exhibited in the following table:

Year.	Received for the Smithsonian library.				For institutions and individuals in the United States and British America.	
	Volumes.	Parts and pamphlets.	Maps and engravings.	Total.	Addresses.	Packages.
1846—1850	470	624	4	1,098	....	....
1851	549	618	....	1,167	....	....
1852	1,481	2,106	1,749	5,336	95	637
1853	1,440	991	125	2,556	160	1,052
1854	926	1,468	434	2,828	149	987
1855	1,037	1,707	26	2,770	219	1,445
1856	1,356	1,834	140	3,330	189	1,245
1857	555	1,067	138	1,760	193	1,273
1858	723	1,695	122	2,540	243	1,539
1859	1,022	2,549	40	3,602	293	1,933
1860	1,271	4,180	220	5,671	335	1,908
1861	821	1,945	120	2,886	274	1,406
1862	1,611	3,369	55	5,035	273	2,111
1863	910	3,479	200	4,589	273	1,522
1864	823	2,754	109	3,686	299	2,482
1865	767	3,256	183	4,206	315	2,368
1866	1,243	4,509	121	5,873	329	2,703
1867	1,557	3,946	328	5,831	317	971
1868	1,770	3,605	134	5,509	436	2,394
1869	1,234	4,089	232	5,555	501	4,130
1870	1,113	3,890	179	5,182	567	3,705
1871	936	3,579	82	4,597	573	3,952
1872	1,262	4,502	198	5,962	587	4,635
1873	889	4,354	454	5,697	689	4,782
1874	863	4,521	162	5,546	750	4,326
1875	1,120	5,813	114	7,047	610	4,661
1876	1,017	6,193	375	7,585	644	4,853
1877	1,889	6,511	326	8,726	766	4,962
1878	1,263	7,392	74	8,729	662	5,292
1879	1,949	8,071	183	10,203	785	6,971
1880	1,143	7,275	152	8,570	945	5,587
1881	1,867	9,904	188	11,959	1,054	8,433
1882	1,296	10,341	152	11,789	947	8,359
1883	1,754	10,702	219	12,675	894	11,000
	39,927	142,830	7,338	190,095	15,127	114,124

From the foregoing table it will be observed that the addition to the Smithsonian library, during the year 1883 amounted to 12,675 parcels. Of this number 2,432 were received through the regular channels of transmission, while the remaining parcels arrived through the mails. All the additions to the Smithsonian library being the direct results of the system of exchanges, this excess should properly be added to the number of packages received. Heretofore mail parcels for the Smithsonian library have been entirely ignored by the exchange office, not passing through this channel, but being delivered directly into the library. This method, however, works great injustice to the exchange office, since all the returns to the Smithsonian library are direct results of the efforts and labors of this office, and it is, therefore, recommended that in future all packages addressed to the Smithsonian library, as exchanges, should pass through the exchange office, that an exact and complete record may be obtained of the actual results of the working of this office.

3. *Government transmissions.*

Although Congress, by act of July 20, 1840, authorized the printing and binding of 50 copies of all volumes published by the two houses, which volumes were to be reserved for the purpose of exchange with foreign powers, yet from the omission to provide for the extra printing, or from other cause, this liberal arrangement failed to go into operation.

An act of March 4, 1846, directed the Librarian of Congress to procure a complete series of the United States courts and of the laws of the United States, and to transmit them to the Minister of Justice of France, in exchange for works of the French law presented to the United States Supreme Court.

June 26, 1848, the Joint Committee on the Library was authorized to appoint agents for the exchange of books and public documents; all books transmitted through these agents of exchange, for the use of the United States, for any single State, or for the Academy at West Point, or the National Institute, to be admitted free.

A resolution of June 30, 1848, ordered that the Joint Committee on the Library be furnished with twenty-five copies of the Revolutionary Archives, twenty-five copies of Little & Brown's edition of the Laws of the United States, seven copies of the Exploring Expedition then published, and an equal number of subsequent publications on the same subject, for the purpose of international exchange.

A joint resolution of March 2, 1849, directed that two copies of certain volumes of the Exploring Expedition be sent to the Government of Russia, in lieu of those which were lost at sea on their passage to that country. The Secretary of State was also directed to present a copy of the Exploring Expedition, as soon as completed, to the Government of Ecuador.

By the act of August 31, 1852, the act of 1848, regulating exchanges, was repealed.

In 1852 the Smithsonian Institution urged that Congress should make some systematic and permanent arrangement for distributing complete series of its works to European libraries, to at least thirty of which they might be judiciously supplied. It was also suggested that particular works of scientific interest, as reports of patents, coast survey operations, Government explorations in geography and geology, and others of a similar character might be assigned in larger numbers, of from one hundred to three hundred, as had already been done in some instances by the Senate. These might be distributed by the Smithsonian Institution at moderate cost to the Government, and direct returns of exchanges obtained for the Library of Congress, if desired.

August 18, 1856, the Secretary of State was authorized to purchase one hundred copies each of Audubon's Birds of America and Quadrupeds of North America, for exchange with foreign Governments for valuable works.

The next steps for inaugurating a system of government documents exchange was taken in 1867, when Congress, in its thirty-ninth session passed the following resolution to provide for the exchange of certain public documents:

"*Resolved by the Senate and House of Representatives of the United States in Congress assembled*, That fifty copies of all documents hereafter printed by order of either house of Congress, and fifty copies additional of all documents printed in excess of the usual number, together with fifty copies of each publication issued by any Department or Bureau of the Government, be placed at the disposal of the Joint Committee on the Library, who shall exchange the same, through the agency of the Smithsonian Institution, for such works published in foreign countries, and especially by foreign Governments, as may be deemed by said committee an equivalent; said works to be deposited in the Library of Congress.

"Approved March 2, 1867."

The last and decisive Congressional action was taken on July 25, 1868, when it passed.

"(No. 72) *A resolution to carry into effect the resolution approved March* 2, 1867, *providing for the exchange of certain public documents.*

"*Resolved by the Senate and House of Representatives of the United States in Congress assembled*, That the Congressional Printer, whenever he shall be so directed by the Joint Committee on the Library, be, and he hereby is, directed to print fifty copies, in addition to the regular number, of all documents hereafter printed by order of either house of Congress, or by order of any Department or Bureau of the Government, and whenever he shall be so directed by the Joint Committee on the Library one hundred copies additional of all documents ordered to be printed, in excess of the usual number; said fifty or one hundred copies to be delivered to the Librarian of Congress, to be exchanged, under direction of the Joint Committee on the Library, as provided by joint resolution approved March 2, 1867.

"SEC. 2. *And be it further resolved*, That fifty copies of each publication printed under direction of any Department or Bureau of the Government, whether at the Congressional Printing Office or elsewhere, shall be placed at the disposal of the Joint Committee on the Library, to carry out the provisions of said resolution.

"Approved July 25, 1868."

The first transmission under this system of exchange was made in 1873, and this and the subsequent shipments are exhibited in the following table:

Year	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	Total.
Boxes	2	18	64	122	73	73	67	35	98	122	76	750

(a) DISTRIBUTION OF GOVERNMENT EXCHANGES.

Governments.	Box 1.	Box 2.	Box 3.	Box 4.	Box 5.	Box 6.	Box 7.
Argentine Confederation	1875	1875	1875	1875	1875	1875	1877
Bavaria	1878	1878	1878	1878	1878	1878	1878
Belgium	1875	1875	1875	1875	1875	1875	1876
Brazil	1875	1875	1875	1875	1875	1875	1876
Buenos Ayres	1876	1876	1876	1876	1876	1876	1876
Canada (Ottawa)	1874	1874	1874	1874	1874	1875	1876
Canada (Ontario)	1874	1874	1874	1874	1875	1875	1876
Chili	1875	1875	1875	1875	1875	1875	1876
Colombia, United States of	1882	1882	1882	1882	1882	1882	1882
Denmark	1879	1879	1879	1879	1879	1879	1879
France	1875	1875	1875	1875	1875	1875	1877
France (second set)	1879	1879	1879	1879	1879	1879	1879
Germany (Empire)	1874	1874	1874	1874	1876	1876	1876
Great Britain	1876	1876	1876	1876	1876	1876	1876
Greece	1877	1877	1877	1877	1877	1877	1877
Hayti	1876	1876	1876	1876	1876	1876	1877
Hungary	1882	1882	1882	1882	1882	1882	1882
India	1882	1882	1882	1882	1882	1882	1882
Italy	1881	1881	1881	1881	1881	18 1	1881
Japan	1874	1874	1874	1874	1874	1875	1876
Mexico	1875	1875	1875	1875	1875	1875	1876
Netherlands	1875	1875	1875	1875	1875	1875	1876
New South Wales	1876	1876	1876	1876	1876	1876	1876
New Zealand	1876	1876	1876	1876	1876	1876	1876
Norway	1873	1873	1876	1876	1876	1876	1876
Portugal	1875	1875	1875	1875	1875	1875	1876
Prussia	1876	1876	1876	1876	1876	1876	1876
Queensland	1876	1876	1876	1876	1876	1876	1876
Russia	1881	1881	1881	1881	1881	1881	1881
Saxony	1876	1876	1876	1876	1876	1876	1876
Scotland	1876	1876	1876	1876	1876	1876	1876
South Australia	1876	1876	1876	1876	1876	1876	1876
Spain	1876	1876	1876	1876	1876	1876	1876
Sweden	1875	1875	1875	1875	1875	1875	1876
Switzerland	1876	1876	1876	1876	1876	1876	1876
Tasmania	1876	1876	1876	1876	1876	1876	1876
Turkey	1875	1875	1875	1875	1875	1875	1876
Venezuela	1876	1876	1876	1876	1876	1876	1877
Victoria	1876	1876	1876	1876	1876	1876	1876
Würtemberg	1879	1879	1879	1879	1879	1879	1879
	40	40	40	40	40	40	40

(a) DISTRIBUTION OF EXCHANGES—continued.

Governments.	Box 8.	Box 9.	Box 10.	Box 11.	Box 12.	Box 13.	Box 14.
Argentine Confederation	1877	1877	1878	1878	1879	1880	1881
Bavaria	1878	1878	1878	1878	1879	1880	1881
Belgium	1877	1877	1878	1878	1879	1880	1881
Brazil	1877	1877	1878	1878	1879	1880	1881
Buenos Ayres	1877	1877	1878	1878	1879	1880	1881
Canada (Ottawa)	1877	1877	1878	1878	1879	1880	1881
Canada (Ontario)	1877	1877	1878	1878	1879	1880	1881
Chili	1877	1877	1878	1878	1879	1880	1881
Colombia, United States of	1882	1882	1882	1882	1882	1882	1882
Denmark	1879	1879	1879	1879	1879	1880	1881
France	1877	1877	1878	1878	1879	1880	1881
France (second set)	1879	1879	1879	1879	1879	1880	1881
Germany (Empire)	1877	1877	1878	1878	1879	1880	1881
Great Britain	1877	1877	1878	1878	1880	1880	1881
Greece	1877	1877	1878	1878	1879	1880	1881
Hayti	1877	1877	1878	1878	1879	1880	1881
Hungary	1882	1882	1882	1882	1882	1882	1882
India	1882	1882	1882	1882	1882	1882	1882
Italy	1881	1881	1881	1881	1881	1881	1881
Japan	1877	1877	1878	1878	1879	1880	1881
Mexico	1877	1877	1878	1878	1879	1880	1881
Netherlands	1877	1877	1878	1878	1879	1880	1881
New South Wales	1877	1877	1878	1878	1879	1880	1881
New Zealand	1877	1877	1878	1878	1879	1880	1881
Norway	1877	1877	1878	1878	1879	1880	1881
Portugal	1877	1877	1878	1878	1879	1880	1881
Prussia	1877	1877	1878	1878	1879	1880	1881
Queensland	1877	1877	1878	1878	1879	1880	1881
Russia	1881	1881	1881	1881	1881	1881	1881
Saxony	1877	1877	1878	1878	1879	1880	1881
Scotland	1877	1877	1878	1878	1879	....	....
South Australia	1877	1877	1878	1878	1879	1880	1881
Spain	1877	1877	1878	1878	1879	1880	1881
Sweden	1877	1877	1878	1878	1879	1880	1881
Switzerland	1877	1877	1878	1878	1879	1880	1881
Tasmania	1877	1877	1878	1878	1879	1880	1881
Turkey	1877	1877	1878	1878	1879	1880	1881
Venezuela	1877	1877	1878	1878	1879	1880	1881
Victoria	1877	1877	1878	1878	1879	1880	1881
Würtemberg	1879	1879	1879	1879	1879	1880	1881
	40	40	40	40	40	39	39

Governments.	Box 15.	Box 16.	Box 17.	Box 18.	Box 19.	Total of boxes.
Argentine Confederation	1881	1882	1882	1883	1883	19
Bavaria	1881	1882	1882	1883	1883	19
Belgium	1881	1882	1882	1883	1883	19
Brazil	1881	1882	1882	1883	1883	19
Buenos Ayres	1881	1882	1882	1883	1883	19
Canada (Ottawa)	1881	1882	1882	1883	1883	19
Canada (Ontario)	1881	1882	1882	1883	1883	19
Chili	1881	1882	1882	1883	1883	19
Colombia, United States of	1882	1882	1882	1883	1883	19
Denmark	1881	1882	1882	1883	1883	19
France	1881	1882	1882	1883	1883	19
France (second set)	1881	1882	....	....	....	16
Germany (Empire)	1881	1882	1882	1883	1883	19
Great Britain	1881	1882	1882	1883	1883	19
Greece	1881	1882	1882	1883	1833	19

(a) DISTRIBUTION OF EXCHANGES—continued.

Governments.	Box 15.	Box 16.	Box 17.	Box 18.	Box 19.	Total of boxes.
Hayti	1881	1882	1882	1883	1883	19
Hungary	1882	1882	1882	1883	1883	19
India	1882	1882	1882	1883	1883	19
Italy	1881	1882	1882	1883	1883	19
Japan	1881	1882	1882	1883	1883	19
Mexico	1881	1882	1882	1883	1883	19
Netherlands	1881	1882	1882	1883	1883	19
New South Wales	1881	1882	1882	1883	1883	19
New Zealand	1881	1882	1882	1883	1883	19
Norway	1881	1882	1882	1883	1883	19
Portugal	1881	1882	1882	1883	1883	19
Prussia	1881	1882	1882	1883	1883	19
Queensland	1881	1882	1882	1883	1883	19
Russia	1881	1882	1882	1883	1883	19
Saxony	1881	1882	1882	1883	1883	19
Scotland	....	....	....	....	....	12
South Australia	1881	1882	1882	1883	1883	19
Spain	1881	1882	1882	1883	1883	19
Sweden	1881	1882	1882	1883	1883	19
Switzerland	1881	1882	1882	1883	1883	19
Tasmania	1881	1882	1882	1883	1883	19
Turkey	1881	1882	1882	1883	1883	19
Venezuela	1881	1882	1882	1883	1883	19
Victoria	1881	1882	1882	1883	1883	19
Würtemberg	1881	1882	1882	1883	1883	19
	39	39	38	38	38	750

(b) GOVERNMENTS IN EXCHANGE WITH THE UNITED STATES.

Governments.	Establishments designated for the reception of Government exchanges.
Argentine Confederation	Minister of Foreign Affairs, Buenos Ayres.
Bavaria	Königliche Bibliothek, Munich.
Belgium	Bibliothèque Royal, Brussels.
Brazil	Commission of International Exchanges, Rio Janeiro.
Buenos Ayres	Government, Buenos Ayres.
Canada	Parliamentary Library, Ottawa.
Do	Legislative Library, Toronto.
Chili	Bibliotheca Nacional, Santiago.
Colombia, United States of	National Library, Bogota.
Denmark	Kongelige Bibliotheket, Copenhagen.
France	Commission des Échanges Internationaux, Paris.
Germany	Bibliothek des Deutschen Reichstags, Berlin.
Great Britain	British Museum, London.
Greece	Bibliothèque Nationale, Athens.
Hayti	Sécrétaire d'État des Relations Extérieures, Port-au-Prince.
Hungary	Presidium des Königlich Ungarischen Ministeriums, Budapest.
India	Secretary to Government of India, Calcutta.
Italy	Biblioteca Nazionale Vittorio Emanuele, Rome.
Japan	Minister of Foreign Affairs, Tokio.
Mexico	National Library, Mexico.
Netherlands	Library of the States General, The Hague.
New South Wales	Parliamentary Library, Sydney.
New Zealand	Parliamentary Library, Wellington.
Norway	Foreign Office, Christiania.
Portugal	Government, Lisbon.
Prussia	Königliche Bibliothek, Berlin.

(b) GOVERNMENTS IN EXCHANGE WITH THE UNITED STATES—continued.

Governments.	Establishments designated for the reception of Government exchanges.
Queensland	Government, Brisbane.
Russia	Commission Russe des Échanges Internationaux (Bibliothèque Impériale Publique), St. Petersburg.
Saxony	Königliche Bibliothek, Dresden.
South Australia	Government, Adelaide.
Spain	Government, Madrid.
Sweden	Government, Stockholm.
Switzerland	Eidgenossensche Bundes Kanzlei, Berne.
Tasmania	Parliamentary Library, Hobarton.
Turkey	Government, Constantinople.
Venezuela	University Library, Caracas.
Victoria	Public Library, Melbourne.
Würtemberg	Königliche Bibliothek, Stuttgart.

(c) SHIPPING AGENTS OF GOVERNMENT EXCHANGES.

Country.	Agent.
Argentine Confederation	Carlos Carranza, consul-general, New York.
Bavaria	North German Lloyd (Schumacher & Co.), Baltimore.
Belgium	Red Star Line, New York, White Cross Line, New York.
Brazil	Charles Mackall, vice-consul, Baltimore.
Buenos Ayres	Carlos Carranza, consul-general, New York.
Canada	Baltimore and Ohio Express Company.
Chili	D. de Castro, consul-general, New York.
Colombia, United States of	Lino de Pombo, consul-general, New York.
Denmark	Henrik Braem, consul-general, New York.
France	Compagnie Générale Transatlantique, New York.
Germany	North German Lloyd, Baltimore.
Great Britain	Monarch Line, New York.
Greece	D. W. Botassi, consul-general, New York.
Hayti	Atlas Steamship Company, New, York.
Hungary	Hensel, Bruckmann & Lorbacher, New York.
India	Monarch Line, New York; transfer made by Secretary of State to India, London, England.
Italy	M. Raffo, consul-general, New York.
Japan	Samro Takaki, consul-general, New York.
Mexico	Juan N. Navarro, consul-general, New York.
Netherlands	R. C. Burlage, consul-general, New York.
New South Wales	R. W. Cameron & Co., New York.
New Zealand	Do.
Norway	Christian Börs, consul-general, New York.
Portugal	Gustav Amsink, consul-general, New York.
Prussia	North German Lloyd, Baltimore.
Queensland	Monarch Line, New York. Transfer made by Queensland department, London, England.
Russia	Hamburg-American Packet Company, New York. Transfer made by Russian consul-general, Hamburg.
Saxony	North German Lloyd, Baltimore.
South Australia	R. W. Cameron & Co., New York.
Spain	Hipolito de Uriarte, consul-general, New York.
Sweden	Christian Börs, consul-general, New York.
Switzerland	North German Lloyd, Baltimore. Transfer made by Consul von Heyman, Bremen, Germany.
Tasmania	Monarch Line, New York. Transfer made by Crown agent for the Colonies, London, England.
Turkey	Turkish legation, Washington, D. C.
Venezuela	Dallet, Boulton & Bliss, New York.
Victoria	R. W. Cameron & Co., New York.
Würtemberg	North German Lloyd, Baltimore.

CORRESPONDENCE RELATING TO GOVERNMENT EXCHANGE.

Letter from the Department of State, April 16, 1883, *to the Secretary of the Smithsonian Institution.*

SIR: I inclose herewith for your information and consideration a copy of a dispatch from Mr. Lowell, the American minister at London, in relation to certain publications which he received from the British Government to be forwarded to the Smithsonian Institution in exchange for the similar publications of this Government, adding that it will afford me pleasure to instruct the legation at London to take any further action in reference to the matter which may be necessary to place the exchanges of documents between the two Governments upon a proper footing.

I am, sir, your obedient servant,
FRED'K T. FRELINGHUYSEN.

(*Inclosure.*)—*From Mr. Lowell, London, March* 21, 1883, *to Mr. Frelinghuysen.*

SIR: I have the honor to inclose herewith the copy of a note which I have just received from Lord Granville, informing me that the lords of the treasury have given directions to forward certain books to the secretary of the Smithsonian Institution in pursuance of a proposition which his lordship states had been made by that association for the interchange of the official publications of the two nations.

In my reply I have expressed the thanks of my Government for this gift, and requested that the volumes should be sent to the agent of the Institution here for transmission to Washington.

There seems to be some confusion in respect to this matter which perhaps can be more conveniently explained at Washington than here.

In my note of the 8th of October, 1880, to which Lord Granville refers, I asked a gift of the record publications on behalf of the library of the Department of State. These were given to us and have already been forwarded. I have since, at the instance of the Secretary of War, which was communicated to me through the Department of State, asked for certain publications of the British ordnance survey and the India Office in exchange for those of our War Department. I do not find that I have ever formally proposed on the part of the Smithsonian Institution that there should be a general interchange of public documents. Perhaps this has been done through the British legation at Washington.

I venture to suggest as to the record publications, if the Smithsonian Institution do not possess the previous volumes, it would seem proper that those now to be sent should be given to the library of the Department of State in continuation of the series it has already received.

I have the honor to be, with great respect, your obedient servant,
J. R. LOWELL.

(*Inclosure.*)—*From Lord Granville, March* 20, 1883, *to Mr. Lowell.*

SIR: With reference to your letter of the 8th October, 1880, and subsequent correspondence relating to the interchange of official publications proposed by the Smithsonian Institution at Washington, I have now the pleasure to inform you that the lords of Her Majesty's treasury have given directions to forward to the Secretary of that institution a complete set of English publications for the year 1882, viz:

1. Papers of all kinds printed for or presented to either house of Parliament.

2. Historical, scientific, or antiquarian works published by the Government, such as record publications.

3. Maps or charts published by Government.

4. Departmental publications which are placed on sale; and to continue to forward to the same address complete sets of English official publications for 1883 and subsequent years, and I have the honor to request that you will inform me as to the manner you would wish these publications to be forwarded. With respect to these publications which are proposed to be sent to Her Majesty's Government by the Smithsonian Institution in return, directions have been given to Mr. West, Her Majesty's minister at Washington, to make the necessary arrangements for their transmission direct to the British Museum.

I have, &c.,
GRANVILLE.

From the Smithsonian Institution, April 19, 1883, *to the Hon. F. T. Frelinghuysen, Secretary of State.*

SIR: I have the honor to acknowledge the receipt of your letter of the 16th April, with one from Minister Lowell, in reference to the exchange of publications through the Smithsonian Institution between the British Government and that of the United States, and suggesting that in the absence of any such negotiation through him that possibly the proposition may refer to proposals made by him in behalf of the Department of State.

In reply I beg to say that this question of a full and exhaustive exchange of the official publications of the two Governments has been proposed for many years by the Smithsonian Institution, sometimes through the Department of State to the American minister in England, sometimes through the British minister in this country, and sometimes by direct correspondence of the Smithsonian Institution with the foreign office in London. It has also formed the subject of special conference between the officers of the Smithsonian Institution and the British ministers here, all of whom seemed to be surprised at the want of action on the part of their Government. There will, I presume, be no difficulty in obtaining special works for the Department of State. The exchange now proposed by Lord Granville, and respecting which I have direct word from the foreign office, is intended specially for the benefit of the Library of Congress.

In further reference to this interchange, it has been arranged that Mr. William Wesley, agent of the Smithsonian Institution in London, is to apply, at stated intervals, for the publications of the British Government, and to forward them in cases, which he sends semi-monthly or more frequently to Washington.

Very respectfully, your obedient servant,
SPENCER F. BAIRD.

From the Department of State, April 23, 1883, *to the Secretary of the Smithsonian Institution.*

SIR: Acknowledging the receipt of your letter of the 19th instant, I have to inform you in reply that I have communicated a copy of it to Mr. Lowell, our minister at London, with instructions to inform the foreign office of the desire of the Government to have the Smithsonian Institution officially recognized as the channel through which exchanges of documents between the two countries are in future to be effected.

I am, sir, your obedient servant,
FRED'K. T. FRELINGHUYSEN.

From the Department of State, May 9, 1883, *to the Secretary of the Smithsonian Institution.*

SIR: I have the honor to inclose herewith, for your information and consideration, a copy of a note to this Department from the British minister at this capital, communicating to this Government a copy of the rules which the lords of Her Majesty's treasury have adopted for regulating the interchange with foreign countries of Parliamentary papers and other official documents published by the British Government.

It is supposed by this Department that we have already presented to Great Britain most of the official publications of our Government, and received, in return, nearly all those scheduled in the rules of the lords of the treasury, for the Library of Congress. If it shall appear, however, that there are any British publications which are needed to complete the collection of those documents possessed by that Library, it will afford this Department pleasure to make application for the same through the British legation in replying to the above-mentioned note.

Requesting that lists of any British publications desired by the Librarian of Congress to complete his collection be furnished as soon as practicable,

I am, sir, your obedient servant,
JOHN DAVIS,
Acting Secretary.

(*Inclosure.*)—*From the British Minister, Mr. West, Washington, April* 29, 1883, *to Mr. Frelinghuysen.*

Hon. FREDERICK T. FRELINGHUYSEN:

SIR: In the note which Sir Edward Thornton addressed to your predecessor under date of the 14th of April, 1881, he acquainted the Department of State that a committee had been appointed by Her Majesty's treasury to inquire into and report upon the question of the interchange with foreign Governments of Parliamentary papers and other official documents, and I have now the honor to inform you that the committee therein alluded to has now made its report, and that the lords of Her Majesty's treasury have been pleased to lay down the following rules upon the subject, which will be found in the accompanying paper, and which Earl Granville has instructed me to make known to the Government of the United States. I am at the same time requested to state that in all cases in which an exchange may be agreed upon, and in which presentations may be made, the books and papers will be packed at the stationery office, and forwarded to such address as may be given by the foreign minister in London of the Government making the application, the cost of transmission in each case being defrayed by the Government to whom the books are presented.

I have the honor to be, sir, your obedient servant,

L. S. SACKVILLE WEST.

(INCLOSURE.)—RULES FOR THE INTERCHANGE WITH FOREIGN GOVERNMENTS OF PARLIAMENTARY PAPERS AND OTHER OFFICIAL DOCUMENTS.

Whenever any application is made by the Government of an independent state for a "complete" exchange of its public documents with Great Britain, the lords of the treasury will be prepared to entertain such a proposal on the following understanding:

1. That a complete set of the English publications to be exchanged would be understood to consist of the following documents:

(*a.*) Papers of all kinds printed or presented to either House of Parliament;

(*b.*) Historical, scientific, or antiquarian works published by the Government, such as the Record publications; with liberty, however, of reserving very costly works, of which only a small number of copies may be printed, as subjects of separate negotiation;

(*c.*) Maps and charts published by the Government; and,

(*d.*) Departmental publications which are placed on sale, but not to include works published by booksellers with the aid of grants or subscriptions from Government.

2. That the Government making the application would in return undertake to send a "complete" set of its own publications for the Library of the British Museum, the "completeness" being of course left to the good faith of that Government.

But besides this general or what may be termed a national exchange, the lords of the treasury will be prepared to entertain within reasonable limits applications which may be made to it through the foreign office for gifts of special classes of British Official publications, such as military, Parliamentary, and statistical works, for the use of national or parliamentary libraries, or of state-supported institutions, or of other libraries of historic interest, provided the Government making the application be ready to give its own works of the same class; but such applications will, as heretofore, be considered on their own merits. Applications for the presentation of official publications to libraries of municipal authorities or voluntary associations of individuals, such as scientific societies or others connected with the state, cannot be entertained.

From the Smithsonian Institution, May 14, 1883, to the Hon. John Davis, Acting Secretary of State.

SIR: I beg to thank you for a copy of the note of the minister resident of Great Britain communicating the rules adopted by the lords of Her Majesty's treasury for the regulation of the interchange with foreign countries of Parliamentary papers and other official documents published by the British Government.

I will hereafter acquaint you with the titles of the publications of the United States Government presented to Great Britain. Meanwhile I shall endeavor to secure from the Librarian of Congress his desiderata of British publications, to enable him to complete the series in his charge so far as the rules of the lords of Her Majesty will permit.

Thanking you for your kind offer to make application for any publications still desired to complete the series presented to the United States by Great Britain through this Institution,

I have the honor to be, very truly, yours,

SPENCER F. BAIRD.

From the Smithsonian Institution, May 25, 1883, to the Hon. F. T. Frelinghuysen, Secretary of State.

SIR: Referring to your letter of the 9th instant, to which I replied under date of the 14th, I beg to state that the library of the British Museum is now supplied with the official documents of the United States mentioned in the three small pamphlets herewith, and a complete set of those previously published since 1868 as far as the same can be furnished. We should, of course, be only too happy to supply any deficiencies if in our power.

The documents supplied prior to those mentioned in box 15 are given in the appendix to the History of the Exchanges, herewith, and to which your attention is invited.

I also have the pleasure of presenting herewith a list of the publications of Her Majesty's Government desired by the Congressional Library, and which you were kind enough to inform us you would make an effort to secure.

I have the honor to be, very respectfully, your obedient servant,

SPENCER F. BAIRD.

From the Legation of the United States, Brussels, June 21, 1883, to the Department of State.

SIR: Referring to my Nos. 114 and 126, I have now the honor to inclose herewith six copies of a note from the British envoy to the Belgian minister for foreign affairs of April 15 (*sic*) last, which was read at the session of the conference of 13th April last.

There is evidently a mistake as to the date of the note from the British legation.

I also send you 12 copies of the report of the Proceedings of the Conference, with the British legation's note.

I strongly recommend to your notice the position of the British Government concerning exchanges of publications. By defining clearly and concisely what publications she is willing to exchange and by confining the offer to *certain* Governments, she assumes no great burden without being sure of an equivalent return. It is a position which appears to me to recommend itself to the large and powerful countries, and to protect them from the inequal exchanges involved by a convention with the smaller and less literate countries.

In the proof copy of the proceedings (inclosure 5 to my No. 114) no mention of the British note was made, and it is consequently not mentioned in the translation thereof (inclosure 6 to No. 114). Should the latter be published, I respectfully suggest that it be revised so as to make it a translation of the completed edition of the Proceedings of the Conference, herewith transmitted.

I have the honor to be, sir, your obedient servant,
NICHOLAS FISH.

Letter from the Department of State, October 15, 1883, *to Prof. Spencer F. Baird.*

SIR: With reference to previous correspondence in regard to the establishment of a complete exchange of public documents between this country and Great Britain, I have the honor to inclose herewith copies of correspondence between this Department and the British legation in regard to certain publications which Her Britannic Majesty's Government has presented to the National Library of the United States in response to the request made through this Department for certain works needed to complete to the present date the collection of British documents in that library.

I am, sir, your obedient servant,
FRED'K T. FRELINGHUYSEN.

(*Inclosure.*)—*From the British Minister, Washington, October* 8, 1883, *to the Department of State.*

SIR: Referring to your note of 1st June last respecting the interchange of Parliamentary papers, I have the honor to inform you for the information of Professor Baird of the Smithsonian Institute, through whose agency the exchange of the future publications of the two Governments is to be regulated, that the controller of Her Majesty's stationery office has been authorized to supply the agent of the Smithsonian Institution in London with the works which are mentioned in the inclosed list for the National Library of the United States.

The trustees of the British Museum, expressing their thanks to the United States Government for the offer to supply that institution with any Government publications that might be wanting, have stated that they are not aware of any deficiencies which need to be supplied, but have expressed their wish to be supplied with all the United States Government publications commencing with the year 1883.

I have the honor to be, with the highest consideration, sir, your obedient servant,

L. S. SACKVILLE WEST.

From the Department of State, July 9, 1883, *to the Smithsonian Institution.*

SIR: I inclose a copy of a dispatch from our minister at Brussels, and a copy of the completed edition of the Proceedings of the Brussels Conference on International Exchanges, to which it refers; also a copy of the "*Note from the British Envoy*" therein mentioned.

I am, sir, your obedient servant,
JOHN DAVIS,
Acting Secretary.

(Inclosure.)—From the United States Legation at Brussels, June 21, 1883, *to the Secretary of State.*

SIR: Referring to my Nos. 114 and 126, I have now the honor to inclose herewith six copies of a note from the British envoy to the Belgian minister for foreign affairs of April 15 (*sic*) last, which was read at the session of the conference of 13th April last.

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I have the honor to be, sir, your obedient servant,
NICHOLAS FISH.

From the Department of State, September 11, 1883, *to the Secretary of the Smithsonian Institution.*

SIR: I have the honor to inclose herewith for your information and consideration a copy of a dispatch from Mr. Lowell, the American minister at London, inclosing a copy of a communication from the colonial secretary of Cape Colony asking that steps may be taken to establish an exchange of publications between this Government and that colony.

In this connection I would suggest that it might be well to take into consideration the practicability of extending the Smithsonian system to all the British colonies, particularly those in Australia, some of which have manifested a desire to establish exchanges by sending their publications to our Government through this Department.

Adding that the publications referred to in Mr. Lowell's dispatch have been forwarded to the Library of Congress,

I am, sir, your obedient servant,

JOHN DAVIS,

Acting Secretary.

(*Inclosure.*)—*From the Legation of the United States, London, August* 22, 1883, *to the Secretary of State.*

SIR: I have the honor to inform you that the agent general of the Cape Colony, Africa, called at this legation yesterday, bringing with him three large packages of public documents, which the authorities of that colony desire to present to our Government, and which I shall request the dispatch agent here to transmit without delay to the Department of State.

The agent general at the same time placed in the hands of the legation a letter to him from the under colonial secretary at Cape Town, a copy of which I inclose herewith. This letter expresses the desire of the authorities of Cape Colony to establish with our Government a regular and mutual system of interchange of statistical and other publications emanating from or circulating under authority of Government Departments. It mentions that copies of the results of the census of 1880 and of the forms, books, and instructions made use of in that undertaking, would be particularly interesting.

It sems to me eminently desirable that the wishes of the authorities of Cape Colony in this matter should be complied with.

I have the honor to be, with great respect, your obedient servant,

J. R. LOWELL.

(*Inclosure.*)—*From the Colonial Secretary's Office, Cape Town, May* 22, 1883, *to the Agent-General for the Cape Colony, London.*

SIR: The colonial secretary is very anxious to establish with the Government of the United States of America a regular and mutual system of interchange of statistical and other publications emanating from or circulating under authority of Government Departments.

2. With this object in view I had the honor last year, by Mr. Scanlan's direction, to forward to your address under cover of letter No. 220 of the 23d September last, for transmission to the honorable the Secretary of State, Washington, three copies of the Colonial Blue Book, 1881.

3. Up to the present date the colonial secretary has not had the satisfaction of receiving any reports or papers in return.

4. May I request of you therefore the favor of your good offices in endeavoring to so arrange matters with the American minister at the Court of St. James that the desired result can be obtained.

5. Copies of the results of the 1880 census of the United States, and of the various forms, book instructions, &c., made use of in connection with that undertaking would be particularly interesting; and Mr. Scanlan will feel obliged if you will procure and forward all such reports.

I am, sir, your obedient servant,
HAMPDEN WILLIS.

From the Smithsonian Institution, September 15, 1883, *to the Hon. John Davis, Acting Secretary of State.*

SIR: I have the honor to acknowledge the receipt of your letter of the 11th September, inclosing a copy of a dispatch from the American minister in London, covering a communication from the colonial secretary of Cape Colony, in reference to establishing an exchange of publications between the United States and that colony.

In reply I beg to say that at present there is no arrangement by which such small colonies of Great Britain as Cape Colony could be placed on the list of exchanges for general publications; but I think there will be no difficulty in making the necessary arrangements with the Joint Library Committee of Congress, by which a larger edition of the more important publications of the United States Government can be placed at the command of the Smithsonian Institution.

By a reference to my letter of a few weeks past you will notice that I alluded to the committee as now having authority to increase the edition of public documents for foreign exchanges. Perhaps 50 more sets of a portion of the series will answer every purpose.

I shall take great pleasure in conferring with the Department of State, after my return to Washington, in regard to this subject.

In reference to your suggestion of extending the system of government exchanges, I may remark that at present Canada, New South Wales, New Zealand, Queensland, South Australia, Tasmania, and Victoria, are all in the first class of exchanges; receiving a full set of everything we have to furnish, and supplying a corresponding series in return, for the benefit of the Library of Congress.

Very respectfully, your obedient servant,
SPENCER F. BAIRD,

From the Public Library, etc., of Victoria, Melbourne, November 10, 1882, *to the Smithsonian Institution.*

SIR: I have the honor to acknowledge the receipt of your letter of the 1st July, 1882, and in reply to inform you that I have this day forwarded to you through our London agent, the agent-general for Victoria, a copy of the Victorian Parliamentary Papers for the sessions 1877, 1878, 1881.

These papers will, in future, be regularly sent you at the end of each session of Parliament.

With regard to your desire for additional copies of documents relating to the civil and natural history of the colony, I have to state that every effort will be made by the trustees to comply with your request. At present a scheme for placing the disposal of Government publications in the hands of the trustees is under the consideration of the Government, and as soon as the subject has been dealt with by the ministry I shall be in a position to announce to you more definitely the intentions of the trustees.

I may add that I am also forwarding copies of our Parliamentary Papers, (1) to the Boston Public Library, (2) to the New York State Library, (3) to the Mercantile Library Association San Francisco, and that I shall be glad to know whether it is your wish that works intended for these or other American institutions should be forwarded to you for registration, or whether any notification of their presentation should be made to the Smithsonian Institution.

I have the honor to be, sir, your obedient servant,

T. F. BRIDE,
Librarian.

Report on the International Conference on Exchanges, held at Brussels, Belgium, on the 10*th of April*, 1883.

During the months of August and September, 1875, an International Congress of Geographical Sciences was held at Paris, consisting of several hundred delegates from all parts of the globe. A prominent result of this conference was a unanimous resolution to enlist the co-operation of the respective Governments there represented in securing the free interchange of official and other publications, in accordance with a proposed plan for the international exchange of scientific publications to be submitted to the contracting powers.

A number of Governments having expressed their adherence to the project, bureaus were established for the purpose indicated.

In 1877 and again in August, 1880, conferences took place in Brussels, and after an experience of some six years a new conference was invited to assemble in Brussels on the 10th of April, 1883, and the proceedings of this conference and the correspondence attending it are here presented:

From the Department of State, January 10, 1883, *to the Smithsonian Institution.*

SIR: I beg to inclose to you herewith, for your information and consideration, a copy of a note received from Mr. Bounder de Melsbroeck, the Belgian minister, dated the 14th ultimo, on the subject of international exchanges, and a draft of a convention calculated to accomplish that end.

I am, sir, your obedient servant,

FRED'K T. FRELINGHUYSEN.

(Inclosure.)—From the Belgian Minister, Washington, December 14, 1882, *to the Department of State.*

MR. SECRETARY OF STATE: The delegates of various European states met at Brussels in the month of August, 1880, for the purpose of discussing questions relative to the system of international exchanges of scientific and literary documents and publications.

Belgium, Austria, Denmark, Spain, France, Italy, Portugal, Russia, and Sweden were represented at that conference.

The provisional arrangement then made has since been converted into a draft of a convention, one of the articles of which reserves the privilege of adhesion to all countries.

Brazil, Spain, Italy, and Portugal have agreed to this draft of a convention. France has proposed some amendments to it, which appear to be calculated to facilitate its adoption. Austria-Hungary has expressed no opinion, either one way or the other.

Belgium intends to propose the addition of an article, to which reference will be made hereafter. Under these circumstances, and in view of the small number of adherents to the draft in question, my Government thinks it desirable to submit all the arrangements, with regard to which an agreement might be reached, to a re-examination in common.

Other countries, perhaps, are unable to execute the clauses drafted in 1880, and it may be that other states desire the adoption of modifications which are essential to the establishment of their exchange service. It is, consequently, inclined to think that, without radically changing the projected arrangements, it might be well to seek to render it more easy of adoption by relaxing certain stipulations, which might be thought vigorous.

It is not probable that any government desirous of the attainment of a beneficial result would refuse to send delegates to Brussels to take part in discussions of the text of the convention to be definitively concluded by those countries which feel interested in the establishment of a system of international exchanges. These discussions would enable the delegates to form a correct idea of the object had in view by the contracting states.

They would call forth explanations relative to the arrangements to be made, and would probably pave the way to additional accessions.

Reports on the proceedings of these delegates would be submitted by them to their respective Governments, and a day would then be fixed for the meeting of the conference which would be charged with the conclusion of the final arrangement.

My Government has, therefore, instructed me to invite the Government of the United States of America, if the foregoing considerations meet its approval, to take part in another conference at Brussels of persons who are familiar with questions connected with international exchanges.

It is proposed that this conference shall meet on the 10th of April, 1883, since that date seems best to suit the convenience of the states interested.

To the end that your excellency may be pleased to take immediate cognizance of the modifications, and to give beforehand the necessary instructions to the delegates whom you may be pleased to designate, I have the honor herewith to transmit to you the original text of the draft of a convention (Inclosure A), the same draft with the amendments proposed by France (Inclosure B), and finally the arrangements, together with the one whose adoption is asked for by Belgium [article 10 of the draft marked C]. It reads as follows:

"The Governments concerned agree, moreover, to transmit to the legislative chambers of each contracting state, without the intervention of the exchange bureaus, one copy [two copies] of their official newspaper and of their annals and parliamentary documents."

The Belgian Government does not anticipate the least opposition to this proposal. All countries are interested in the prompt transmission of official documents and the reports of parliamentary debates.

I think it proper for me to add that my Belgian colleagues at Berlin, Berne, Bucharest, The Hague, Lisbon, London, Madrid, Paris, Rio de Janeiro, Rome, St. Petersburg, Stockholm, and Vienna, have likewise received instruction to address invitations to the conference of April 10 to the Government to which they are respectively accredited.

I trust that your excellency will favorably receive the invitation which I hereby have the honor to address you, and I will thank you to favor me with a reply.

I gladly avail myself of this occasion to renew to your excellency the assurances of my highest consideration.

DE BOUNDER DE MELSBROECK.

[*Inclosure.*—A.]

His Majesty the King of the Belgians, His Majesty the Emperor of Austria, King of Bohemia and Apostolic King of Hungary, His Majesty the King of Denmark, His Majesty the King of Spain, the President of the French Republic, His Majesty the King of Italy, His Majesty the King of Portugal and the Algarves, His Majesty the Emperor of all the Russias, His Majesty the King of Sweden and Norway, desiring to establish on the basis adopted by the Brussels conference, a system of international exchanges for the official documents, and for the scientific and literary publications of their respective states, have appointed as the plenipotentiaries, to wit: ———* who, having exhibited to each other their full powers, which were found to be in good and due form, have agreed upon the following articles:

* Names of delegates omitted.

A. *Text adopted.*	B. *Modifications proposed.*
ARTICLE 1. A bureau having charge of the exchange service shall be established in each of the contracting states.	
ART. 2. The contracting states agree to exchange the following publications: 1. Parliamentary and executive documents published by them. 2. Works issued by order and at the expense of or with the aid of a subsidy from the Governments. 3. Publications issued by academies or learned societies, universities, and schools, so far as it may be in the power of the Governments to procure them.	ART. 2. The contracting states agree to exchange the following publications: 2. Works issued by order and at the expense of the Governments.
ART. 3. Each bureau shall cause to be printed a list, as complete as possible, of the publications that it may be able to furnish to the contracting states.	ART. 3. Each bureau shall cause to be printed a list, as complete as possible, of the publications that it may be able to furnish to the contracting states. This list shall be corrected and completed each year and addressed to all the exchange bureaus.
ART. 4. During the first quarter of each year each bureau shall publish a report of the progress of the service and of the results accomplished in the course of the preceding year. This report shall contain all necessary corrections and additions to the list mentioned in Art. 3.	
ART. 5. Exchange bureaus shall arrange with each other as to the number of copies which, in certain cases, may be asked for and furnished.	ARTICLES 3 and 4 are combined in one, and Article 5 thus becomes Article 4.
ART. 6. The exchange bureaus shall arrange among themselves with regard to the method of transmitting the various publications.	ART. 6 becomes Article 5.
ART. 7. The documents shall be transmitted directly from bureau to bureau. Uniform models and forms shall be adopted for lists of the contents of boxes, and for all executive communications, requests, acknowledgment of receipt, &c.	ART. 7 becomes Article 6.
ART. 8. When documents are to be sent abroad, each state agrees to pay the expenses of packing and	ART. 8 becomes Article 7.

transportation to the place of destination, and, when the documents are to be sent to countries lying beyond the sea, to pay such expenses to the port where they are to be discharged.	
ART. 9. The exchange bureaus may, unofficially, serve as mediums between the learned societies of the contracting states for the reception and transmission of the publications of the said societies.	ART. 8, § 1. The exchange bureaus may, unofficially, serve as mediums between the parliaments, the Government departments, and the learned societies of the contracting states for the reception and transmission of their publications. § 2. It shall, however, be understood that, on these occasions, the functions of the exchange bureaus shall be confined to the free transmission of the works exchanged, and that these bureaus shall in no wise take the initiative in bringing about the establishment of such relations between foreign parliaments, governmental departments, and learned societies.
ART. 10. These provisions are applicable to none but documents and works published at or subsequent to the date of this convention. It is, nevertheless, desirable that the contracting states should endeavor to procure the preceding series of volumes, so that a complete copy of each collection may be in at least one library in each State.	ART. 10 becomes Article 9.
ART. 11. States that have not taken part in this convention shall have the privilege of adhering thereto whenever they may express a desire to do so. Notice shall be given of such adhesion, through diplomatic channels, to the Belgian Government and by that Government to all the signatory states.	ART. 11 becomes Article 10.
ART. 12. This convention shall be ratified, and the ratification shall be exchanged at Brussels, as soon as possible. It is concluded for ten years, reckoned from the day of the exchange of the ratification, and shall continue to exist after that time until one of the Governments shall have declared, six months beforehand, that it desires the cessation of its effects.	ART. 12 becomes Article 11.

[The draft referred to in Mr. de Bounder de Melsbroeck's letter as inclosure C, differs from the adopted text in the following respect:

After Article 3 the following words are inserted: "This list shall be corrected and completed each year and regularly addressed to all the exchange bureaus."

Article 4 of the adopted text is omitted.

Article 5 of the adopted text becomes Article 4 of this draft, and a similar change is made in each article (*i. e.*, its numbers diminished by one) up to Article 10, which is a new article added in this dratt.

Article 9 of the adopted text becomes Article 8 of this draft.

It is here divided into two sections, and is identical with Article 8 of the modified text given in parallel columns with that adopted.

Article 10 of the adopted text becomes Article 9 of this draft.

Article 10 of this draft is, as above stated, an entirely new one, and reads as follows:

Article 10. The Governments concerned agree, moreover, to transmit to the legislative chambers of each contracting state, without the intervention of the exchange bureaus one copy [two copies] of their official newspaper and of their annals and parliamentary documents.

Articles 11 and 12 of this draft are identical with Articles 11 and 12 of the adopted text.]

From the Smithsonian Institution, February 27, 1883, *to the Secretary of State.*

SIR: Your letter of January 10, inclosing a communication from the Belgian minister in Washington, was duly received, but I have delayed an answer in order to give a careful consideration to the various questions involved.

The proposition to have a conference of official delegates at Brussels on the 10th of April next is, of course, a practical one; but, on its acceptance by the United States, it will be necessary to determine whether the American minister in Belgium or some other official of the State Department in Europe can be charged with the duty, or whether it will be expedient to send some one from Washington who has had a thorough practical acquaintance with the system now in operation by the Smithsonian Institution and who can point out any technical difficulties or inconveniences. Perhaps, in any event, such agent should be on hand to make the necessary explanations and suggestions.

Mr. George H. Boehmer, the author of the report of the Institution to the Department on this very subject, could be spared for this purpose; but the cost of his mission could not conveniently be defrayed from the funds of the Institution, or from the appropriations of Congress for the purpose of international exchanges. Whether the State Department has the means at its command to send him, or whether it will be expedient to ask for a moderate appropriation of say $500 is for you to decide.

There is nothing among the details agreed upon at the conventions of 1877 and of 1880 differing materially from the practice of the Smithsonian system so far as the purely governmental exchange is concerned; but in the interchange of publications between the learned bodies of the two countries, respectively, there is a decided difference. The Smithsonian Institution aims at establishing direct relationships—parcels for foreign societies and institutions being sent to us addressed by the donors and the Institution simply charging itself with securing their safe delivery abroad—while the foreign exchange agencies, on the other hand, assume also the responsibility of delivering unaddressed packages to such societies as they deem suitable. While the Smithsonian Institution has at times performed this latter service, on special request, it nevertheless endeavors to establish direct relations between donor and recipient, confining itself, as far as possible, to the work of a carrier. This method is, I think, very much the better of the two.

Permit me to inquire whether the wording of Article 8 has been correctly rendered in the translation, so far as the use of the word "post" near the end is concerned? If this be port it will be in strict accordance with the practice and preference of the Smithsonian Institution. In the entire inability to follow a package across the water to its ultimate destination, we deliver the same either at New York or at the corresponding port in Europe, and expect to be responsible for charges only from the opposite port, or from New York, as may be agreed upon.

I may say, in conclusion, that the system of governmental exchange does not work as satisfactorily as where we have our own agents in the respective countries, and it is extremely difficult to induce Government officials to take the necessary pains to see that packages addressed to minor institutions or to individuals reach their destination. Booksellers, who have usually served as our agents, attend to this matter much more carefully.

I inclose an article prepared by Mr. Boehmer, showing the parallelism in the letter of the Belgian minister and the practice of the Smithsonian Institution, together with a general brief of the Smithsonian plan. For full details I would refer to the report of the Smithsonian Institution on this subject made to the Department of State some months ago.

Very respectfully, your obedient servant,

SPENCER F. BAIRD.

Comparison of proposed and Smithsonian systems.

ARTICLES AGREED UPON BY BRUSSELS CONFERENCE.	WORK DONE BY THE SMITHSONIAN EXCHANGE.
ARTICLE 1. A bureau having charge of the exchange service shall be established in each of the contracting states.	The establishment of the Smithsonian exchange service is fully explained in the "History of the Smithsonian Exchanges."

ART. 2. The contracting states agree to exchange the following publications:

1. Parliamentary and executive documents published by them.

2. Works issued by order and the expense of or with the aid of a subsidy from the Governments.

3. Publications issued by academies or learned societies, universities, and schools, so far as may be in the power of the Governments to procure them.

ART. 3. Each bureau shall cause to be printed a list, as complete as possible, of the publications that it may be able to furnish to the contracting states.

ART. 4. During the first quarter of each year each bureau shall publish a report of the progress of the service and of the results accomplished in the course of the preceding year. This report shall contain all necessary corrections and additions to the list mentioned in Article 3.

This list shall be corrected and completed each year and addressed to all the exchange bureaus.

ART. 5. The exchange bureaus shall arrange with each other as to the number of copies which in certain cases may be asked for and furnished.

ART. 6. The exchange bureaus shall arrange among themselves with regard to the methods of transmitting the various publications.

ART. 7. The documents shall be transmitted directly from bureau to bureau. Uniform models and forms shall be adopted for lists of the contents of boxes and for all executive communications, requests, acknowledgment of receipts, &c.

ART. 8. Whenever documents are to be sent abroad, each State agrees to pay the expense of packing and transportation to the place of destination, and, when the documents are to be sent to countries lying beyond the sea, to pay such expenses

The Smithsonian Institution distributes (see act of Congress March 2, 1867).

The official documents printed by either house of Congress and delivered by the Public Printer in fifty copies.

3. Publications of societies, &c., are obtained by the Smithsonian Institution at the request of foreign correspondents.

Such a list forms a part of the annual report of the clerk in charge of exchanges submitted to the Secretary of the Smithsonian Institution at the close of each year.

This is also given in the statistics of the exchanges appended to the Secretary's annual report.

Of the 50 copies supplied by Congress to the Smithsonian Institution only 8 are unassigned.

The method adopted by the Smithsonian Institution is to transmit whenever a sufficient number of books have accumulated to fill one regulation "size" case for each Government.

This method has been adopted by the Smithsonian Institution since the first establishment of exchange bureaus (in Paris, France, in 1876) resulting from the Geographical Congress in August and September, 1875.

The Smithsonian Institution pays the expenses of packing, &c., and delivers the boxes free of charge to the representative (generally the consuls) of the respective Government at any seaport in the country, while the returns are to be delivto the port where they are to be discharged.

ART. 9. The exchange bureaus may, unofficially, serve as mediums between the learned societies of the contracting states for the reception and transmission of the publications of the said societies.

It shall be understood that on these occasions the functions of the exchange bureaus shall be confined to the free transmission of the works exchanged, and that the bureaus shall in no wise take the initiative in bringing about the establishment of such relations between foreign Parliaments, governmental departments, and learned societies.

ART. 10. These provisions are applicable to none but documents and works published at or subsequently to the date of this convention. It is nevertheless desirable that the contracting states should endeavor to procure the preceding series or volumes, so that a complete copy of each collection may be in at least one library in each state.

ART. 11. States that have not taken part in this convention shall have the privilege of adhering thereto whenever they may express a desire to do so. Notice shall be given of such adhesions through diplomatic channels to the Belgian Government, and by that Government to all the signatory states.

ART. 12. The convention shall be ratified and the ratifications shall be exchanged at Brussels as soon as possible. It is concluded for ten years, reckoned from the day of the ratification, and it shall continue to exist after that time until one of the Governments shall have declared, six months beforehand, that it desires the cessation of its effects.

ered to the regularly appointed agents of the Smithsonian Institution located in the several countries.

This constituted the most important branch of the Smithsonian operations. Scientific productions are distributed throughout the world so as to secure for them a greater circulation than could be obtained in any other way.

The complete collection of official publications, which the Smithsonian Institution distributes under the system of international exchanges comprises 17 boxes of about 260 pounds each, to the set, and includes all the Government documents issued between the year 1867 and the present time.

Details of Smithsonian Exchange Operations.

[1. A list of the addresses and a statement of the contents of each sending is to be mailed to the Smithsonian Institution at or before the time of transmission.

2. The packages must be enveloped in stout paper and securely pasted or tied with strong twine; they must be legibly addressed and indorsed with the name of the sender; they must not exceed one-half of one cubic foot each in bulk; they must have no inclosures of letters; they must contain a blank acknowledgment to be signed and returned by the party addressed, and must be delivered to the Smithsonian Institution free of expense.

3. On arrival of exchanges for transmission, the parcels are compared with the list of addresses, and, if found correct, acknowledgment is mailed to the sender and each entire sending entered as a single transaction in the book of incoming exchanges.

4. The addresses in the invoices and on the parcels are then provided with the numbers corresponding to those in the "List of Foreign Correspondents" and the consignees charged with the parcels on their account, which are kept in this office in the form of a card catalogue.

5. The packages are then laid away in bins, each representing a certain city or cities or a part of them in any given country.

6. When a sufficient number of parcels have accumulated to justify a sending to any country, invoices are made up from the card catalogue of all parcels for any one society; this is inclosed in an envelope and sent by mail to the consignee. This invoice is the notification of the sending and enables the consignee to correspond with the agent of the Smithsonian Institution in his country regarding the final disposition of his package.

7. While the invoices are being made out, the accumulations are taken from the bins and all the parcels for any one society, after being compared with the invoice, are wrapped in one or more bundles.

8. All the bundles for one country are then packed in boxes of uniform, or nearly uniform, size, the lids fastened with ten screws and the boxes addressed to the agent of the Smithsonian Institution in that country.

9. The shipment is made through local express and railroad freight to the shipping agent at any given seaport, receipts being taken from the respective carriers.

10. The shipping agent forwarding the cases mails one bill of lading directly to the agent and duplicate copies to the Smithsonian Institution, which retains one copy and mails the other to the agent.

11. The agent distributes the parcels in accordance with the instructions received from the respective consignees, taking for them receipts, which he forwards to the Institution.]

From the Department of State, May 15, 1883, *to the Smithsonian Institution.*

SIR: I inclose a copy of a dispatch from our minister at Brussels, giving the results of the Brussels conference on international exchanges, also, its original inclosures, and have to ask for an expression of your views in the premises, and especially as to the Belgian proposals. [Inclosure 9.]

I am, sir, your obedient servant,
JOHN DAVIS,
Acting Secretary.

(*Inclosure.*)—*From the Legation of the United States, Brussels, April* 24, 1883, *to the Secretary of State.*

SIR: Referring to your Instruction No. 26, and to my dispatches 106 and 107, I have the honor to inclose herewith a copy and translation of a note from the Belgian Government of the 4th instant, respecting the conference to draft a convention to regulate the international exchanges of official documents, and scientific and literary publications.

Immediately upon the receipt of the pamphlet, "History of the Smithsonian Exchanges," I commenced a careful examination of the question to be discussed at the conference.

The letter from the Secretary of the Smithsonian Institution to you of February 27 last, and its accompaniment, with the pamphlet above mentioned, constituted my instructions.

On studying the comparison made by Mr. Boehmer between the articles agreed upon in 1880 at Brussels, and the work done by the Smithsonian Institution in regard to the exchanges, I found the principal divergence to be in reference to article 8. The provisions of that article are thus stated by him: "When documents are to be sent abroad each State agrees to pay the expenses of packing and transportation to the place of destination, and, when the documents are to be sent to countries lying beyond the sea, to pay such expenses to the port where they are to be discharged." There is no disagreement as to the cost of packing, but merely as to the transportation by and beyond the sea. The Smithsonian's rule being "to pay the expenses of packing, &c., and to deliver the boxes free of charge to the representative (generally the consul) of the respective Governments at any seaport in the United States, while the returns are to be delivered to the regularly appointed agents of the Smithsonian Institution located in the several countries."

Under the existing generous action of the various steamship lines the question of ocean transportation is not a material one, but I considered that I should endeavor to avoid signing a draft which, if ratified, would bind us to the payment of the ocean freight, even if we received the return exchanges free of cost in our own ports.

The new text of this article, which becomes article 6 in the present draft, leaves the question of the transportation by sea a matter to be fixed by special arrangements. This will permit the continuation of the method pursued by the Smithsonian Institution.

In the conference the countries represented were the United States, Austria-Hungary, Belgium, Brazil, France, Italy, Portugal, Spain, Roumania, Servia, and Switzerland.

It may not be altogether uninteresting to compare them as to extent of territory and population. I gather the following from the Almanach de Gotha:

Countries.	Square kilometers.	Population.	To the square kilometer.
United States	9,331,360	50,442,066	5.4
Austria-Hungary	625,168	37,869,954	61.0
Belgium	29,445	5,519,844	187.0
Brazil	8,337,218	10,108,291	....
France (proper)	528,572	37,672,048	71.0
France (colonies)	1,994,113	30,173,234	....
Italy (proper)	296,323	28,459,451	96.0
Italy (colonies)	632	1,193	....
Portugal (proper)	89,625	4,160,315	46.0
Portugal (colonies)	1,825,252	3,333,700	....
Roumania	129,947	5,376,000	41.0
Spain (proper)	500,443	16,342,996	33.0
Spain (colonies)	436,747	8,839,015	....
Servia	48,590	1,700,211	35.0
Switzerland	41,390	2,846,102	69.0
Total	24,214,835	242,844,420	....

The development of the sciences and literature in the respective countries and the amount of the illiterate classes would doubtless furnish a better gauge of the desirability and advantages of entering into a convention of this nature, but in the absence of such statistics the foregoing will not be altogether useless.

In addition to the countries represented in the conference, Greece, Russia, Sweden and Norway, and Uruguay have evinced a desire to adhere to the convention.

The same statistics concerning them are—

Countries.	Square kilometers.	Population.	To the square kilometer.
Greece	54,688	1,979,423	31
Russia	5,016,024	81,598,569	16
Sweden and Norway	775,997	6,772,568	
Uruguay	186,290	438,245	2
Total	6,042,999	90,788,805	

The conference met under the presidency of Mr. Rolin-Jacquemyns, the Belgian minister of the interior, on the 10th instant, at 11 A. M. The president, after a short address, declared the general question open for debate, whereupon the Swiss delegate, Mr. Abt, read a statement defining the position of Switzerland, and opposing the extension of the obligation to exchange other than official parliamentary and administrative documents, and works executed by order of, and at the expense of, the contracting states. I invite particular attention to this document, which is given in full in the protocols of the conference.

The Austrian delegate, Mr. de Dechy, maintained that the convention of 1880 would not affect the exchange between the literary and scientific societies.

Mr. Charmes, the French delegate, maintained that while the exchange of official publications should be rendered obligatory, the bureaus should also be allowed to act as the friendly agents for effecting exchanges between the learned scientific and literary societies of the different countries.

The president agreed with Mr. Charmes, and this appeared to be the sense of the conference. Mr. Alvin, one of the Belgian delegation, the venerable head of the Royal Library of Brussels, explained his experience of the working of the exchanges. As the Royal Library is the regularly appointed agent of the Smithsonian Institution, his remarks have a special interest. He mentioned a newly created reading-room for periodical literature, attached to the library, where 1,100 or 1,200 publications are accessible to the public. (I regret to say that those of the United States are conspicuous by their almost total absence.)

Mr. Alvin expressed the hope that similar reading-rooms might be established in all the great centers of population and that the exchanges would greatly benefit them.

The discussion of Article 1 was then begun. Mr. Charmes (France) said that Article 1 prescribed the establishment of bureaus of exchange in each contracting state, but until now it has not been carried into effect.

The president called attention to the fact that until now there was no obligation, and suggested that we should cursorily examine the condition of affairs in the respective countries. Mr. Alvin said that bureaus had been established in France, in Russia, in Italy, and in Spain.

Mr. de Villeneuve (Brazil) said that in Brazil there was a bureau.

Mr. Alvin said that in the United States there was the Smithsonian Institution, but that as it was not an official bureau it did not fully answer the ends that the conference sought.

Mr. Vacaresco (Roumania) said that in Roumania there was no bureau, and he could not guarantee the establishment of one until the ratification of the convention.

I said that in the United States the Smithsonian Institution had undertaken the exchanges of Government publications; that as to the other publications it was sometimes difficult to obtain them from the societies, but that the Institution willingly undertook to send them at the request of the learned societies.

That Congress had placed 50 copies of the official publications at the disposition of the exchanges, and that but eight of these remained undistributed.

Mr. Alvin added that the Smithsonian also distributes European packages in North and South America, but not officially. Article 1 was then adopted without alteration.

Upon the discussion of Article 2 as it was in the draft of 1880, there was a conjunction of obligatory stipulations with a contingent stipulation. In the present draft this is avoided by the unanimous omission of the last paragraph.

The words, "with the aid of a subsidy," in the next to last paragraph, were also suppressed.

Article 3 was adopted so as to read: "Each bureau shall cause to be printed the list of the publications that it is able to place at the disposal of the contracting states.

"That list shall be corrected and completed each year and regularly addressed to each of the bureaus of exchanges."

In the morning session of 11th of April Article 4 was adopted with the omission of the words "in certain cases."

Article 5 was omitted.

Article 6 having become Article 5, was adopted.

Article 7 (having become Article 6) was then taken up for discussion and Mr. Ruelens (Belgium) explained that the reason of making a distinction in regard to payment of the sea transportation, was because it is generally impossible for the shipper to know the railway tariffs beyond the port of debarkation, and that when they are known there is great difficulty in obtaining the railway receipt for the freight.

I stated the custom of the Smithsonian of sending its boxes to the consuls at our own ports free of charge.

Mr. Alvin and Mr. Ruelens seemed surprised to learn that we did not pay the charges to the port of debarkation, and were of opinion that we did so in regard to the shipments to Belgium.

I read the rule of the Smithsonian quoted above, taken from Mr. Boehmer's memorandum, and explained to the conference that these gentlemen were doubtless misled by the fact that the steamship companies had consented to carry the parcels of the Institution free, but that I could not guarantee that our Government would bind itself to deliver them free of cost beyond its own ports.

Neither Mr. Alvin's, Mr. Ruelens', nor my own remarks in regard to steamship companies are fully given in the printed accounts of the proceedings of the conference, but the text of the article as finally adopted rendered an amendment on this subject in the accounts of the proceedings unnecessary.

The president calling attention to the fact that shipments by sea were sometimes made to countries that were not *beyond the sea*, suggested substituting therefor *shipments by sea*.

The discussion of the article was then postponed. It was resumed in the session of the 14th instant, upon my demand that in the final protocol mention should be made that I had reserved the rights of the United States in regard to this article.

The president then suggested the adoption of the article in the following form:

"Pour l'expédition à l'extérieur chaque état se charge des frais d'emballage et de port jusqu'à destination. Toutefois, quand l'expédition se fera par mer, des arrangements particuliers règleront la part de chaque état dans les frais de transport."

(Translation: For shipment to foreign countries, each state assumes the cost of packing and of transportation to destination. When, however, the shipment is to be made by sea, special arrangements shall determine the proportion of each state in the cost of transportation.)

Which was adopted.

Article 8 (become Article 7) was then taken up, and gave rise to a long discussion.

The suppression of the last paragraph of Article 2 had left the convention relating solely to the obligatory exchanges of official documents, parliamentary and administrative.

I felt that the omission of a provision creating a voluntary channel for the exchange of literary and scientific societies would be a most regrettable result, and that it would seriously interfere with one of the most useful and extended means of spreading information and knowledge.

The enactment of the provision, although merely optional in its character, would materially aid the Smithsonian in carrying out this, in Mr. Boehmer's opinion, "the most important branch of its operations."

It would be of equal benefit in case the bureau of exchanges were to be transferred to the Department of State or any other branch of the Government. I therefore assumed that I was carrying out your wishes in endeavoring to secure its retention, if not in its letter, at least in its spirit.

The text as it now stands was adopted to avoid a pleonasm in the former French text, and to define more clearly the societies whose publications may be exchanged.

There is no greater obligation created than in the former convention, and the result may be considered as merely an improvement in the phraseology of the text.

The discussion of this article is worthy of a perusal, and for its full comprehension that of Article 2 should be also consulted. I hope my remarks in favor of its retention will merit your approval.

Article 9 (now become Article 8) was adopted with the omission of the second paragraph, the latter wish being expressed in the final protocol.

Article 10 (the new proposal of the Belgian Government) is as follows:

"The respective Governments further agree to cause to be sent to the legislative chambers of each contracting state, as soon as they are published, and without passing through the intermediary bureaus of exchanges, a copy of the official journal and of the parliamentary documents and annals."

In your instruction to me there was no mention of this proposition. It is not referred to by Professor Baird or by Mr. Boehmer in his memorandum.

Upon verbal inquiry at the foreign office, I ascertained that it was sent in November last to the Belgian legation at Washington, with instructions to bring it to your notice.

I had therefore to deal with the proposition entirely as a measure of possible utility to Congress. I saw that the transmission of fifteen or twenty copies of the Congressional Record, of all the bills, motions, petitions, reports, &c., by post would involve a large outlay in postage, in addition to the cost of paper and printing, and that it would entail the employment of additional clerks to attend to it. On the other hand, the daily receipt of similar matter from fifteen or twenty Governments would require a considerable staff to sort and care for the publications, and soon involve the construction of additional room for their preservation.

I have no doubt that such an exchange established with *certain* Governments would prove of great usefulness to Congress, but I very much question whether it would be wise to bind ourselves to such an exchange with *all* the countries represented in the convention. If you should differ with me, the way is still open for our Government to enter into such an arrangement, as the article proposed by the Belgian Government was omitted from the convention signed by all the delegates to the conference, and was made the subject of a special convention between those which supported it.

The delegates of Austria-Hungary, Belgium, Brazil, Italy, Portugal, Roumania, Spain, and Servia signed the two conventions.

The delegates of the United States, France, and Switzerland, being opposed to the Belgian proposal, signed only the draft of the general convention, which was signed by all the delegates.

For a more thorough comprehension of the discussion of the conference I inclose herewith (inclosure 3) a copy and (inclosure 4) a translation of the proposals originally submitted to our discussion at the opening of the conference, and a proof copy of the proceedings of the conference (inclosure 5), of which I have made a free translation (inclosure 6).

I inclose herewith copies and translations of the final protocol which was signed by the delegates of all the powers represented at the conference (inclosure 7), and of the draft of the convention signed by them (inclosure 8).

I also inclose a copy and translation of the convention embodying the Belgian proposal for the immediate exchange of parliamentary documents (inclosure 9), which was signed by the delegates of eight of the eleven powers represented at the conference.

The original text of these documents being in French, my translations of them will require careful revision.

I likewise inclose lithographic copies of the two conventions and of the final protocol (inclosures 10, 11, and 12). The latter was only received to-day. The convention adjourned late in the afternoon of the 14th instant.

On the 12th the King received us at Lacken, and although suffering from a severe cold, exhibited his wonderful knowledge of the current events of all countries, which with his courteous manners render him always a most entertaining host and a most enlightened sovereign.

The Belgian minister of the interior, Mr. Rolin Jacquemyns, entertained the delegates at dinner the same evening.

I have the honor to be, sir, your obedient servant,

NICHOLAS FISH.

INCLOSURES.

1. Mr. Frère-Orlean to Mr. Fish, 4th of April, 1883.
2. Translation of No. 1.
3. Proposals originally submitted for the discussion of the contents.
4. Translation of inclosure No. 3.
5. Proof copy of proceedings of conference.
6. Translation of inclosure No. 5.
7. Final protocol of conference signed by delegates of all the states represented, with the translation.
8. Draft of convention for the international exchanges of official documents and of scientific and literary publications, signed by the delegates of all the states, with translation.
9. Draft of convention for the immediate exchange of parliamentary documents, signed by the delegates of eight of the eleven states represented at the conference, with translation.

(*Inclosure* 1, 2, *Translation.*)—*From the Minister of Foreign Affairs, Brussels, 4th April,* 1883, *to Mr. Fish.*

MR. MINISTER: The Belgian minister at Washington has informed me that the Government of the United States of America, acceding to the request which was made to it in my name, has decided to take part in the conference which is to be held at Brussels on the 10th of April instant, and that it has confided to you the duty of representing it at that assembly.

No doubt you are aware that at present a preparatory reunion is contemplated, to discuss and determine all the questions relating to the system of international exchanges of official document and scientific and literary publications.

It is to be hoped, however, that it will be possible to agree upon the text of a project of convention, which shall be afterwards submitted to the approbation of the respective Governments interested therein.

Belgium, Austria, Denmark, Spain, France, Italy, Portugal, Russia, and Sweden were represented at the first conference, which was held at Brussels in 1880. The provisional arrangement which resulted from that preliminary conference has since been converted into a project of convention, the text of which is herewith annexed (A).

Certain modifications to this preliminary project of conventions have been proposed. They are set forth in the document which you will also find inclosed herewith (B).

The Government of the King has demanded on its part the adoption of an amendment which seems of incontestable utility. It would be the tenth article of the new arrangement, of which I have the honor, Mr. Minister, to communicate to you the text, and concerning which the deliberations of the reunion of the 10th April will be held. As I stated to you above, Mr. Minister, the labor of the delegates will be submitted by them to their respective Governments, and thereafter the time of meeting of the conference which will be held for the purpose of signing the final arrangement will be fixed.

The following is, Mr. Minister, the text of the amendment which I have proposed:

"The respective Governments moreover engage themselves to cause to be forwarded to the legislative chambers of each contracting state, as soon as they are published, and without passing through the intermediary of the bureaus of exchange, one [two] copies of the official journal, parliamentary annals, and documents."

I do not presume that this proposition can incur any opposition. A common interest is attached to it for all countries to secure the prompt communication of official acts and documents relating to parliamentary debates. In the last Belgian legislative session a member of the Chamber of Representatives called my attention to this important point, and it seemed to me that the projected convention furnished an opportunity of attaining, by a channel more efficacious than any other—that is, of an international agreement—the object which we have in view. Each Government will no doubt deem it expedient to admit a clause which cannot fail to be fertile in good results and which cannot raise any difficulty.

I will add, Mr. Minister, that the following powers have been invited to participate in the deliberations to which I allude: Germany, England, Austria-Hungary, Brazil, Denmark, Spain, United States of America, France, Greece, Italy, the Netherlands, Portugal, Roumania, Russia, Servia, Sweden and Norway, and Switzerland.

The meetings will be held in the session room of the Royal Academy of Belgium, in the Palace of the Academies (Rue Ducale 1). The first meeting will be held Tuesday next, April 10, at 11 o'clock. The installation of the conference will be under the care of the minister of the interior.

Pray accept, Mr. Minister, the assurances of my most distinguished consideration.

FRÈRE-ORLEAN.

(*Inclosure* 3, 4.)—TRANSLATION OF PROPOSALS ORIGINALLY SUBMITTED FOR THE DISCUSSION OF THE CONFERENCE.

New draft of a convention for the international exchanges of official documents and of scientific and literary publications.	*Amendments made to the drafts agreed upon by the conference of* 1880.
ARTICLE 1. There shall be established in each of the contracting states a bureau charged with the duty of the exchanges.	Without alteration.
ART. 2. Publications which the contracting states agree to exchange are the following: (1) The official documents, parliamentary, administrative, which are published in the country of their origin; (2) the works executed by order and at the expense of the Governments; (3) the publications of academies and learned societies, of universities and schools, as far as the Governments shall be able to obtain them.	The words "*with subsidies*" have been omitted from the second paragraph.
ART. 3. Each bureau shall cause to be printed a list, as complete as possible, of the publications that it is able to place at the disposal of the contracting states. That list shall be corrected and completed each year, and regularly addressed to all the bureaus of exchange.	The second paragraph of this article replaces the fourth article of the draft of 1880.
ART. 4. The bureaus of exchange will arrange between themselves the number of copies which in certain cases they may demand and furnish.	Article 5 of the draft of 1880.
ART. 5. The bureaus of exchanges will determine among themselves the models of packages of different publications.	ART. 6 of the draft of 1880.
ART. 6. Shipments shall be made directly from bureau to bureau. Uniform models and formulas for the invoices of the contents of the cases, as well as for all administrative correspondents' requests and acknowledgments of reception, &c., shall be adopted.	ART. 7 of the convention of 1880.
ART. 7. For shipments to foreign countries, each state assumes the cost of packing and of transportation to destination and for countries beyond the sea to the port of debarkation.	ART. 8 of the draft of 1880.

ART. 8, § 1. Bureaus of exchanges may in an official capacity serve as the intermediary between the Parliaments, the administrations, and the learned societies of the contracting states for the reception and forwarding of their publications.

§ 1 is a reproduction of Article 9 of the former draft, to which have been added the words *Parliament et administration.*

§ 2. It remains, however, well understood that in such cases the duty of the bureaus of exchanges will be confined to the transmission free of cost of the works exchanged, and that those bureaus will not in any manner take the initiative to bring about the establishment of such relations between the parliaments, administrations, and learned societies of foreign countries.

§ 2 is new.

The amendments to the foregoing articles were requested by the French Government.

ART. 9. These provisions apply only to documents and works published after the date of the present convention. It is nevertheless desirable that the contracting states should endeavor to obtain the preceding series or volumes, so that a complete set of each collection at least should be found in one of the libraries in each state.

ART. 10 of the draft of 1880.

ART. 10 [*New*]. The respective Governments agree further to cause to be sent to the legislative chambers of each contracting state, as soon as they are published, and without passing through the intermediary of the bureaus of exchanges, a copy of the official journal and of the parliamentary documents and annals.

Proposed by the Belgian Government.

ART. 11. The states which have not taken part in the present convention are admitted to adhere to it upon making the request.

This adhesion is to be notified to the Belgian Government through the diplomatic channel and by the latter Government to all the other states signing it.

These last two articles did not form part of the text agreed on in 1880; they have been adopted by the department of foreign affairs of Belgium at the same time as the introductory formula of such diplomatic documents.

It is not deemed necessary to here reproduce that preamble in which all the contracting states should be enumerated.

ART. 12. The present convention shall be ratified and the ratifications exchanged at Brussels as soon as it is practicable. It is concluded for ten years from the day of the exchange of ratifications, and it shall remain in force beyond that time so long as one of the Governments shall not have declared six months in advance that it denounces the same.

(*Inclosure* 5, 6, omitted.)

[*Inclosure* 7.—Translation.]—FINAL PROTOCOL OF A CONFERENCE SIGNED BY ALL THE DELEGATES.

The undersigned delegates of Austria-Hungary, of Belgium, of Spain, of Brazil, of the United States of America, of France, of Italy, of Portugal, of Roumania, of Servia, and of Switzerland, met at Brussels on the 10th of April, 1883, with a view of preparing an international convention, having for its object the exchanges of official documents and literary and scientific publications.

As a result of the deliberations recorded in the minutes of their meetings, they have signed a draft of the convention annexed to the present final protocol, marked A. They agreed to submit it to the approbation of their respective Governments.

The undersigned deem it proper to remark that in preparing this draft of a convention the delegates of the Governments represented at the conference sought to attain two quite distinct ends.

1. To centralize as much as possible in a single library in each of their countries all those official documents, parliamentary and administrative, that the contracting Governments publish, and such of the publications of the learned bodies, and of the literary, scientific, artistic, &c., societies, as they may be able to procure.

2. To facilitate for these learned societies in all countries the means of exchanging their publications among themselves.

The rôle of the contracting countries will therefore be twofold; on the one hand initiative, corresponding to the formal obligation to furnish the documents emanating from them; on the other hand, a rôle of voluntary intermediary in the assistance which they will accord at their pleasure to learned societies and bodies of all sorts for the establishment of relations with similar institutions in foreign countries.

In the opinion of the delegates such assistance should always remain purely friendly and officious. The obligation to exchange extends in no respect to the independent associations; but the Governments may demand in return for the services they render to those societies, as in-intermediaries and for the free transportation which they accord them, a certain number of documents which will increase the number of those which the bureaus of exchange have for the purpose of sending abroad.

The undersigned delegates of Austria-Hungary, of Belgium, of Brazil, of Spain, of Italy, of Portugal, of Roumania, and of Servia, considering the utility of direct and prompt exchanges of parliamentary documents between the legislative assemblies of the different states, have, moreover, signed the draft of a convention annexed to this final protocol, marked B. They agree to submit it at the same time as the draft of the general convention, marked A, to the approbation of their respective Governments.

The undersigned delegates of France, while recognizing the incontestable advantage of rapid exchanges among the various Parliaments, and the exceptional interest which the international conference may assign to them, deem that those exchanges do not require to be direct, that they may be very rapidly made by the bureaus of exchanges, and that they should remain entirely free for the Parliaments. The delegates of France think that it would have sufficed to express the wish of the chambers, and to render them regular.

The undersigned delegates of the United States of America and of Switzerland share this opinion.

Finally, before separating the conference expresses the wish that the contracting states shall endeavor to obtain the series or volumes published prior to the date of the general convention, so that a complete set of each collection will be found in at least one library in each state.

In testimony whereof the undersigned delegates have drawn up the present final protocol and have set their signatures thereto.

Done at Brussels the —— April, 1883.

The signatures of the delegates of Austria-Hungary, Belgium, Brazil, Spain, United States of America, France, Italy, Portugal, Roumania, Servia, and Switzerland follow.

[*Inclosure* 8.—Translation.]—(A.)—DRAFT OF CONVENTION SIGNED BY ALL THE DELEGATES TO THE CONFERENCE AT BRUSSELS, APRIL, 1883.

ARTICLE 1. There shall be established in each of the contracting states a bureau charged with the duty of the exchanges.

ART. 2. The publications which the contracting states agree to exchange are the following: (1) The official documents, parliamentary and administrative, which are published in the country of their origin; (2) The works executed by order and at the expense of the Governments.

ART. 3. Each bureau shall cause to be printed the list of the publications that it is able to place at the disposal of the contracting states.

That list shall be corrected and completed each year and regularly addressed to all the bureaus of exchanges.

ART. 4. The bureaus of exchanges will arrange between themselves the number of copies which they may demand and furnish.

ART. 5. The shipments shall be made directly from bureau to bureau. Uniform models and formulas for the invoices of the contents of the cases, as well as for all administrative correspondence, requests, and acknowledgments of reception, &c., shall be adopted.

ART. 6. For shipments to foreign countries, each state assumes the cost of packing and of transportation to destination. When, however, the shipment is made by sea, special acknowledgments shall determine the proportion of each state in the cost of transportation.

ART. 7. (§ 1.) The bureaus of exchanges will serve as the official intermediaries between the learned bodies and the literary, scientific, &c., societies of the contracting states for the reception and forwarding of their publications.

(§ 2.) It remains, however, well understood that, in such cases, the duty of the bureaus of exchanges will be confined to the transmission free of cost of the works exchanged, and that those bureaus will not in any manner take the initiative to bring about the establishment of those relations.

ART. 8. These provisions apply only to the documents and works published after the date of the present convention.

ART. 9. The states which have not taken part in the present convention are admitted to adhere to it upon making the request.

This adhesion is to be notified to the Belgian Government through the diplomatic channel and by the latter Government to all the other states signing it.

ART. 10. The present convention shall be ratified and the ratifications exchanged at Brussels as soon as practicable. It is concluded for ten years from the day of the exchange of the ratifications, and it shall remain in force beyond that time, as long as one of the Governments shall not have declared six months in advance that it denounces the same.

(The signatures of the delegates of Austria-Hungary, Belgium, Brazil, Spain, United States of America, France, Italy, Portugal, Roumania, Servia, Switzerland, follow.)

[*Inclosure* 9.—Translation.]—(B.)—DRAFT OF CONVENTION FOR THE IMMEDIATE EXCHANGE OF PARLIAMENTARY DOCUMENTS.

Brussels, April, 1883.

ARTICLE 1. Apart from the obligations arising from article 2 of the general convention of April, 1882, concerning the exchange of official documents and of scientific and literary publications, the respective Governments agree to cause to be forwarded to the legislative chambers of each of the contracting states, as soon as they are published, a copy of the official journal and of the parliamentary annals and documents which are made public.

ART. 2. The states which have not taken part in the present convention are admitted to adhere thereto upon requesting it.

This adhesion is to be notified by the diplomatic channel to the Belgian Government and by the latter Government to all the other states signing it.

ART. 3. The present convention shall be ratified and the ratifications exchanged at Brussels, as soon as practicable. It is concluded for ten years from the day of the exchange of the ratifications, and it shall remain in force beyond that time, so long as one of the Governments shall not have declared six months in advance that it denounces the same.

(The signatures of the delegates of Austria-Hungary, of Belgium, of Brazil, of Spain, of Italy, of Portugal, of Roumania, and of Servia follow.)

Remarks by Mr. Boehmer, on the proceedings of the Brussels Conference.

[The principal desire of the delegates to the conference at Brussels (at least of those of European powers) appears to have been to centralize—by the establishment of bureaus of exchange—in a single library in each of their countries all the official documents, parliamentary and administrative, which the contracting Governments publish, and those publications of the learned bodies and of literary, scientific, and artistic societies, &c., which they may be able to procure.

Although M. Charmes (delegate from France) said, "*To confide to an institution the exchange of all that may interest science is a chimera, or, at least, a very complicated affair,*" the Smithsonian Institution has shown that such a thing is possible, and had the Institution the necessary means it would not be a very difficult task, with its experience of thirty-four years and constant improvements on the system, to demonstrate the feasibility of a universal exchange, comprising all scientific societies in the world. The increase to its library, from this source, during the year has been 11,789 books, and its total number of books received from the exchange of its publications with scientific establishments abroad since its organization now represent 177,420 books. The number of packages received from abroad for scientific establishments and individuals in the United States and British America during the year 1882 is 8,359 packages, and a total of 103,124 packages since the introduction of the exchange system. The packages sent abroad through this channel in 1882 were 58,047, representing a bulk of 2,950 cubic feet, and the entire transmissions abroad from the United States since introduction of theexchange system represents a bulk of 35,525 cubic feet, weighing 1,160,413 pounds.

The system now in operation in its methodical and business-like character of bookkeeping could readily be extended so as to meet all requirements and include every known society in the world desiring exchanges with the United States.

The French Government, however, does not appear to be particularly anxious to promote a general scientific and literary exchange to any great extent. At her request Mr. Charmes introduced the following modification:

"*It remains, however, well understood that in such cases (the exchange between societies) the duty of the bureaus will be confined to the transmission, free of cost, of the works exchanged, and that those bureaus will not, in any manner, take the initiative to bring about the establishment of such relations.*"

The Governments of Austria and Switzerland express themselves through their delegates to the effect that the bureaus of exchange shall confine themselves to the exchange of Government documents and leave the exchange between societies to themselves.

Mr. Alvin, of the Belgian commission, states:

"*There is a bureau of exchanges in the United States, the Smithsonian Institution, but which, not being official, does not fully answer the object we aim at.*"

The general impression of the delegates at the conference seems to have been that the Smithsonian Institution, as a private establishment, has gradually possessed itself of the exchanges, both of scientific and of Government documents, without authority, and cannot be considered as fully responsible, or equal to the bureaus established in consequence of the convention.]

Comments on the Articles of Convention.

[ART. 2. This article in its original form was to include as (3) *The publications of academies and learned societies, of universities and schools, as far as the Government shall be able to obtain them.*

This paragraph was discussed at great length and objected to by the delegate from Switzerland on the same grounds as would prevent the adhesion of the United States, both of which have not a centralized Government in respect of public instruction, each State or county having a separate system.

In monarchical countries the Government controls the majority of educational establishments and also subsidizes a large number of societies. Their publications, therefore, would, in a measure, be available to the Government for exchange purposes. But the case does not apply to a republic.

All the delegates who favored the passage of this paragraph gave it only a secondary importance; hence its defeat was easily obtained.

ART. 4. It was suggested to furnish as many as 15 or 20 copies to each bureau to enable them to supply the principal libraries. This, however, was opposed by the delegate from Austria-Hungary, who thinks one copy of each work sufficient for each country.

The Smithsonian Institution, on behalf of Congress, under the existing laws could not give more than one copy to each country, and even at this rate only 8 copies are left for distribution.

ART. 5. The question of forms, receipts, &c., appears to be satisfactorily settled by the Smithsonian blanks, which are the result of an experience of many men and extending over many years.

ART. 6. This paragraph has been opposed by the Smithsonian Institution since its first introduction for several good reasons, which were explained by the United States delegate at the convention. The Smithsonian Institution, on behalf of the Government, should protest against its passage, which would work great injustice to the United States.

ART. 7 (Sec. 2). The delegates of Austria-Hungary and of Switzerland explain that the duty of the bureaus of exchanges should be confined to Government publications, and state that in their respective countries the scientific societies have established a system of exchanges between themselves.

The delegate from France proposes that only the exchange of Government documents shall be obligatory, while the bureaus *may* serve as intermediary for the exchange of the others, so as to form for that exchange a sort of well-organized postal service.

To the Smithsonian Institution, the greater part of whose library has been the direct result of exchange, and in "taking the initiative to bring about the establishment of those relations" (repudiated by the 2d section of the 7th Article), the importance to itself, no less than to the great body of learned societies, of the liberal interchange of scientific transactions and journals is too well recognized to be lightly surrendered.

Another supplementary point discussed by the convention and accepted by all the delegates, except those of the United States, France, and Switzerland, provides:

ART. 1. *Apart from the obligations arising from Article 2 of the general convention concerning the exchange of official documents and of scientific* *and literary publications, the respective Governments agree to cause to be forwarded to the legislative chambers of each of the contracting states, as soon as they are published, a copy of the official journal and of the parliamentary annals and documents which are made public.*

This article of agreement cannot, under existing circumstances, be accepted by the Smithsonian Institution on behalf of the Government, owing to the limited number of copies at the disposal of the Institution. The sendings of the United States Government publications are made in the comparatively short intervals of about six months, and contain all the documents that are desired in two copies under this act. This would constitute three copies to each bureau. The additional number of copies could only be obtained by special act of Congress, and it would be an unnecessary expense, both in cost of printing and transportation, without giving an equivalent advantage.]

From the Department of State July 9, 1883, *to the Smithsonian Institution.*

SIR: I inclose a copy of a dispatch from our minister at Brussels, and a copy of the completed edition of the proceedings of the Brussels Conference on International Exchanges, to which it refers; also, a copy of the "*note from the British Envoy*," therein mentioned.

I am, sir, your obedient servant,
JOHN DAVIS,
Acting Secretary.

From the Smithsonian Institution, July 10, 1883, *to the Hon. John Davis, Assistant Secretary of State.*

SIR: I have the honor to acknowledge the receipt of the copy of the dispatch from the United States minister at Brussels, giving the results of the Brussels Conference on International Exchanges, inclosed with your letter of May 15, and respectfully return the same herewith in accordance with your request.

Very respectfully, your obedient servant,
SPENCER F. BAIRD.

From the Smithsonian Institution, July 24, 1883, *to the Hon. John Davis, Acting Secretary of State.*

SIR: I have the honor to acknowledge the receipt of your communication of July 9, and to thank you for the copy it inclosed of the proceedings of the Brussels Conference on International Exchanges.

Very respectfully, your obedient servant,
SPENCER F. BAIRD,

From the Smithsonian Institution, August 20, 1883, *to the Hon. John Davis, Acting Secretary of State.*

SIR: In forwarding here a special communication in reference to the proposition for the immediate exchange of parliamentary documents, I beg to offer some general remarks upon the proceedings of the Belgian convention.

I was much gratified to find that the position of the Smithsonian Institution in regard to the expenses of the transportation of packages was, in great measure, acceded to. As suggested by Mr. Ruelens, it is usually perfectly practicable to arrange for the prepayment of charges for land transportation through from the point of transmission. The case is very different where shipments by steamer interpose; and it is for this reason that the Smithsonian Institution urges that delivery, free of expense, should terminate at the port of embarkation, rather even than at the port of debarkation, although the latter could perhaps be arranged for, if the former were not equally convenient. In no event can it agree to arrange for delivery free of charge at the ultimate destination of the sending.

The Smithsonian Institution does not insist on delivery to consuls of foreign Governments at the shipping ports, although this is a convenience. It is quite willing to deliver directly on board the steamships, although it has found no hesitation whatever on the part of any foreign consuls in taking charge of the packages. In some cases these parcels are forwarded by Government vessels that happen to be in port; in others, by regular foreign steamship lines carrying free under subsidies. In all cases a bill of lading for each shipment is transmitted direct by the Institution to the agent of the international exchange in the countries addressed.

The second point which seems to have involved more or less debate was whether the system of exchange should include the publications of the Governments only, or those of societies and individuals generally.

The Smithsonian Institution agrees with those who take the more liberal and comprehensive view, as the increase and diffusion of knowledge depend much more upon the interchange of information in regard to scientific, industrial, and technical researches than upon the transmission of the publications alone of the several Governments.

It was solely and exclusively for the distribution and exchange of its own publications, and those of affiliated bodies, that the Smithsonian Institution undertook, nearly one-third of a century ago, its responsible duty, and unless permitted to include both divisions in its functions, it would prefer to confine itself to the more comprehensive and original one.

As, however, the machinery of administration is sufficiently elastic to embrace the whole subject, and the additional expense attendant comparatively trifling, there appears to be no good reason for a duplication of agencies. It is fully believed by the Institution that a cessation of its general system of exchanges would be considered, the world over, a very disastrous blow to the cause of science and education.

The Institution however does not undertake any responsibility in the matter beyond transmitting what is offered to it, or in distributing what comes through its agencies; although it is frequently called upon to make out lists of addresses, both in America and elsewhere, to which special or continued publications may be advantageously supplied.

I may say in this connection that our experience of the administration of the system of miscellaneous exchanges by Government bureaus has not been satisfactory. In nearly all cases where we have changed our agency from that of a bookseller, or other private party, to that of an international bureau, there have been energetic and earnest expressions of dissatisfaction in regard to the latter. This, however, will doubtless be remedied with time and experience.

Referring to the expression of Minister Fish's regrets as to the absence of American publications among the 1,100 or 1,200 periodicals in the reading room of the Royal Library of Brussels, there would appear to be no particular obligation on the part of the publishers of such journals in the United States to forward them to any one library other than in exchange, or in return for a proper compensation.

Very respectfully, your obedient servant,

SPENCER F. BAIRD.

From the Smithsonian Institution, August 20, 1883, *to the Hon. John Davis, Acting Secretary of State.*

SIR: I have the honor to acknowledge receipt of your communication of July 24, inclosing a second copy of a dispatch from Minister Fish, of the 24th April, in reference to the proceedings of the Convention on International Exchanges, held in Brussels during the present year.

The proposition for this supplemental exchange of parliamentary documents involves the transmission from Washington, to all nations giving their adhesion to the same, of copies of the Congressional Record, of all bills and joint resolutions, and of official reports made by Congress, day by day as they come from the press; but does not include the publications of the Departments, which are embraced in the general system of distribution by the Smithsonian Institution.

This will involve the procuring of a second set of the publications in question for the legislature of each Government, in addition to that which is now furnished to a designated depositary.

It will be impossible to promise such a second set of legislative publications to a considerable number of addresses without ascertaining the views of the Joint Library Committee of Congress in regard to it. This body, however, already has the power to enter into the arrangement, as existing law directs the Public Printer, in addition to the regular number of fifty sets, to furnish fifty additional copies of any work that may be indicated by the aforesaid committee as needed for purposes of international exchange.

At present all the Governments of the several countries engaged in this system of international exchanges have indicated some public library as the recipient of what may be sent from the United States, and in most cases the actual agent of collection and distribution. The transmissions themselves, however, are made by an international bureau.

To make daily sendings of the publications in question would involve much additional trouble and very great expense for postage; and I would suggest that the State Department take the necessary measures to bring to the notice of the International Postal Union the propriety of considering all matter of this kind as privileged, and to be forwarded free. As all the great nations of the world are members of the Union, and each Government collects its postages in advance, it will simply amount to the relinquishing by each of the postal charges on its own official matter. It would seem quite proper, in addition, that the frank should extend to all official correspondence of the United States Government with parties outside of its limits, although American members of the Postal Convention appear to have been largely instrumental in preventing this simplification of the official intercourse.

In view of all these circumstances, it would, I think, be quite proper to notify Minister Fish that, while the United States accepts the general principle of this supplementary exchange, formal action and participation must be deferred until the pleasure of the Joint Committee of the Library of Congress can be ascertained.

In this connection I would inquire whether it might not simplify matters to deliver to the agents in Washington of the respective Governments the publications to be forwarded under this regulation. In the contrary event, each country should be requested to designate a specific address to which the publications in question should be transmitted.

I may mention that at present a definite exchange of the publications in question has already been indicated through the Smithsonian Institution between the United States House of Representatives and the Legislative Chambers of France, in virtue of a proposition to that effect from France, and formally accepted by resolution of the House of Representatives. These, however, are sent in bulk, or by sessions, and not day by day as proposed.

Very respectfully, your obedient servant,

SPENCER F. BAIRD.

From the Department of State, September 26, 1883, to the Smithsonian Institution.

SIR: Acknowledging the receipt of various letters from you bearing date the 20th August last, touching different features of the question of the international exchange of documents, which formed the subject of consideration at a recent conference in Brussels, I beg to inclose herewith a printed report of the proceedings of the conference, and to observe that the Belgian Government informs the Department through its minister here that it adheres to the two drafts of a convention marked respectively A and B, and to the final report of the deliberations of the conference [pp. 36 *et seq.* of the inclosed pamphlet], and expresses a desire to learn the attitude of the United States with respect to these conclusions at the earliest convenient date, in order that the conference which is to adopt the final arrangement may be convoked with little delay.

Although the view already stated by you in your various communications of August 24 are apparently ample, it seems proper that the questions thus formally submitted by the Belgian minister, should be referred for such supplementary consideration of the Secretary of the Smithsonian Institution as he deems it pertinent to give.

A more special response to one or more of your letters of August 24 will doubtless soon be prepared.

I am, sir, your obedient servant,
JOHN DAVIS,
Acting Secretary.

From the Smithsonian Institution, October 4, 1883, *to the Hon. John Davis, Acting Secretary of State.*

SIR: I have just received at this place your letter of the 26th of September asking a formal consideration of paragraphs A and B and the general conclusions of the report of the conference in regard to international exchanges held at Brussels.

In compliance therewith the Smithsonian Institution recommends the acceptance of section A in its actual form, and begs to express its willingness to carry out the provisions thereof as far as the means at its command will allow. More than one series of Government publications cannot at present be promised to any one foreign Government.

The latitude permitted by Article 6 in reference to shipments by sea removes the objection made to the previous agreement.

So far as the class of beneficiaries referred to in Article 7 is concerned, the Institution reserves the right, as a branch of its own original system, to use such additional agencies of distribution as it may deem proper, since experience has shown that in some cases at least these are the more expeditious channels of transmission. The same reservation is made in reference to the service between scientific men in America and those elsewhere; between individuals and public libraries, as also in connection with the interchange of specimens of natural history, for none of which is provision made as recommended by the Institution subject to the approval and co-operation of Congress.

The general conclusions of the conference, as indicated on page 36 of the pamphlet (herewith returned), are satisfactory to the Institution; but modifications may be found necessary in carrying the system into full operation.

I have the honor, &c., &c., SPENCER F. BAIRD.

LIST OF OFFICIAL PUBLICATIONS RECEIVED FROM THE PUBLIC PRINTER DURING THE YEAR 1883.

AGRICULTURAL DEPARTMENT.

Artesian wells upon the great plains. 37 p. and map. 8vo. Paper.

Preliminary report on the forest trees of the Mississippi Valley, and tree planting on the plains. 45 p. 8vo. Paper.

Results of field experiments with various fertilizers. By Prof. W. O. Atwater, Ph. D. 183 p. 8vo. Paper.

Annual report 1881–'82. 704 p. 8vo. Cloth.

Culture of the date. By W. G. Klee. 25 p. 8vo. Paper.

Encouragement to the sorghum and beet sugar industry. A record of practical experiments conducted under the direction of the Commissioner of Agriculture. 64 p. 8vo. Paper.

Investigation of sorghum as a sugar producing plant. Season 1882. Peter Collier. 68 p. 8vo. Paper.

Contagious diseases of domesticated animals. Investigations by the Department of Agriculture. 271 p. 8vo. Paper.

Special Reports.

No. 52. Report on yield per acre of cotton, corn, potatoes, and other field crops, with comparative product of fruits; also local freight rates of transportation companies. November, 1882. 109 p. 8vo. Paper.

No. 53. Report upon product and price of principal crops of 1882. Also freight rates of transportation companies, including changes of the winter tariff. December, 1882. 79 p. 8vo. Paper.

No. 54. Sorghum sugar industry. Address of the Hon. George B. Loring before the Mississippi Valley Cane-Growers Association. Saint Louis, Mo., December 14, 1882. 19 p. 8vo. Paper.

No. 55. The Grange. Its origin, progress, and educational purposes. 18 p. 8vo. Paper.

No. 56. Report upon the numbers and values of farm animals, of product and quality of cotton, and comparative values of American and European farm implements; also rates of transportation in Europe and the United States. February, 1883. 74 p. 8vo. Paper.

On jute culture and the importance of the industry. By Prof. S. Waterhouse. 21 p. 8vo. Paper.

No. 57. Report on the distribution and consumption of corn and wheat, and the rates of transportation of farm products. March, 1883. 39 p. 8vo. Paper.

No. 58. Report on the area and condition of winter wheat, and the condition of farm animals. Also spring rates of transportation of farm products. April, 1883. 46 p. 8vo. Paper.

No. 59. Report of condition of winter grain, the progress of cotton planting, and estimates of cereals of 1882, with freight rates of transportation companies. May, 1883. 65 p. 8vo. Paper.

No. 60. Report of acreage of spring grain and cotton, the condition of winter wheat, and European grain prospects, with freight rates of transportation companies. June, 1883. 56 p. 8vo. Paper.

No. 61. Report on the area of corn, potatoes, and tobacco, and the condition of growing crops in the United States and Europe, with a report on rates of transportation. July, 1883. 48 p. 8vo. Paper.
No. 62. Observations on the soils and products of Florida. By William Saunders. 30 p. 8vo. Paper.
No. 63. The Grasses of the United States. By Dr. George Vasey. 47 p. 8vo. Paper.
No. 64. Report on condition of crops, American competition, and freight rates of transportation companies. August, 1883. 80 p. 8vo. Paper.
No. 65. Report on condition of crops, and freight rates of transportation companies. September, 1883. 55 p. 8vo. Paper.

Division of Entomology.

Bulletin No. 1. Reports of experiments, chiefly with kerosene, upon the insects injuriously affecting the orange tree and the cotton plant. 62 p. 8vo. Paper.
Bulletin No. 2. Reports of observations on the Rocky Mountain locust and chinch bug, together with extracts from the correspondents of the division on miscellaneous insects. 36 p. 8vo. Paper.
Bulletin No. 3. Reports of observations and experiments in the practical work of the division made under the direction of the Entomologist. 75 p., and plates. 8vo. Paper.

Chemical Division.

Bulletin No. 1. An investigation of the composition of American wheat and corn. By Clifford Richardson, assistant chemist. 69 p. 8vo. Paper.

Division of Statistics (new series).

Report No. 1. Report on condition of crops, yield of grain per acre, and on freight rates of transportation companies. October, 1883. 28 p. 8vo. Paper.
Report No. 2. Report on yield of crops per acre, on the progress of sorghum growing, the crops of Europe, and on freight rates of transportation companies. November, 1883. 59 p. 8vo. Paper.

Miscellaneous.

Special Report No. 1. Forest trees in the United States. Address of the Hon. George B. Loring, before the American Forestry Congress, at Saint Paul, Minn. August 8, 1883. 41 p. 8vo. Paper.

AMERICAN ASSOCIATION OF THE RED CROSS.

Constitution for State and Associate Societies of the Red Cross of the Geneva Convention. With notes. 10 p. 8vo. Paper.
History of the Red Cross. 227 p. 8vo. Paper.

CIVIL SERVICE COMMISSION.

Civil service act, rules and regulations. 18 p. 8 vo. Paper.
Amended civil service rules. 8 p. 8vo. Paper.

COURT OF CLAIMS.

Cases decided in the Court of Claims at the December term, 1881, with abstracts of decisions of the Supreme Court in appeal to cases from October, 1881, to May, 1882. Reported by Charles C. Nott and Archibald Hopkins. Vol. 17. 499 p. 8vo. Paper. Vol. 18, December term, 1882-'83. Reported by William A. Richardson. 814 p. 8vo. Paper.

UNITED STATES CONGRESS.

Congressional directory, second session, Forty-seventh Congress, first edition corrected to December 11, 1882. 176 p. 8vo. Paper.
Memorial address. Ferdinand Wood. February 28, 1881. 40 p. 8vo. Cloth.
Congressional Record, second session Forty-seventh Congress. Vol. 14. Parts 1-4. 3,777 p. 4vo. Half Russia. Index to Vol. 14. 221 p. 8vo. Half Russia.

HOUSE OF REPRESENTATIVES.

Digest and manual of the rules and practice of the House of Representatives. Sixth edition, second session Forty-seventh Congress. 461 p. 8vo. Paper.
Executive documents:
  Second session Forty-sixth Congress. Vols. 2, 10, 14, 18, 20, 22. 8vo. Sheep.
  Third session Forty-sixth Congress. Vols. 1, 5, 6, 9, 10, 11, 14, 15, 28, 29, 30. 8vo. Sheep.
  First session Forty-seventh Congress. Vols. 5, 8, 13, 15, 19, 24. 8vo. Sheep.
House journal:
  First session Forty-seventh Congress. 2,380 p. 8vo. Sheep.
  Second session Forty-seventh Congress. 834 p. 8vo. Sheep.
House reports:
  First session Forty-seventh Congress. Vols. 1, 5. 8vo. Sheep.
Miscellaneous documents:
  Forty-fifth and Forty-sixth Congresses, 1876–1880 inclusive. Digest of election cases. 522 p. 8vo. Sheep.
  First session Forty-seventh Congress. Vols. 1, 9, 11, 14, 24. Parts I and II. 8vo. Sheep.

UNITED STATES SENATE.

Senate journal:
  Special session, October 10, 1881, and first session Forty-seventh Congress. 1,750 p. 8vo. Sheep.
  Second session, Forty-seventh Congress, 742 p. 8vo. Sheep.
Executive documents:
  Third session Forty-fifth Congress. Coast Survey Report, June, 1878. 306 p. Appendices and maps. 8vo. Sheep.
  Special session, October 10, 1881. Proceedings of the International Sanitary Convention. 8vo. Sheep.
Miscellaneous documents:
  Second session Forty-sixth Congress. Vol. 3. 846 p. 8vo. Sheep. Coast Survey Report. 214 p. 32 maps. 4vo. Sheep.
  Third session Forty-sixth Congress, and special session Forty-seventh Congress. Vol. 1. 8vo. Sheep.
  First session Forty-seventh Congress. Vol. 4.
  Second session Forty-seventh Congress. Nos. 33-85, except 77 and 84. 8vo. Sheep. Special session, October 10, 1881, and first session Forty-seventh Congress. Vol. 2.
Senate reports:
  First session Forty-seventh Congress. Vols. 1, 2, 3. 8vo. Sheep.

INTERIOR DEPARTMENT.

Report on the Hot Springs of Arkansas. By Alonzo Bell. 27 p. 8vo. Paper.
Laws, regulations, &c., relating to the Hot Springs Reservation. 1883. 25 p. 8vo. Paper.
Register of the Department, corrected to April 25, 1883. 152 p. 8vo. Paper.
Register of the Department, corrected to July 15, 1883. 160 p. 8vo. Paper.
Supplementary catalogue of books added to the library of the Department from February 1, 1881, to June 30, 1883. 15 p. 4to. Paper.

Census Office.

Area and product of cereals grown in 1879 as returned by the census of 1880. 97 p. 8vo. Paper.

Bureau of Education.

Bulletin. Natural science in secondary schools. 9 p. 8vo. Paper.
Bulletin. High school for girls in Sweden. 6 p. 8vo. Paper.
Circular No. 4, 1882. Industrial art in schools. By Charles G. Leland. 37 p. 8vo. Paper.
Circular No. 5, 1882. Maternal schools in France. 14 p. 8vo. Paper.
Circular No. 6, 1882. Technical instruction in France. 63 p. 8vo. Paper.
Circular No. 1, 1883. Legal provisions respecting the examination and licensing of teachers. 46 p. 8vo. Paper.
Circular No. 2, 1883. Co-education of the sexes in schools of the United States. 40 p. 8vo. Paper.
Circular No. 3, 1883. Proceedings of the department of superintendence of the National Educational Association, at its meeting in Washington, February 20 and 22, 1883. 81 p. 8vo. Paper.
Sketch of Philadelphia normal school for girls. 39 p. 8vo. Paper.
Historical sketches of the universities and colleges of the United States. Edited by Dr. Franklyn B. Hough. 72 p. 8vo. Paper.
Articles exhibited in the Southern exposition of 1883, at Louisville, Ky., from the Museum of the United States Bureau of Education. 17 p. 8vo. Paper.
Answers to inquiries about the United States Bureau of Education, its work and history, prepared under the direction of the Commissioner by Charles Warren, M. D. 29 p. 8vo. Paper.

General Land Office.

Restoration of lost and obliterated corners. March 18, 1883. 13 p. 8vo. Paper.
Decisions of the Department of Interior and General Land Office in cases relating to lands and land claims. From July, 1881, to June, 1883. 669 p. 8vo. Paper.
Mining laws and regulations thereunder. October 31, 1883. 36 p. 8vo. Paper.
Rules of practice in cases for the United States district land offices, the General Land Office, and the Department of the Interior. Approved December 28, 1882. 16 p. 8vo. Paper.
Instructions to special agents appointed to prevent timber depredations on Government lands, and to protect the public timber from waste and destruction. 39 p. 8vo. Paper.
Circular. Instruction relative to entries under the homestead, pre-emption, and timber-culture laws. March 20, 1883. 8 p. 8vo. Paper.
Circular July 19, 1883. In regard to fencing of public lands. 1 p. 8vo. Paper.
Circular. Instructions as to deposits by individuals for the survey of public lands. September 15, 1883. 10 p. 8vo. Paper.

Indian Office.

Rules governing the court of Indian offenses. 8 p. 8vo. Paper.
Laws and regulations relating to trades with Indian tribes. November 1, 1883. 10 p. 8vo. Paper.
Peace ratified in the Creek Nation. Report of Commissioners Clinton B. Fisk and E. Whittlesey, Muskogee, Ind. T. 34 p. 8vo. Paper.
Report on the condition and needs of the Mission Indians of California. Made by Special Agents Helen Jackson and Abbot Kinney. 35 p. 8vo. Paper.

National Museum.

Bulletin No. 16. Synopsis of the fishes of North America, by David S. Jordan and Charles H. Gilbert. 8vo. Paper.

Bulletin No. 24. Check-list of North American reptilia and batrachia, with catalogue of specimens in the United States National Museum, by H. C. Yarrow, M. D. 249 p. 8vo. Paper.

Patent Office.

Rules of practice. Revised February 1, 1883. 8vo. Paper.

Rules of practice. Revised November 15, 1883. 92 p. 8vo. Paper.

Decisions of the Commissioner for the year 1882. 594 p. 8vo. Paper.

Names and addresses of attorneys practicing before the United States Patent Office, Washington, D. C. 26 p. 8vo. Paper.

Supplemental list of attorneys. August 1, 1883. 10 p. 8vo. Paper.

Catalogue of additions to the library of the United States Patent Office, from May 1, 1878, to May 1, 1883. 452 p. 8vo. Paper.

Pension Office.

A digest of the laws of the United States governing the granting of Army and Navy pensions and bounty-land warrants; decisions of the Secretary of the Interior, and rulings and orders of the Commissioner of Pensions thereunder. Compiled by Calvin B. Walker. 314 p. 8vo. Paper.

A treatise on the practice of the Pension Bureau, governing the adjudication of Army and Navy pensions, being the unwritten practice, formulated by Calvin B. Walker. 129 p. 8vo. Paper.

General instructions to special examiners of the United States Pension Office. Revised December 1, 1882. 44 p. 8vo. Cloth.

List of special examiners, May 14, 1883. 23 p. 8vo. Paper.

Roster of examining surgeons appointed under authority of the Commissioner of Pensions. 138 p. 8vo. Paper.

COMMISSION OF FISH AND FISHERIES.

Forms of quarterly returns of property. 80 p. 8vo. Paper.

DEPARTMENT OF JUSTICE.

Register of the Department. Corrected to July 1, 1883. 230 p. 8vo. Paper.

NATIONAL BOARD OF HEALTH.

Annual report for the year 1882. 43 p. 8vo. Paper.

Index to volume 3, 1881–'82. Bulletin. 17 p. 4vo. Paper.

NAVY DEPARTMENT.

Navy register:
- January 1, 1883. 186 p. 8vo. Paper.
- August 1, 1883. 76 p. 8vo. Paper.

Theoretical researches on the effects of gunpowder and other explosives, by M. E. Sarron. Translated by Lieutenant Meigs, U. S. N. Part 1. 35 p. 8vo. Paper.

The probability of hitting an object of any form, by P. Breger, Captain Navy artillery. Translated by C. A. Stone, lieutenant, U. S. N. 58 p. 8vo. Paper.

Acts and resolutions relating chiefly to the Navy, Navy Department, and Marine Corps, passed at the second session of the Forty-seventh Congress. 1881–'82. 39 p. 8vo. Paper.

Regulations relating to the uniforms of the officers of the United States Navy. January 22, 1883. 14 p. 5 plates. 8vo. Papers.

Regulations governing the admission of candidates into the Naval Academy as naval cadets. 1882–'83. 5 p. 8vo. Paper.

Specifications for a three-cylinder horizontal back-acting compound screw-engine for each of the United States steamers "Boston" and "Atlanta." 48 p. 8vo. Paper.

Specifications for two direct-acting compound twin-screw beam engines of 5,000-horse power for the United States steamer "Chicago." 46 p. 8vo. Paper.

Specification for steam machinery for the United States dispatch-boat (1,500 tons). 59 p. 8vo. Paper.

Compilation of laws relating to the Navy, Marine Corps, &c.; from the Revised Statutes and subsequent acts to March 3, 1883. Prepared by John W. Hogg. 401 p. 8vo. Paper.

Bureau of Navigation.

American Practical Navigator, being an epitome of navigation and nautical astronomy. 674 p.

Useful tables from the American Practical Navigator.

Naval scientific papers No. 10. Discussions on iron ships. 176 p. 13 plates. 8vo. paper.

Naval scientific papers No. 11. Steel for shipbuilding. 208 p. and tables. 8vo. Paper.

Naval scientific papers No. 12. Papers and discussions on screw-propulsion. 222 p. Papers.

Naval professional papers No. 14. Papers and discussions on experiments with steel. 82 p. 8vo. Paper.

Naval professional papers No. 15. Papers and discussions on ships guns, and armor. Reprinted from various sources. 119 p. and 9 plates. 8vo. Paper.

Telegraphic determination of differences of longitude in the West Indies and Central America. By Lieut.-Commander F. M. Green. 12 p. 4vo. Paper.

Telegraphic determination of longitudes in Japan, China, and the East Indies. By Lieut.-Commander F. M. Green and C. H. Davis and Lieut. J. A. Norris, U. S. N. 1881–'82. 73 p. 4vo. Paper.

Information from abroad:

- The war on the Pacific coast of South America between Chili and the allied republics of Peru and Bolivia in 1879-'81. 77 pages. 8vo. Paper.
- Operations of the French Navy during the recent war with Tunis. 30 p. 8vo. Paper.
- Observations upon the Korean coast, Japanese and Korean ports, and Siberia, made during a journey from the Arctic stations to the United States, through Siberia and Europe, June 3 to September 8, 1882. 163 p. 8vo. Paper.

Coasts and islands of the Mediterranean Sea, Part IV, compiled from various sources, by Lieut. John M. Hawley, U. S. N. 417 p. 8vo. Paper.

Azimuth tables, prepared by Lieut. S. Schroeder and Master W. H. H. Southerland, U. S. N. 109 p. 4vo. Paper.

Hydrographic Office.

Charts and plans published during the quarters ending—

- December 31, 1882. 7 p. 8vo. Paper.
- March 31, 1883. 8 p. 8vo. Paper.

Nautical Monographs, No. 4. North Atlantic cyclones of August, 1883, by Lieut. W. H. H. Southerland, U. S. N. 22 p. 4vo. Paper.

List of geographical positions, for the use of navigators and others. Prepared by Lieut. Commander F. M. Green, U. S. N. 99 p. 4vo. Paper.

Publications of the United States Hydrographic Office during the quarter ending—

- June 30, 1883. 8 p. 8vo. Paper.
- September 30, 1883. 9 p. 8vo. Paper.

Supplement to pilot chart of the North Atlantic for December. 11 p. 8vo. Paper.
Supplement, navigation of the strait of Magellan. 19 p. 8vo. Paper.
Hydrographic notices:
1882. Nos. 55-59 to 69 except 65, and index. 8vo. Paper.
1883. Nos. 1-16; 19; 22-47; 53-56; 56-69; 72. 8vo. Paper.
Notice to mariners:
1882. Nos. 33, 82, 91, 92, 94, 95, 97–124, and index 1-124. 8vo. Paper.
1883. Nos. 1-11; 13-30; 32-38; 50; 52-61; 63–94; 96-137; 149; 153-180. 8vo. Paper.

Bureau of Steam Engineering

Report made to the Board of Steam Engineering, Navy Department, March 3, 1883, by B. F. Isherwood, Chief Engineer, U. S. N., on the hull, engine, and boiler of the steam-yacht "Siesta," constructed by the Herrsehof Manufacturing Company, at Bristol, R. I. 62 p. and pl. 8vo. Paper.
Report on an air refrigerating machine for applying cold dry air to vessels, hospitals, &c., made to the bureau April 6, 1883. 32 p. 8vo. Paper.

Nautical Almanac.

Catalogue of the Library. 110 p. 8vo. Paper.
The American Nautical Almanac for 1884. 266 p. and tables. 8vo. Paper.

United States Naval Academy.

Annual register:
1882–'83. 76 p. 8vo. Paper.
1883-'84. 63 p. 8vo. Paper.
The theory of the construction of ordnance, with special reference to the resistance of guns to tangential strain. 31 p. 8vo. Paper.
Notes on navigation and the determination of meridian distances. For the use of naval cadets at the United States Naval Academy. 145 p. and pl. 6mo. Paper.
Examination papers, 1881 and 1882. 59 p. 8vo. Paper.

United States Naval Observatory.

Washington astronomical and meteorological observations:
1878. Vol. 25. 4to. Cloth.
1879. Vol. 26. 4to. Cloth.

POST-OFFICE DEPARTMENT.

Regulations international money-order business between the United States, Belgium, and Tasmania, respectively. 8 p. 8vo. Paper.
Regulations to take effect July 2, 1883, for the guidance of postmasters in the transaction of international money-order business between the United States and Portugal, including the Azores and Madeira Islands. 7 p. 8vo. Paper.
Regulations and instructions for the transaction of the postal-note business, to take effect September 3, 1883. 13 p. 8vo. Paper.
Instructions to railway postal clerks, October 5, 1883. 37 p. 8vo. Paper.
Schedule of the railway post-offices on the principal through mail-routes of the United States. Corrected to June 1, 1883. 72 p. 8vo. Paper.
Departmental quarterly, monthly, and daily salary pay tables, calculated and carefully revised by Richard T. Bryan, for the several quarters of the common and leap year, showing the quarterly, monthly and daily pay of salaries from $1,000 to $25,000 per year. Printed by order of the Postmaster-General. 375 p. 4to. Paper.

STATE DEPARTMENT.

Register of the Department. Corrected to October 1, 1883. 109 p. 8vo. Paper.
The statutes at large of the United States of America from December, 1881, to March, 1883, and recent treaties, postal conventions, and executive proclamations. Vol. 22. 1,147 p. 4to. Sheep.

SUPREME COURT.

Rules of the Supreme Court of the United States, and rules of practice for the circuit and district courts of the United States in equity and admiralty cases, and orders and references to appeals from Court of Claims. 77 p. 8vo. Paper.

TREASURY DEPARTMENT.

Fifth annual report of the Treasurer of the United States on the sinking fund and funded debt of the District of Columbia. 28 p. 8vo. Paper.
Custom-house fees. Document No. 377. February 3, 1883. 14 p. 8vo. Paper.
Custom-house fees to be collected from all vessels navigating the waters of the northern, northeastern, and northwestern frontiers of the United States. 13 p. 8vo. Paper.
Comparative duties and the relation of the Treasury Department to tariff legislation. By Joseph Nimmo, jr. February 20, 1883. 22 p. 8vo. Paper.
Laws and regulations for the government of customs inspectors, weighers, gaugers, and measurers, and list of penalties for violation of customs-revenue and navigation laws. 213 p. 8vo. Paper.
Digest of appropriations, 1884. 242 p. 4to. Half Russia.
Catalogue of books and blanks issued by officers of the customs at the port of New York, October, 1883. 70 p. 8vo. Paper.

Bureau of Statistics.

Fifteenth annual list of merchant vessels of the United States, for the year ending June 30, 1883. 454 p. 4to. Paper.
Summary statements of the imports and exports of the United States:
No. 3. September, 1882–'83. 10 p. 4to. Paper.
No. 4. October, 1882–'83. 10 p. 4to. Paper.
No. 5. November, 1882–'83. 20 p. 4to. Paper.
No. 6. December, 1882–'83. 12 p. 4to. Paper.
No. 7. January, 1883–'84. 10 p. 4to. Paper.
No. 8. February, 1883–'84. 10 p. 4to. Paper.
No. 9. March, 1883–'84. 10 p. 4to. Paper.
No. 10. April, 1883–'84. 10 p. 4to. Paper.
No. 11. May, 1883–'84. 10 p. 4to. Paper.
No. 12. June, 1883–'84. 12 p. 4to. Paper.
No. 2. August, 1883–'84. 14 p. 4to. Paper.
No. 3. September, 1883–'84. 14 p. 4 to. Paper.
Quarterly reports relative to the imports, exports, immigration, and navigation of the United States for the three months ended—
September 30, 1882. 157 p. 8vo. Paper.
December 31, 1882. p. 158–359. 8vo. Paper.
March 31, 1883. p. 361–464. 8vo. Paper.
June 30, 1883. p. 465–572. 8vo. Paper.

United States Coast and Geodetic Survey.

Report of the Superintendent for the year ending June, 1882. 18 p. 8vo. Paper.
A treatise on projections. By Thomas Craig. 4to. Paper.
Catalogue of charts, 1883. 64 p. 4to. Paper.

Tide tables of the Atlantic coast of the United States, 1884. 136 p. 8vo. Paper.
Tide tables of the Pacific coast of the United States, 1884. 66 p. 8vo. Paper.
General instructions for hydrographic work, 1883. 81 p. 8vo. Paper.
Original topographic and hydrographic sheets registered in the archives of the United States Coast and Geodetic Survey. 70 p. 4to. Paper.

First Comptroller's Office.

Decisions in the matter of the right of the United States, after payment is made to a contractor for a quarter's service on carrying the mails, to deduct from compensation due him for services thereafter performed (1) the price of trips so paid for as performed when not in fact performed, and (2) not exceeding three times the price for failure to perform said trips occasioned by fault of the contractor. Reeside's appeal. 29 p. 8vo. Paper.

Internal Revenue.

Internal-revenue laws in force since March 4, 1879. Reprint, with subsequent laws. 234 p. 8vo. Paper.

Life-Saving Service.

Official register, June 1, 1883. 15 p. 8vo. Paper.
Annual report, June 30, 1882. 504 p. 8vo. Paper.

Supervising Architect.

Annual report, September 30, 1882. 45 p. 8vo. Paper.

Supervising Inspector-General of Steamboats.

Annual report, June 30, 1882. 15 p. 8vo. Paper.
Laws governing the inspection of foreign steam-vessels, &c. 27 p. 8vo. Paper.

WAR DEPARTMENT.

Record of engagements with hostile Indians within the military division of the Missouri from 1868 to 1882. 112 p. 8vo. Paper.
Report of an exploration of parts of Wyoming, Idaho, and Montana in August and September, 1882, made by Lieutenant General Philip Sheridan. 69p. 8 vo. Paper.
Report of an expedition from Fort Colville to Puget Sound, Washington Territory, made by First Lieut. Henry H. Pierce, Twenty-first Infantry. 25 p. and maps. 8vo. Paper.
Regulations for the United States Military Academy at West Point, N. Y. 82 p. and 18 p. Index. 8vo. Paper.

Adjutant-General.

General court-martial orders:
For 1882. Nos. 54–85, except 67 and 70.
For 1883. Nos. 1–51, except 12 to 15.
Index to general court-martial orders for 1882. 8vo. Paper.
General orders:
For 1882. Nos. 86, 87, 93, 103, 106, 109, 110, 113, 118, 119, 122, 123, 125–138.
For 1883. Nos. 1–81, except 9, 39, and 89.
Official register, January 1, 1883. 8vo. Paper.
Circular 1. March 7, 1883. 4 p. 8vo. Paper.
Circular 2. March 16, 1883. 3 p. 8vo. Paper.
Circular 3. April 10, 1883. 2 p. 8vo. Paper.
Circular 5. June 22, 1883. 3 p. 8vo. Paper.

Circular 6. August 10, 1883. 2 p. 8vo. Paper.
Circular 7. August 14, 1883. 2 p. 8vo. Paper.
Circular 8. September 8, 1883. 1 p. 8vo. Paper.
Circular 9. October 12, 1883. 1 p. 8vo. Paper.
Index to general orders for 1882. 56 p. 8vo. Paper.

Engineer Bureau.

Professional papers, No. 25. Report upon the practice in Europe with the heavy Armstrong, Woolwich, and Krupp rifled guns. Submitted by the Board of Engineers for Fortifications. 48 p. and 5 pl. 4to. Paper.

United States Military Academy.

Annual report, 1883. 6 p. 8vo. Paper.
The fortifications of to-day. Fire against models of coast batteries and parades. Horizontal and curved fire in defense of coast. 29 p. and pl. 4to. Paper.

Ordnance Office.

Notes on the construction of ordnance:
- No. 20. May 8, 1893. The secretion of gas in steel casting. 28 p. 4to. Paper.
- No. 21. Fabrication of cannon in Russia. 42 p. and 5 pl. 4to. Paper.
- No. 22. The structure of steel. 12 p. and pl. 4to. Paper.

Ordnance notes:
- No. 293. Preservation of moisture for seasonable rainfall. 3 p. 4to. Paper.
- No. 294. The English military power and the Egyptian campaign, 1882. 13 p. 4to. Paper.
- No. 295. Researches on the penetration of projectiles. 19 p. 4to. Paper.
- No. 296. Captain Dutton's report on the tertiary history of the Cañon District. 3 p. 4to. Paper.
- No. 297. The cavalryman and his horse. 6 p. 4to. Paper.
- No. 298. Improved arms rack. 3 p. and 3 pl. 4to. Paper.
- No. 299. Subjects for a military library. 11 p. and 4to. Paper.
- No. 300. The French army. 10 p. 4to. Paper.
- No. 301. Theoretical and practical ballistics. 7 p. 4to. Paper.
- No. 302. Notes on the embarkation and debarkation of horses and their care on board ship. 5 p. 1 pl. 4to. Paper.
- No. 303. The practice regulations of some European artilleries. 4to. Paper.
- No. 304. Notes on field artillery. 13 p. 4to. Paper.
- No. 305. The effects of the increased powers of infantry weapons. 5 p. 4to. Paper.
- No. 307. Improved capstan. 5 p. and 1 pl. 4to. Paper.
- No. 308. Armor, June 22, 1883. 7 p. 4to. Paper.
- No. 309. Description of some of the improvements introduced at Frankford Arsenal during the present fiscal year. 13 p. and 12 pl. 4to. Paper.
- No. 310. Report on naval experiments against armor plating. 17 p. and 4pl. 4to. Paper.
- No. 311. Headless shell extractor for Springfield rifle and carbine. 2 p. 4to. Paper.
- No. 312. On the discovery of gunpowder by the Chinese. 4 p. 4to. Paper.
- No. 313. Ballistic apparatus employed by the French marine artillery. 79 p. and 22 pl. 4to. Paper.
- No. 314. Armor-plate experiments. 2 p. and 1 pl. 4to. Paper.
- No. 316. The critical condition of the British army. 16 p. 4to. Paper.
- No. 318. A short history of the iron-clad trains. By Lieut. E. Warre-Slade, R. N. 4 p. and 1 pl. 4to. Paper.

Ordnance notes—Continued.

No. 319. Infantry fire versus artillery fire. By Col. Lonsdale Hale, Staff College. 8 p. 4to. Paper.

No. 320. The duties of the personnel of a battery of field artillery in action. By Lieut. Col. B. Kemmis, R. A. 12 p. 4to. Paper.

No. 322. The combination anvil in small-arm cartridge. 1p. and 5 pl. 4to. Paper.

Index to notes:

236–259. 4to. Paper.

260–284. 4to. Paper.

285–219. 4to. Paper.

Quartermaster-General.

Specifications of the plumber work and materials required in the construction and completion of the various buildings comprising the United States Army and Navy Hospital at Hot Springs, Ark.

1. Specifications. 9 p. 8vo. Paper.
2. Plans. 20 pl. 8vo. Paper.
3. Circular. 4 p. 8vo. Paper.

The military shoe. By Maj. S. A. Salquin. 58 p. 8vo. Paper.

Signal Office.

Professional papers:

No. IX. Charts and tables showing geographical distribution of rainfall in the United States. By H. H. C. Dunwoody, first lieutenant, Fourth Artillery. 51 p. and pl. 4to. Paper.

No. XI. Meteorological and physical observations on the east coast of British America. By R. A. Taft Sherman. 202 p. 4to. Paper.

Signal Service notes:

No. 9. Weather proverbs. By H. H. C. Dunwoody, first lieutenant, Fourth Artillery. 148 p. 8vo. Paper.

Official danger, distress, and storm signal code for Signal Service sea-coast stations and mariners. 74 p. 8vo. Paper.

Subsistence Department.

Regulations governing the clerical and other employés in the office of the Commissary-General of Subsistence. 8 p. 8vo. Paper.

Surgeon-General.

Medical and surgical history of the war of the rebellion. Part III. Surgical volume. 986 p. 29 p. Index. 4to. Cloth.

Standard supply table of the Medical Department of the United States Army, 1883. 30 p. 8vo. Paper.

Index catalogue of the library. Vol. IV. 1033 p. 4to. Paper.

Circular No. 3. September 1, 1883. Instructions for the government of medical officers in preparing the medical and surgical reports of the Army Medical Department. 21 p. 8vo. Paper.

The foregoing list of official documents received from the Public Printer during the year 1883 represents 721 distinct publications; each being delivered in 50 copies, they form an aggregate of 36,250 copies, weighing 21,065 pounds, and were packed in two boxes apiece for each set, which now consists of 19 boxes of about 260 pounds weight.

REPORT OF THE ASSISTANT DIRECTOR OF THE U. S. NATIONAL MUSEUM, TOGETHER WITH THE REPORTS OF THE CURATORS, FOR THE YEAR 1883.

Prof. SPENCER F. BAIRD,
Director of the U. S. National Museum:

SIR: In accordance with your instructions, I have the honor to submit herewith a report upon the present condition of the U. S. National Museum and upon the work accomplished in its various departments during the year 1883.

In accordance with established usage, I have reviewed the work of the several scientific departments of the Museum, as well as that of the Division of Administration. The reports of the curators are this year for the first time printed in full, their extent and importance being so great as to render this necessary. In my own report I have included an account of the operations of the department of arts and industry, for the present assigned to my care, in preference to preparing a special curator's report upon this department: the reports of certain of the curators of "sections" of this department are, however, furnished with the others.

In the present report, as in those which have preceded it, are incorporated certain suggestions relating to the administration of the Museum, for which I desire to be held individually responsible, and which the readers should not assume to be definitely determined elements of the policy of the Museum, since they may, any or all of them, at some future time either in their present form or with modifications, be recommended for adoption, or pronounced undesirable.

Should Congress during its present session make provisions for the publication of a special report upon Museum work, it is the desire of myself and my associates, should you approve, to present in the first report of the new series a somewhat exhaustive statement of the present condition of the Museum, together with a review of its past history as a whole, and of its several departments, together with the history of the steps by which the present position of the establishment has been attained.

Very respectfully,

G. BROWN GOODE,
Assistant Director.

WASHINGTON, *January*, 1884.

REPORT OF THE ASSISTANT DIRECTOR.

During the year the officers of the Museum have continued the work of rearranging the materials under their charge in the greatly extended space afforded by the completion of the new building. It will be remembered that this building was first occupied late in 1881; and that 1883 is really, therefore, only the second year of systematic effort. Some experiments in installation were made in 1881, but the chief thing accomplished was the accumulation, in some of the inner courts of the building, of a great mass of unclassified material which had been gathering for many years in the various store-rooms of the Smithsonian building and elsewhere, and which, on account of lack of space, had for the most part been allowed to remain in the original packing cases.

After a struggle of twenty-four months with this mass of unassorted material, the floors of the Museum have been almost cleared, and at present only three of the seventeen exhibition halls are occupied for storage purposes, viz: The southwest court, which is still full of specimens belonging to the departments of metallurgy, mineralogy, and lithology; the southeast court, which is used as a general receptacle for empty cases and unmounted material belonging to the departments of zoology and anthropology; and the northeast court, which has been temporarily given up to the uses of the Geological Survey and the Bureau of Ethnology.

A provisional assignment of exhibition space has been made as follows: North Hall, the historical collections and costumes; east Hall and west Hall, general collections in ethnology and art and industry; south Hall, collection of mammals; east north range, fisheries collections; north-east range, collection of models of boats and other appliances of transportation; south-east range, sculpture and architecture; east-south range, the osteological collections, the table cases in the west half of the room being temporarily occupied by storage cases for fossil plants and invertebrates; the eastern end of the west south range, mineralogy; its western end, lithology and physical geology; south-west range, metallurgy and economic geology; the southern end of north-west range, the collections of materia medica; its northern end, the collection of foods and pigments, &c. The west north range is used for a lecture-room and hall for the meetings of societies, and also for the temporary exhibition of recent accessions to the collections. The inner courts, being used as work-rooms, are as yet unassigned, save the northwest court, which is devoted to North American pottery.

In the Smithsonian building the four main exhibition halls are assigned as follows: Main hall, ornithology; upper main hall, prehistoric archæology; west range, ichthyology; west hall, marine invertebrates. These assignments are entirely provisional, and, indeed, the separation of the material belonging to the different departments is not yet entirely accomplished.

It will be observed that several departments—notably, those of reptiles, mollusks, and fossils—have received no assignment of space in the exhibition halls. The curator of mollusks and the curators of invertebrate fossils are, however, provided with particularly commodious and well-fitted laboratories, which, from the nature of the material under their charge and the at present only partially organized condition of the collections, are considered adequate for their immediate needs.

Organization of the departments and assignment of staff.—A provisional classification of the departments of the Museum was adopted early in 1882, and during the past two years has been practically applied. As is shown by the accompanying schedule, twenty-two scientific departments were provided for and grouped in five divisions, namely: Anthropology, zoology, botany, geology, and exploration and experiment. There are also eleven executive departments, grouped together in the Division of Administration.

Classification of the departments.—The following classification of the collections has been provisionally adopted:*

Division of Administration:

Department A.—Direction.

(Supervision of routine work; installation and labeling; apartments and keys; cases and furniture; supplies; offers, bids, and contracts; certification of accounts; requisitions and complaints; assignments of work—leaves of absence; general correspondence and circulars; supervision of other departments in division of administration; reports.)

Department B.—Registry and storage.

(Registry; reception and assignment; packing and unpacking; shipment; storage; catalogues, blanks, and labels; acknowledgments; transportation.)

Department C.—Archives.

(Records and registers; files.)

Department D.—Library.

Department E.—Publication.

Department F.—Duplicates and exchanges.

(Preparation of duplicates for distribution; distribution of duplicates; applications and proposals for exchanges.)

Department G.—Property and supplies.

(Purchase; registry; storage; requisitions and issue; samples and price-lists.)

Department H.—Accounts.

(Estimates; contracts and orders; audit; disbursement.)

Department I.—Buildings and labor.

(Police and inspection; mechanics and labor; heating and lighting; construction and repairs; cleaning; public comfort.)

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* This classification is founded solely upon considerations of present convenience in Museum administration.

Division of Administration—Continued.
  Department K.—Electric service.
    (Telephone service; time service; burglar-alarm service; watch-clock service.)
  Department L.—Preparation.
    (Taxidermy; modeling; skeleton preparation; mounting and attaching labels; lapidaries' work; stone-cutting work; draughting; photographing; painting; poisoning and applying preservators.)
Division of Anthropology:
  Department I.—Art and industry.
  Department II.—Races of Men.
  Department III.—Antiquities.
Division of Zoology:
  Department IV.—Mammals.
  Department V.—Birds.
  Department VI.—Reptiles and Batrachians.
  Department VII.—Fishes.
  Department VIII.—Mollusks.
  Department IX.—Insects.
  Department X.—Crustaceans.
  Department XI.—Worms.
  Department XII.—Radiates and protozoans.
  Department XIII.—Invertebrate fossils.
Division of Botany:
  Department XIV.—Recent plants.
  Department XV.—Fossil plants.
Division of Geology:
  Department XVI.—Mineralogy.
  Department XVII.—Lithology and physical Geology.
  Department XVIII.—Metallurgy and economic Geology.
Division of Exploration and Experiment:
  Department XIX.—Exploration and field work.
  Department XX.—Chemistry.
  Department XXI.—Experimental Physiology.
  Department XXII.—Vivaria.

A brief review of what has been accomplished in each department up to the present time, and especially during the past year, will perhaps be the most satisfactory mode of bringing before the Board the present methods and tendencies of the work in the Museum. I shall not, however, attempt to discuss the additions of the year to the Museum, since these will be treated of in detail in the reports of the several executive officers, while a complete list, arranged alphabetically by donors, will be found in the appendix to this report.

DIVISION OF ADMINISTRATION.

Department A: Direction.—During the period of the reconstruction of the east end of the Smithsonian building the Director has occupied an office in the northwest pavilion of the Museum. Early in the year the assistant director was appointed commissioner to the International Fisheries Exhibition to be held in London from May 1 to November 1, and his duties in this connection necessitated his absence from the middle of April until the 1st of October: during this period Mr. Frederick W. True was appointed to serve as acting assistant director, and rendered most efficient service.

The assistant director was instructed while in Europe to study the methods of administration of the most important museums, and has now in preparation a report upon his observations during the present year and in 1880 upon the chief museums of England, France, Germany, and Italy. He desires in this place to make acknowledgment of numerous courtesies and valuable aid received from Sir Philip Cunliffe Owen, director of the South Kensington Museum; Dr. A. C. G. Gunther, keeper of the zoological collections of the British Museum; Prof. W. H. Flower, curator of the Museum of the Royal College of Surgeons; Dr. P. L. Sclater, secretary of the Zoological Society of London; Dr. William Murie, librarian of the Linnæan Society of London; Mr. W. Saville Kent, curator of the Buckland Museum of Practical Fish Culture, South Kensington; Prof. H. N. Mosely, of the University of Oxford; Mr. John W. Clarke, superintendent of the Cambridge University Museum; Mr. A. J. R. Trendell, of the Science and Art Department, South Kensington; Prof. Thomas C. Archer, director of the Edinburgh Museum of Science and Art; Mr. T. J. Moore, curator of the Liverpool Museum; Mr. Mark H. Judge, curator of the Parkes Museum of Hygiene; Mr. John Durand, of Paris; Dr. E. Sauvage, of the Museum of Natural History, Paris; Prof. E. H. Giglioli, director of the Royal Museum of Vertebrates, Florence; Dr. Franz Steindachner, keeper of the Imperial Cabinet, Vienna; and Baron N. De Solsky, director of the Musée Imperial Agronomique, St. Petersburg.

The act of Congress authorizing and directing the participation of the United States in the International Fisheries Exhibition at London necessarily added an enormous weight to the work of the division of administration.

Departments B and C: Registry and storage, and archives.—These departments, under the supervision of Mr. S. C. Brown, registrar, have been efficiently administered. The total number of packages received was 2,196. The regular storage rooms in the Smithsonian building having been temporarily dismantled, a shed for the reception of the daily acquisitions was erected at the south entrance of the Smithsonian building, and the contents of several of the store-rooms transferred to the Armory. The shed, built adjoining the Armory in 1882, and also the upper stories of the Armory building, are now filled with boxes full of specimens awaiting assignment; and, as has already been stated, three of the inner courts of the Museum building are now filled in the same manner. The collection of the American Institute of Mining Engineers, presented to the Museum, has been packed and stored under the direction of Mr. Thomas Donaldson in the basement of the Memorial Hall, Fairmount Park, Philadelphia, and cannot be removed to Washington without a special appropriation for that purpose.

In the department of archives two copyists are constantly employed in making a duplicate copy of the Museum registers—a work which is considered to be of great importance owing to the fact that the original catalogues, being distributed through numerous departments, may accidentally suffer mutilation or destruction.

Department D: Library.—The library has remained in charge of Mr. Frederick W. True. The importance of this library to officers of the Museum and others, who by an exchange of courtesies are allowed its privileges, is very considerable. In fact, without it, Museum work would be greatly crippled and retarded, since, for every reference required, it would be necessary to dispatch a messenger to the Congressional Library, where the Smithsonian Library has for many years been deposited. One additional sectional library has been established during the year, viz, that in the section of foods and textiles. These sectional libraries are of material advantage to the curators of the various departments, since they may thus have close at hand all the available authorities required for the prosecution of their several specialties. The care of these sectional libraries however devolves upon the librarian, and does not encroach upon the time of the curators themselves.

By the introduction of a large sky-light in the roof of the library much additional illumination has been secured. Full details of work connected with the library will be found in the report of the librarian.

Department E: Publications.—During the year volume 5, Proceedings of the U. S. National Museum, a book of 714 pages, has been published; also Bulletin 16 (Synopsis of Fishes of North America, by D. S. Jordan); Bulletin 20 (Bibliography of writings of Spencer Fullerton Baird, by G. Brown Goode); Bulletin 22 (Guide to the Flora of Washington and vicinity, by Lester F. Ward); and Bulletin 24 (Check-list of North American Reptilia and Batrachia, by H. C. Yarrow). The descriptions of these will be found in the bibliographical appendix. A portion of Bulletin 27 was also published in 7 sections, these being a collection of the special catalogues of the American Department at the London International Fisheries Exhibition. Dr. T. H. Bean has rendered his usual efficient service as editor of the publications: the preparation of the admirable indexes of the volumes of the Proceedings has been his special care, and add greatly to the value of the volumes as a record of current work.

It is hoped that Congress may order the preparation and publication of a special report upon the work of the Museum, which, if the necessary provision is made for illustrations, will afford the means of publishing, more fully than has hitherto been possible, the archives of the Museum.

The preparation of printed labels has been a work of considerable magnitude during the year, and over four thousand labels, the average length of which is about one-sixth of an octavo page, have been prepared at the Government Printing Office. In addition also a large number of special labels in black and gold for the outside of cases, have been prepared by the Museum printer. Important additions have been made to the stock of the Museum printing office, which is now thoroughly equipped for all kinds of job-work.

Mr. A. Howard Clark has been temporarily placed in charge of the printing and general administration and section of labels.

Department F: Duplicates and exchanges.—The distribution of specimens to Museums, colleges, and individuals for the year is represented in the table appended hereto, viz:

	Boxes and packages.
Minerals, ores and rocks	21
Invertebrates	73
Marine invertebrates (duplicate sets)	59
Bird-skins	57
Ethnological objects	28
Insects	7
Plants	17
Fossils	7
Mammals	9
Building stones	2
Fishes	11
Reptiles	19
Skeletons	1
	251

Including an aggregate of about 16,270 specimens.

During the year 84 applications for specimens of general natural history, from museums, schools, and individuals in the United States and Territories, have been filed, and many of them have already been filled.

The shipments of miscellaneous packages to the great International Fisheries Exhibition at London, England, consisted of 917 packages of all kinds. Considerable returns have been received in the way of exchanges for specimens distributed. These are referred to in the reports of the several curators.

Department G: Property and supplies.—In this department a large number of exhibition and storage cases have been made during the year, chiefly by contract as hitherto. Cases to the value of about $10,000 were provided at the expense of the appropriation for the London Fisheries Exhibition; these have been returned to the Museum and will be used in the permanent installation of the fishery collection. The number of cases and screens now in use in the Museum exceeds 800, and the number of drawers for storage and exhibition purposes is more than 7,000. In next year's report I hope to present a detailed account of these cases, and the methods of administration employed in the Museum.

Appended is a list of the cases received during the year.*

* CASE C, 1-3.—Door screens, 8′ 6″ × 1′ 3″ × 7′	20
2-2.—Door screens, 8′ 6″ × 2′ 2″ × 7′	10
2-6.—Door screens, 8′ 6″ × 2′ 6″ × 7′	6
Total	36
Case D, 1-3.—Sliding screens, 8′ 6″ × 1′ 3″ × 7′	60
1-10.—Sliding screens, 8′ 6′ × 1′ 10″ × 7′	30
2-6.—Sliding screens, 8′ 6″ × 2′ 6″ × 7′	20
Total	110
CASE E.—Flat screens	100
CASE F.—Fold screens, whole pillar	1
CASE G.—Slope screens	20
CASE G, 1-2.—Slope screens	1
CASE H, 1-2.—Table uprights	2
CASE I.—Unit tables	20
CASE J.—Unit drawers, 2-inch	199
3-inch	386
4-inch	891
5-inch	246
6-inch	228
8-inch	162
9-inch	9
10-inch	110
12-inch	10
Total	2,331
CASE K.—Unit boxes, 2″ × 24″ × 30″	200
3″ × 24″ × 30″	300
4″ × 24″ × 30″	20
8″ × 24″ × 30″	83
13½″ × 24″ × 30″	3
14½″ × 24″ × 30″	1
Total	607
CASE K.—Unit boxes, 3″ × 24″ × 61½″	43
4″ × 24″ × 61½″	40
6″ × 24″ × 61½″	40
8″ × 24″ × 61½″	40
12″ × 24″ × 61½″	40
18″ × 24″ × 61½″	16
Total	219

During his absence in Europe the assistant director made studies of exhibition cases used in the best arranged museums, and a number of additional forms of cases are now being made for trial. It may be said, however, that in most of the European museums the cases are far inferior in workmanship and in adaptation to the needs of the museum to those already in use in our buildings. This opinion is confirmed by the experience of Prof. Edward S. Morse, director of the Peabody Museum of Salem, Mass., who also visited the European museums in 1883, and who states in his annual report that he saw no cases which he considered preferable to those used by the Smithsonian Institution and the Peabody Museum of Archæology at Cambridge. Many of our standard museum cases were used in connection with the London Fisheries Exhibition, and their construction and the manner in which the specimens were mounted in them met with general approbation among museum administrators.

The system of purchase and issue of general supplies was described in last year's report. Minor modifications have been introduced during the year and others are in contemplation. Mr. C. W. Schuermann has rendered efficient service as property clerk. He has submitted inventories of all articles in the several buildings, and also statements of the exact quantity of each kind of article received during the year, balanced by a report of the quantity of each article now in stock, and the exact disposition of such articles as have been issued upon requisition. He has also been charged with the duty of inspecting and reporting upon each article of furniture and all supplies purchased for the Museum, and of unpacking and cataloguing these articles when received, of issuing the same upon "house requisitions," and of preparing a semi-annual report.

Department H: Accounts.—As heretofore, all accounts have been administered under the direction of the chief clerk of the Smithsonian Institution, and all payments have been made through his office. The question of receipts and expenditures will not be discussed in this report, since it is included, as hitherto, in the report of the Executive Committee of the Board of Regents of the Smithsonian Institution.

Department I: Buildings and labor.—The administrative staff for police and inspection now consists of one superintendent of buildings, two

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CASE L.—Wall uprights:

	1 case	Corner sections	12
		Door sections	14
		Panel sections	12
		Triangle sections	3
		Panel sections	5
		Door sections	4
	1 case	Door sections	4
		Panel sections	5
CASE P.—Sectional library cases			44
CASE S.—Quarter tables			51

assistant superintendents, thirteen watchmen, and three doorkeepers; for construction, care of building, and repairs: two carpenters, a painter, and a mason; for labor and cleaning: sixteen laborers and six attendants and cleaners. For heating and lighting there are employed one engineer and four firemen; for messenger service, one messenger and three office boys. The messenger service is almost entirely replaced by the electric service. For out-door messenger service the District Telegraph Company has been made use of. This is advantageous in respect to both economy and efficiency, the whole cost to the Museum for all outside messenger work not exceeding $10 a month. The messenger employed in the building is engaged in circulating packages between the different laboratories, and in receiving and distributing mail, receptacles for which have been placed in every executive office.

To expedite communication between the various officers, one special messenger has been detailed to go from office to office, taking in and carrying out mail, memoranda, &c. In almost every office has been established a mail box or tray, made in two partitions, one of which is labeled "incoming," and the other "outgoing." By this means all unnecessary delay is avoided. He simply deposits in the former whatever he may have collected in the other offices for the one in which he may happen to be, and takes from the latter all letters, &c., intended for other offices, arranging them alphabetically in a large folding case, containing 26 sections, one for each letter of the alphabet.

In addition to the regular force of laborers and mechanics, it was found necessary during the spring to employ additional help on account of the extra work involved in the preparation and packing of the exhibit for the London International Fisheries Exhibition. Notwithstanding the increase, however, the men were obliged to work night and day, in order that the material might be in London in time for the opening day of the exhibition.

The carpenter shop has been transferred from the southeast court to the frame building east of, and adjoining, the Museum. This has materially increased the storage facilities for specimens in the Museum.

Extensive improvements have been made in the drainage. Additional sewers have been laid, and connected with the main on B street immediately south of the Museum. This action was hastened by the backing up of the water in the basement of the café and southeast pavilion, during sudden and severe rain storms, which caused considerable damage to flooring and traps.

Department K: Electric Service.—Under the management of Mr. W. J. Green the electrical service has been improved and extended during 1883. There are now 40 separate telephone lines connecting the residences of the chief officers of the Smithsonian and Museum buildings, and lines have also been put up connecting the Armory building, carp ponds, and the Central Telephone Exchange with the Museum.

The whole system, as completed at the end of the year, consists of the following apparatus: One 50-drop telephone annunciator. One 100-drop burglar alarm annunciator, connecting three hundred windows and 85 doors. One time and watch-clock which is connected with 14 stations, and records the time and place of the watchmen patroling the Museum building and its annexes. There are also 50 electric push-buttons, situated in different parts of the building, connected with a 100-drop annunciator for the use of floor inspectors, watchmen, and others who may be in need of assistance.

There is one standard-time clock connected with the Naval Observatory. This is regulated every day at noon. There has also been erected one control-clock giving standard time to six 30-inch dials in the different exhibition halls, and seven 15-inch dials in various offices.

In addition there are eight 10-inch electric bells for general calls; 12 test-boards to facilitate testing and putting in wires in different parts of the building; 1 watch-box, which records the watchmen's signals on the watch-clock dial, and in the offices of the police and messenger company; 40 incandescent lamps; 10 call bells worked from the telephone office; 250 feet of wire cable have also been used in connection with the outside telephone service.

The Brush-Swan Electric Light Company have placed a storage battery in the lecture room and put in 43 burners for the use of the Museum.

The electric light service consists of one 6-light Brush-dynamo and one 1-light Brush-dynamo, which are driven by a 20 horse-power engine. There are also six arc lamps of 1,500-candle power, and three electric focusing lamps of 2,000-candle power. These are used for photographic purposes. In addition there are forty incandescent lamps of 16-candle power, and a Brush storage battery of 63 elements. All of the exhibition halls are furnished with wire for electric light, and in such a manner that one or all can be illuminated at a given time. It is estimated that 75,000 feet of insulated wire are required to carry on these systems in both the Smithsonian and Museum buildings. At least eight miles of wire are in use for the outside connections.

Department L: Preparation.—The efficiency of the various taxidermists has undoubtedly increased during the year. A number of very excellent pieces of work were prepared for the London Fisheries Exhibition.

The Museum has adopted the plan of printing upon the labels of large pieces of taxidermic work the names of the preparators, and is doing all in its power to encourage the taxidermists of the country in improving their standard of work. To this end it has offered to the Society of American Taxidermists the privilege of exhibiting in the Museum, in a section devoted especially to taxidermy, examples of the finest work which may from time to time be produced in connection with this collection. Mr. W. T. Hornaday is in special charge of this matter, and has already secured for the Museum a considerable number of very interesting specimens, which, however, are not yet on exhibition, and therefore need receive here only passing notice.

It was gratifying to the Museum that a number of the members of its staff of preparators received special awards at the third annual exhibition of the Society of American Taxidermists held in New York.*

The appearance of the mammal gallery has been very greatly improved by the mounting of eighteen new specimens of pinnipeds, the most important of which is a large hooded seal, and a young elephant seal, mounted in a swimming attitude.

Mr. Joseph Palmer, chief modeller, was in the early part of the year busily engaged in making lay-figures of fishermen and Indians. Two large specimens of whales were cast, and a number of porpoises and fishes. He also made a series of models illustrating the oyster fisheries, in addition to preparing specimens for the Louisville Exhibition. His assistant, Mr. William Palmer, spent several months in New Haven, making, under the direction of Mr. J. H. Emerton, the large paper models of the giant squid and octopus for exhibition in London, and now permanently displayed in the fishery section of the Museum. Early in October, Mr. William Palmer was sent to Barnegat City, N. J., where he successfully made a mold of the "bottle-nose" whale (*Ziphius curvirostris*), and preserved the skeleton in perfect condition. This latter is now in maceration, preparatory to being mounted. In addition he spent some time in making molds and *papier maché* casts of the Moqui towns. These casts and molds were made from clay models prepared under the direction of Mr. Victor Mindeleff.

Mr. Marshall has, as usual, devoted his time to the mounting of birds. He prepared five noticeable groups for the London Fisheries Exhibition, and has mounted during the year about five hundred specimens.

Mr. A. Z. Shindler has been employed in making sketches from new fishes received, and in painting the casts made by Mr. Palmer. He has also been engaged in painting casts of Indian implements, and has performed most efficient work in the completion of the collection of casts of fishes and reptiles.

Although much has been done in the preparation and mounting of skeletons, as well as in the repair of those already on exhibition, yet

* Prizes and commendations awarded to preparators of the U. S. National Museum at the third annual exhibition of the Society of American Taxidermists at New York, May 1 to May 5, 1883.

To William T. Hornaday: Silver medal for best specimen of taxidermy in the exhibition, African elephant Mungo. Special medal recommended for setter dog and quail. Hairless Mexican dog and cinnamon bear highly commended.

To Frederic A. Lucas: Bronze medal for group of turtles.

To William Palmer: Special medal recommended for cast of leather-back turtle's head. Certificate of merit for birds.

To Joseph Palmer: Casts of mammal heads and fishes very highly commended.

To L. M. McCormick: Certificate of merit for birds.

To J. W. Hendley: Cast of fishes very highly commended.

the greater part of the year has been consumed in the transfer of the large collection of unmounted mammal skeletons and skulls from storage in the Smithsonian building to the osteological hall (east south range) of the National Museum building. Owing to the length of time during which this large amount of material has been accumulating, and to the lack of suitable accommodations, the collection had fallen into a state of confusion. Moreover, a portion had never been catalogued, and a still larger portion remained unidentified. It was therefore necessary to compare each specimen with its original record, while a large number were identified or entered for the first time. For lack of room, a portion of this collection, namely, the skeletons which have not yet been cleaned, has been temporarily stored in the Armory building. The remaining portion has been arranged, labeled, and placed in table cases in the osteological hall. Seventeen cases are thus occupied, and many more will eventually be required to accommodate this important and steadily increasing collection. The service of Mr. F. A. Lucas as an aid in the department of osteology has done very much to stimulate its growth.

Messrs. E. H. Hawley and T. M. Sweeney have rendered efficient aid in the mounting of specimens in the cases for exhibition, and to the former especially the Museum is indebted for numerous ingenious contrivances for the better display of its material. Mr. T. W. Smillie, photographer, produced for the London Fisheries Exhibition enlarged photographs of fishermen and fishing scenes. These, which were printed by the electric light, and in some instances retouched by Messrs. Elliott and Moeller, constituted a prominent feature in the American section at the Fisheries Exhibition, and received a gold medal—the only one awarded to photography. They seem to deserve especial mention here, since it is believed that pictures of this description can be used with great effect hereafter in various departments of the Museum.

Mr. Hendley has done some excellent work in the preparation of lay figures for the London Fisheries Exhibition. Two of these figures were representative of the negro fisherman of the United States, and five, of the white fisherman. He has also commenced the work of preparing casts of vegetables, fruits, meats, &c., to be arranged hereafter in the food collection.

Preliminary exhibition of the fishery collection.—On the 26th of February an exhibition of the collections about to be sent to London was held in the halls of the Museum. Preparations for this exhibit were made in three days' time by dint of hard work of an extra force night and day. The building was lighted for the first time by the electric lamps, and the display was considered a great success. On the following night the building was also opened for the inspection of these exhibits. On the first evening 2,339 persons were present, and on the following night, 2,298. During the week before the collections were packed the attendance in the Museum averaged nearly 2,000 a day.

The Southern Exposition of Louisville, organized in 1882, obtained permission from the last Congress to remove certain objects from the National Museum, with the sanction of the Director and without cost to the Government, for exhibition in the Southern Exposition. (See Rev. Stat., Forty-seventh Congress, second session, chap. 99.) This exposition opened on August 1, and a collection, the contents of which are elsewhere enumerated, was sent from the Museum, and was returned after the close of the exhibition, in good order, on November 8. The contributions of the Museum were greatly appreciated by the visitors to the exhibition, and the expenses incurred in its preparation were promptly and cheerfully paid by the company. Several applications from other similar exhibitions were received, but the Museum has always taken the position that loans of this kind cannot be made without special Congressional enactment. It is, however, my desire to prepare for such purposes a special series of specimens which may be temporarily sent to different parts of the United States for the purpose of public instruction and of awakening interest in museum work. An excellent precedent for this move may be found in the policy of the Science and Art Departments of Great Britain, which at the present time has eighteen loan collections of this kind in different parts of the United Kingdom.

Exhibition of the Pharmaceutical Association.—On September 10, the Pharmaceutical Association held its annual meeting and exhibition in the Museum, the lecture-room being used for the meeting and the north-east and east-north ranges for the exhibition, which was very largely attended, the number of visitors during the five days of its session amounting to 7,571.

On the 4th, 5th, and 7th of December the Brush-Swan Electric Light Company gave an exhibition of its incandescent lights produced by the Brush storage battery. During the four evenings of the display there were 1,543 visitors.

Meetings and lectures during the year.—The National Academy of Sciences held its regular semi-annual meeting in the lecture-room of the Museum on April 17. The Biological Society has held its regular fortnightly meetings in the lecture-room. The Philosophical Society held its annual meeting in the lecture-room of the Museum on December 8. The Pharmaceutical Association, as has already been mentioned, held its annual meeting in the lecture-room on the 10th of September.

A course of 12 lectures, under the auspices of the Biological and Anthropological Societies of Washington, was given on successive Saturdays, commencing on January 13. These were followed by a course of 8 lectures on materia medica by Dr. D. W. Prentiss, commencing April 7 and continuing until May 26, illustrated by specimens from the materia medica section of the Museum: they were attended by about 200 students of medicine and pharmacy.

Number of visitors.—By means of the tally machine, it has been ascertained that the total number of visitors to the Museum during the year was 202,112, making a daily average of 674. The number of visitors to the Smithsonian building for the year was 104,693, or a daily average of 349.

The above figures show an increase during 1883 of 34,657 visitors to the Museum building over the number registered in 1882, and a decrease of 48,051 visitors to the Smithsonian Institution.

DIVISION OF ANTHROPOLOGY.

I. *Department of Art and Industry.*

In the Department of Art and Industry is included for the present all ethnological material except that belonging to prehistoric archæology. Under the head of "art and industry" are included the products of the arts and industries of civilized as well as of semi-civilized and barbarous races. These collections are being arranged in accordance with a teleological rather than geographical plan of classification, objects of a similar nature being placed side by side, musical instruments together, weapons together, &c., and arranged in such a manner as to show the progress of each idea from the most primitive type. In discarding the ethnographic method of arrangement, almost universal among museums, special care has been taken not to sacrifice the possibility of bringing together the objects belonging to any particular locality or race, if this shall at any time be required for purposes of study.

In our method of installation, objects are mounted in glass-covered trays or deep frames, 24 by 30 inches in dimension, which are arranged for study or exhibition in cases of various forms. The articles belonging to two different tribes are never mounted together in the same tray; and if at any time it should be found desirable to bring together the collections from any given race, for instance, from the Eskimos, the Siamese, or the Japanese, this might be accomplished in a few hours; in fact, when once the present system of mounting has been completed, the rearrangement of the Museum upon the ordinary ethnographic plan would be the work of only a few hours, and may be effected by a small force of mechanics and laborers under the direction of a single curator.

The system of classification just described has been criticised in certain particulars by administrators, and from their standpoint the criticism is a just one. I therefore take this opportunity to explain that the policy of the department has been misunderstood by them. It is no part of the plan, nor has it ever been, to separate articles which belong together. The parts of any collection or group of objects which may justly be considered a unit of administration are always kept together; for instance, if a costume is complete it is not intended to dissect it and distribute its parts. Hats, gloves, boots, and coats are only placed by themselves when they have no related objects associated with them. In the same way a costume of a family, whether composed of two or ten individual suits, might with propriety be regarded as a unit. Collections illustrating the history of a special tribe in a monographic way may also with propriety be kept together. Such a collection would, however, not be assigned to the department of art and industry, where the preferred method of arrangement is evolutionary or progressive, but would rather be made over to the department of ethnography. The teleological plan of arrangement has already been criticised by persons who prefer the more usual system of arrangement by race, a system which is in many respects no less desirable and for some museums is to be much preferred. This system, however, is not at present convenient for the uses of this establishment. It is probable that these critics have not studied the plan of the classification of the Museum sufficiently to be aware that an ethnographic series of objects as well as the teleological series is provided for. It has been publicly suggested that the plan of classification, sketched out provisionally and submitted for consideration in my report for the year 1881, has been settled upon "without allowing the voice and criticisms of scientific men to be heard." In response to this I can only say that this plan, which, it may be stated in passing, has never been anything more than a tentative and provisional one, is simply an extension of the plan adopted in the archæological division of the Museum previous to 1874, and reported upon favorably by a committee of the Board of Regents early in 1875.*

The department of art and industry must in time necessarily be subdivided into a number of special departments. At present, and until the material now on hand is properly assorted, such subdivision is not particularly to be desired. There have grown up, however, a number of sections in this department, the result of the accumulation of large quantities of material requiring the care of a special officer.

A very large part of the material now in the custody of this department may with propriety be given over to the proposed new curatorship of races of men.

Section of Fisheries.—The collection to illustrate the fisheries of North America has been the object of close attention since 1875, when a special appropriation was made by Congress to enable the Commissioner of Fisheries to present a thorough representation of this industry at the Philadelphia Exhibition. The same collection, largely expanded by means of a second appropriation, was sent to the International Fisheries Exhibition at Berlin in 1880, and again in 1883 to a similar exhibition in London. Although a considerable portion of each special appropriation was consumed in expensive transportation and temporary installation, yet considerable sums from each were devoted to improving this collection. Expanded as it has since been by gifts from and exchanges

* See report of Asa Gray and Henry Coppée, special committee on Museum, in Annual Report of the Board of Regents of the Smithsonian Institution for the year 1874; pp. 126–138.

between foreign Governments, it is now not only as perfect as possible a presentation of the fishery industries of the United States, but is by far the most complete exposition in existence of the fisheries of the world. In addition to material from various foreign countries previously secured, this collection has during the present summer been enriched by large contributions from England, India, the Straits Settlements, Siam, Greece, Spain, Sweden, and Russia. The Government of Greece presented to the United States its entire exhibit in London, and the Government of Spain was equally liberal, sending the United States everything which was indicated as desirable from the collections exhibited in London by the Madrid Naval Museum.

The American section of the Fisheries Exhibition occupied about 25,000 square feet, and the high appreciation with which it was received is marked not only by the verdict of the juries, by whom it was awarded 150 medals and diplomas,* but by the universal commendation of the European press.

The last shipment of this material has been returned, and in two or three months will be re-installed as a permanent section of the Museum.

The concentration of a considerable amount of money upon this collection has enabled us to provide for it all necessary cases, to do the required work of mounting, to prepare printed labels for every specimen, and to bring together a large number of pictures, photographs, and sketches, which supplement the labels and complete the significance of the specimens. It will, consequently, for some years no doubt, stand as the first completed and most thoroughly arranged section of the department of art and industry.

Section of Historical Relics.—The relics of George Washington and other distinguished persons, for many years displayed in the Patent Office, and the Lewis collection of Washington relics purchased by Congress at a cost of $12,000, which was stored in the Patent Office but kept in the original packing-boxes, have, during the year, been given into the charge of the National Museum by the Commissioner of Patents. These have been placed on exhibition in temporary cases, together with many articles of similar nature already in the possession of the Museum. It is intended, as soon as practicable, to install the Washington relics in a more effective manner, perhaps by placing the furniture in a case, the interior of which shall resemble one of the apartments in the Washington homestead at Mount Vernon. In the Lewis collection are two portraits of General Washington and Mrs. Martha Washington, painted by Col. John Trumbull, which are among the choicest treasures of American art.

Section of Materia Medica.—This section is already thoroughly under control, the specimens being installed in exhibition cases in systematic order, and a large number of labels being attached. This department

* Fifty of this number were awarded to the National Museum and Fish Commission and their employés.

has been for two years under the care of Dr. James M. Flint, surgeon, U. S. N., who has been detailed for this service by the Surgeon-General of the Navy, and to whose skill the Museum is indebted for the development of a collection of medicinal substances probably unequaled elsewhere.

The whole number of specimens at present on exhibition is 3,240. The series begins with objects that illustrate the forms in which medicinal substances appear in commerce or are prepared for administration by pharmacists. The labels attached give concise and accurate definitions of each class. Next following is the general collection arranged according to the detailed classification published elsewhere, beginning with animal products in their zoological order, and succeeded by vegetable products in their botanical order, &c. Supplementing the general collection is an exhibit of the most popular mineral waters, and, finally, as a distinct series, a considerable number of Chinese drugs. The plan of organization and the methods of work in this department, together with a full account of what has been accomplished, will be found in the report of its curator.

Section of Naval Architecture.—The collection of models of boats and vessels now includes between two and three hundred specimens. This series has been developed in connection with the fisheries exhibit, and is especially complete in representations of American forms, both aboriginal and modern. The series of primitive types is particularly full, and the collection, which will be installed in the room adjoining the fisheries court, will, when arranged upon the evolutionary plan, be thoroughly unique. Of that most primitive of types, the skin boat, the Museum now possesses five examples, the bull-boat of the Haidatsa Indians, and four others obtained during the summer, namely, the coracle of the Ganges, gift of the Government of India; the Irish curragh, gift of the Marquis of Hamilton; the Boyne coracle, and the Dee coracle, obtained from persons at the Fisheries Exhibition. The Government of India contributed also some exceedingly interesting and primitive forms of dug-outs. A number of other specimens have been acquired during the year, chiefly by gift. This collection has been placed in the charge of Capt. J. W. Collins, of the U. S. Fish Commission, to whom very much of its recent expansion is due.

Section of Keramics.—The specimens of pottery and porcelain from Europe and the Orient are not numerous, but include a number of very important pieces, such as the two immense Centennial vases given by Haviland & Co., a very excellent representation of the products of Doulton's Lambeth pottery, and a large number of decorated tiles exhibited by Minton & Co., and Moore, Maw & Co., at the Philadelphia Exhibition. During the year the Museum has received from the French Government a gift of seventy-five specimens from the Manufacture Nationale de Sèvres. This is a technological display, including the materials, implements, and products used in this establishment. There has also been received a very valuable vase from the same place decorated in gold and colors by F. de Courcy, the gift of L. Straus & Son, of New York, importers.

Mr. W. H. Holmes has been detailed by the Director of the Bureau of Ethnology of the Smithsonian Institution to prepare a report upon American aboriginal pottery, and the entire collections of the Museum have been placed in his hands for that purpose, and are now concentrated in the northwest court, where cases are already prepared for their reception, which will be occupied as soon as the interior fittings are decided upon. This collection is wonderfully rich, and, after its arrangement has been completed, will be one of the most impressive in the whole Museum. It has been increased during the year by a number of important contributions, among which may be mentioned especially a gift of 100 pieces of Peruvian pottery from Mr. W. W. Evans, of New Rochelle, N. Y.

Section of Costumes.—Mr. J. K. Goodrich and Ensign A. P. Niblack, U. S. N., have rendered efficient service in the work of assorting and preparing labels for the general collections of costumes, implements, &c. The wealth of the Museum in articles of costume derived from the North American aborigines is very great, as also in all classes of implements and other articles which usually make up the bulk of ethnological collections. The mass of unassorted material is still very large, and is being increased every week by the arrival of new accessions.

The extensive collections of the Bureau of Ethnology from the pueblos of New Mexico and Arizona were transferred to the custody of the Museum in November, including numerous specimens of basket-ware, pottery, gourds, grinding-stones or mortars, weapons, ceremonial, household, agricultural, and industrial implements. In referring to this material I feel it my duty to call attention to the fact that many of these specimens have suffered deterioration during the interval between the time when they were collected and the time when it became practicable for the Museum to assume their custody, as must necessarily be the case when perishable objects of wood, grass, wool, and feathers are allowed to remain without the protection of dust- and insect-tight cases. Very many of them, too, suffered damage in the necessarily rough carriage on pack-mules from the remote regions where they were collected to the lines of railroad transportation, and consequently are by no means so beautiful and well preserved as they would appear to be from the illustrations of them published in the reports of the Bureau of Ethnology, which represent them in their best condition as seen in the hands of their original owners by the persons who gathered them.

Ensign A. P. Niblack has furnished the following list of the most valuable accessions:

Among the most important collections made by employés of the Government in connection with their regular work under other branches, and which were paid for out of the fund previously alluded to, may be mentioned—

A collection from William J. Fisher, the Coast Survey tidal observer on Kadiak Island, Alaska, who made several trips on the peninsula and mainland. It embraces about 100 specimens, the most interesting being several heavy elaborate bead-work head-dresses, some of them weighing as much as 2¼ pounds.

The collections made by the U. S. Signal Service observers are as follows:—

1. One by C. L. McKay, from in and around Bristol Bay, north of the Aliaska Peninsula, from the Nushagag-mut and Ugulmut Eskimos of that region—about 45 specimens in all, including a full outfit for a Beluga-whale hunter, which was exhibited in London last year. This outfit includes harpoons, lines, buoys, extra heads, killing lances, &c. A second collection of about 50 or 60 specimens, consisting of household utensils and articles of personal adornment, were received after the death of McKay. He was drowned in April, 1883, while out in a *kaiak* in Nushagak river in bad weather.

2. One by J. J. McLean, from around Sitka, which had been pretty well worked up by other collectors. Besides the usual lot of wooden carvings, kantags, or wooden dishes, &c., there are some fine specimens of native wicker and basket work in the collection made from a species of grass, *Iris tenax*.

3. A *kaiak*, with complete fittings, from Greenland, deposited by the Chief Signal Officer of the Army. It was exhibited in London.

4. The Point Barrow collection which was brought down when the expedition returned recently. The collection is a good one and embraces over 700 specimens. Mr. Murdock is now working up the collection, and I will not anticipate his report. Part of the earlier collection which came down on the Corwin went to London to the Fisheries Exhibit.

5. Mr. Stejneger, of the Signal Service, made a small collection from the Aleuts on Bering Island, Commander Group (off the coast of Kamschatka). There are some interesting models of fox and bear traps and boats, some seal-skin costumes worn in their native dances, besides some accessions of costumes peculiar to the Aleuts.

6. A collection coming more properly under 1884 was received several weeks since from L. M. Turner, of the Signal Service, from the Eskimos of Ungava Bay, New Labrador. It is a fine one, and embraces over 450 specimens. The articles have not the *oily*, used look that most Eskimo implements have, which indicates that other collectors have been among them recently, although a great many specimens are models of traps, snow-shoes, tobogans, and spears, and are necessarily *new*. There are some large tobogans and snow-shoes of a peculiar pattern. The costumes are remarkably handsome, and show the effects of contact with civilization.

A second collection from Fisher, made in the Aleutian Archipelago and Aliaska Peninsula, has just been received. It consists of about 120 specimens of costumes, Aleutian heads, household utensils, accessories of costume, &c.

Among the small purchased collections may be mentioned, a Zuñi sacred blanket, 100 Peruvian water-bottles, or huacas, and some shoes, hats, dishes, baskets, &c., from the La Costa Indians of South California, woven of mescal fiber and palm leaves.

(1.) Among the principal donations are 40 musical instruments supplemental to the set of American musical instruments, all presented by Mr. J. Howard Foote, of 31 Maiden Lane, New York.

(2.) The original Catlin collection of Indian portraits, &c., painted by him during his eight years amongst the 48 tribes, of which he has handed down to us these most valuable ethnological records. There are about 500 in the collection, which Mrs. Harrison, of Philadelphia, has so generously presented to the Institution.

(3.) At the close of the Boston Exhibition, recently, some 50 musical instruments, numerous clay figures, and various other specimens were presented to the Institution by Sourindro Mohun Tagore, rajah of one of the provinces of India and president of the Bengal music school. The musical instruments are accompanied by full notes, and the Museum is taking steps to obtain a supplemental collection to complete the series. These objects were installed a few days since and are now on exhibition.

Among the principal exchange collections are—

(1st.) Some miscellaneous weapons from Polynesia and South America, obtained at the Fisheries Exhibition.

(2d.) Some 16 musical instruments and accessories, from Tiflis, in the Caucasus, obtained through Mr. Englemann, of Saint Louis.

(3d.) About 40 specimens from the Leipzig Museum, consisting of knives, bows, arrows, baskets, mats, &c., from Africa, particularly the Loango coast, and Gaboon River, on the west coast. The admirable native steel implements are well illustrated. This collection, combined with a few stray or miscellaneous articles and a small number given by Rev. Dr. Gurley, constitutes but a meager African ethnological exhibit.

The Museum has just sent to the Trocadero, at Paris, an ethnological collection, selected from the material in its possession, and doubtless their exchange will embrace some additions to the above.

Mr. J. G. Swan, in addition to the regular collections which he sends in from time to time, last summer made a special trip for the Smithsonian Institution to the Queen Charlotte Islands, B. C., and the results have just been received.

In the early part of the year he sent in some photographs and about 100 specimens, supplemental to his series illustrating the fisheries of the Indians in and around Cape Flattery, Washington Territory. The complete collections went to London.

In the trip referred to above, he started from Masset Sound, N. of Graham Island, and coasted around the west side; then through Skidegate Channel to the southeast coast; then home to Victoria. Now that he has partially carried out his long-cherished desire, it is to be hoped that his forthcoming notes will prove as valuable as those previously published. A better knowledge of the Haidah totems and totemic carvings is desired. The collection is rich in masks, wood carvings, ladles, ancient stone implements, robes, clubs, shamans' wands, ceremonial bows, whistles, rattles, fishing gear, &c., but particularly so in the slate carvings, of which he sends 30 specimens—dishes, boxes, and models of totem posts. There was already on hand a sufficient number of specimens to illustrate the Haidah wood carvings and working in silver, but the additions to the slate carvings have made it appear desirable to install the latter as a monographic collection, illustrating this art, which alone places the Haidahs at the head of the Indians of the northwest coast.

The Catlin collection of Indian paintings, presented in 1881 by Mrs. Joseph Harrison, of Philadelphia, have been unpacked and placed on exhibition in the lecture-room. The value of this collection is almost inestimable, consisting, as it does, of over 600 paintings made by Catlin previous to 1840 in various parts of the western United States, Mexico, and British North America, and representing members of what were then considered to be forty-eight distinct tribes. About one-half of the figures are portraits, while the others represent ceremonies, games, and hunting scenes. It was claimed by Mr. Catlin that over 3,000 figures are represented in these paintings, and they are of the greatest value as contemporary delineations of costume in addition to their importance as portraits of the various types of Indian before they had become changed by contact with the white man. This collection, which consists of the original paintings made by Catlin in the field, is quite distinct from the one exhibited in the Smithsonian building many years ago, and is in excellent condition, notwithstanding the fact that it has been stored in a warehouse in Philadelphia for fifteen or twenty years.

The collection of musical instruments is deserving of mention, since it is, up to the present time, the only one, excepting the fisheries collection, which has been thoroughly arranged and labeled in accordance with the accepted plan of installation. This material has been considerably extended during the year by gift of modern European instruments from Mr. J. Howard Foote, of New York City; an exchange collection of Caucasian instruments from Dr. George J. Engelmann, of Saint Louis; the gift from the Rajah Sourindro Mohun Tagore, of Madras, of a series of 80 instruments from Hindoostan, exhibited at the Foreign Exhibition in Boston. The thanks of the Museum are due Col. C. B. Norton for his friendly offices in securing for the Museum this valuable donation.

Another important accession to this department has been the contribution by Mr. L. Prang, of Boston, of a series of specimens illustrating the history and methods of lithography in all its branches. These were selected, arranged, and labeled by Mr. S. R. Koehler, of Roxbury, Mass., who has in preparation a hand-book, to be printed by the Museum, and to accompany the collection. Rev. C. H. A. Dall, of Calcutta, has contributed a considerable collection of foods, textiles, and other substances from India.

A most interesting and rare accession to the Museum during the year is that of a piece of antique Roman mosaic, which formed a part of the floor of the temple of Astarte, and which was secured by Sir Richard Wood, British consul-general at Tunis, exhibited at the Centennial Exhibition, Philadelphia, 1876, in the collection of his Highness the Bey of Tunis, and presented to the Museum by Sir Richard Wood, at the instance of G. H. Heap, esq., United States consul to Tunis. This specimen has been placed on exhibition, after having been carefully repaired and mounted under glass by Mr. E. H. Hawley.

Section of Foods and Textiles.—The Museum is very rich in the textile products and food substances of the North American aborigines and of a number of foreign countries, acquired at the close of the Philadelphia Exhibition. Prof. W. O. Atwater, of the Wesleyan University, Middletown, Conn., has been acting as honorary curator of the section of foods, and has carried on extensive operations in the analysis of food products for the benefit of this collection and of the Fish Commission. Mr. Romyn Hitchcock, of New York, an experienced microscopist and chemist, has recently been designated acting curator of the department of textiles and acting assistant curator of the department of foods. The work of preliminary arrangement has been rapidly pushed forward.

These departments are full of interest, and that of foods especially, as has been shown by the experience of the Bethnal Green Museum, in London, may be made one of the most instructive to the public.

II. *Department of Races of Men.*

The experience of the past year has impressed upon us more strongly than ever before the importance of the organization of this department, which was provided for in the original plan of classification, but which, owing to lack of money, has not yet been organized. It is hoped that during the coming year it may be possible to appoint a skillful ethnologist to this curatorship. The department of arts and industries is now overburdened with material which cannot properly be cared for, owing quite as much to the lack of knowledge and skill on the part of its officers as to the inadequacy of the numbers of the staff employed.

III. *Department of Antiquities.*

The department of prehistoric antiquities, under the charge of Dr. Charles Rau, has advanced with its usual steps of progress during the year. The present somewhat unsettled condition of the upper main hall of the Smithsonian building, in which these collections are stored, is due to the fact that the arts and industries collections, formerly exhibited here, have been only in part removed, owing to the lack of exhibition cases in the new building. An exceedingly important addition to this department, which, on account of its size, has been installed in the Museum, is the Lorillard collection of Central American antiquities, consisting of a series of forty-eight casts of wall sculptures and picture-writings, made in Mexico and Yucatan, by M. Desiré Charnay, at the expense of Mr. Pierre Lorillard, of New York. This collection, of which a duplicate is deposited in the Trocadero Museum in Paris, was forwarded from that city in May, and set up in the most skillful and artistic manner by M. Barbier, from the Trocadero Museum. The Museum is greatly indebted to Mr. Allen Thorndike Rice, editor of the North American Review, who, at Mr. Lorillard's request, acted as director of the Charnay expedition, and by whose advice its results were deposited in Washington.

In the same gallery with the Lorillard collection has been installed a considerable number of monolithic statues from Yucatan, Costa Rica, and Nicaragua, which have been for some time in the possession of the Museum, but not exhibited until recently on account of a lack of room; also the Syrian sarcophagus for many years exhibited in front of the Smithsonian building, and a number of casts of prehistoric statuary from Egypt and elsewhere.

A large collection from the mounds of the United States has been transferred by the Bureau of Ethnology. This collection has been made under the direction of Prof. Cyrus Thomas in important localities from Dakota Territory to Florida, and from Nevada to the New England States, and forms the basis of his reports to the Bureau of Ethnology. This collection of aboriginal remains embraces skulls, bones, celts, fragments of pottery and walls of dwellings, shells, copper and iron implements, flints, flakes, pipes, arrow-heads, perforated tablets, stone disks, ceremonial stones, &c. The number of specimens estimated by Professor Thomas in 1883 was 3,544. A small lot of quartz celts from Madras was also received from the same bureau.

DIVISION OF ZOOLOGY.

IV. *Department of Mammals.*

The accessions of the year have been numerous and important, and are discussed in full in the report of the curator, Mr. F. W. True. The most noteworthy, perhaps, are various species of cetaceans, hitherto unknown in American waters, obtained through the co-operation of the U. S. Life-Saving Service; and the collection of Greenland seals, obtained for the Museum by Dr. C. Hart Merriam during his trip on a Newfoundland sealing steamer. Dr. Stejneger's magnificent collection of Rhytina bones from Siberia have been received mainly during the year, and by efforts in various directions the Museum series of Sirenians has now been completed. Mr. Hornaday's group of Bornean Orangs has been placed on exhibition in the mammal gallery; also several other products of the skill of the Museum taxidermist, by which the appearance of this collection has been greatly improved. In this connection may be also mentioned the gift by Mr. Edward Kemeys, the sculptor, of the original model of his bronze figure, "The Still Hunt," and a large number of working models of various species of North American mammals which are of great interest to the student of art as well as to the mamalogist and the taxidermist. The curator of mammals has devoted a considerable portion of his time during the year to the reorganization of the collection of skeletons, which is exceedingly rich in North American material. The cases for their reception not having been finished, the mounted preparations still remain in the Smithsonian building. The articulated skeletons have all been systematically arranged in the osteological gallery. It is but fair to the curator to state that, owing to his appointment as acting assistant director during the absence of the assistant director in Europe for six months of the year, the work of the department was necessarily interrupted.

The number of specimens added during the year was 365; 260 of which were skins and 105 osteological specimens. The total number of specimens now in the custody of the curator is estimated at 8,663. In his report several important suggestions are made, all of which I would recommend for adoption.

V. *Department of Birds.*

In the department of birds, under the care of Mr. Robert Ridgway, the work of the year has necessarily been confined to the laboratory, all the space in the ornithological galleries outside of the cases having been occupied by the offices of the Smithsonian Institution during the re-construction of the eastern end of the building. There has been, however, very much important work accomplished in the rearrangement of the study series, and valuable collections have been received, especially from Dr. Stejneger, Mr. Ridgway, Mr. Nutting, Captain Bendire, and Mr. Belding.

The total number of specimens in the custody of the curator is estimated at 47,246, of which 6,000 are on exhibition, 13,000 are duplicates, and 28,246 are in the reserved skin series.

VI. *Department of Reptiles and Batrachians.*

Under charge of Dr. H. C. Yarrow, honorary curator, the usual administrative work has been accomplished, and an annotated catalogue of the American specimens belonging to the Museum has been published.

A considerable number of species lacking in the Museum series has been added during the year, chiefly by R. W. Shufeldt, Mr. George Shoemaker, Mr. Robert Ridgway, Col. Nicholas Pike, Mr. S. Belding, and Mr. G. W. Mamorly, and the work of assorting and arranging the collections of exotic reptiles has been pushed nearly to completion. No exhibition space has as yet been assigned to this department.

VII. *Department of Fishes.*

This department is perhaps one of the most unmanageable in the Museum, its material being for the most part alcoholic. From 1865, when it was thoroughly disorganized by the fire in the Smithsonian building, up to 1878, this department was without a curator, though subsequently to 1881 the bulk of the collection was largely increased every year by the work of the U. S. Fish Commission. For two years Dr. Tarleton H. Bean, the curator, assisted by Messrs. Parker, Dresel, Miner, and Bean, has been engaged in re-arranging the entire material and preparing a card catalogue, a task which has been doubly difficult owing to the lack of sufficient room in which to work. The collection is, however, now very well under control, and several thousand bottles have been set aside for the exhibition series. From June to October of this year Dr. Bean was detailed for special service in connection with the International Fisheries Exhibition, and devoted a considerable portion of this period to the study of the ichthyological collections in London, Paris, Genoa, Vienna, Berlin, and Liverpool, establishing additional relations of exchange in those cities. This department has been, as usual, enriched by the work of the U. S. Fish Commission, whereby many new species and genera have been added to the fauna of North America.

The curator estimates the number of specimens in his department at 65,000, of which 20,000 are on exhibition and 10,000 are duplicates, the remainder being held in the study series.

VIII. *Department of Mollusks.*

This department continues under the charge of Mr. William H. Dall, as honorary curator, Mr. R. E. C. Stearns having acted during a portion of the year as non-resident assistant curator. The collection has been greatly enriched by the acquisition of Mr. Stearns' cabinet of American mollusks and the very rich collections of J. Gwyn Jeffreys, esq., F. G. S. &c., of London. Lieut. Francis Winslow, U. S. N., who was detailed to duty at the Smithsonian Institution, has rendered important service to this department during the year in developing and classifying the collection of oysters and other economic mollusca for the London Fisheries Exhibition, and later in the year assisting in the administration of the general collections.

It is earnestly recommended that the staff of this department be increased by the appointment of at least one person who will be able to give his whole time to the care of the material. As is shown in the annual report of the curator, serious damages have resulted every year to some portions of the collections, owing to the lack of constant care, which he, being fully occupied with other duties in a remote part of the city, could not, of course, be expected to give.

IX. *Department of Insects.*

The Museum is still unfortunately without a collection of entomological specimens worthy of the name, the valuable specimens accumulated by the Government service having years ago suffered destruction in the hands of the entomologists of the Department of Agriculture, with whom they were deposited. Prof. C. V. Riley, who is acting as honorary curator of this department, has deposited his extensive cabinet of American insects in the Museum, and it is hoped that in time this may become the property of the United States. In the mean time all possible efforts to keep up a nominal department of insects are being made through the employment for a few months in each year of an assistant to Professor Riley.

X, XI, XII. *Department of Marine Invertebrates.*

The collections of crustaceans, radiates, worms, and protozoans are in charge of Mr. Richard Rathbun, being grouped together under the general heading of "marine invertebrates." The west hall of the Smithsonian building has been assigned to this department for exhibition purposes, but is still occupied in large part by property belonging to other departments, so that the curator has had but little opportunity for perfecting the exhibition series. Very extensive progress, however, has been made during the year by the curator, with the assistance of Ensign W. E. Safford, Ensign C. S. McClain, and Mr. R. S. Tarr, in the way of assorting the material already on hand and the distribution of duplicates. A card catalogue of the department is nearly completed, and a number of important exchanges with several European museums have been made during the year, and valuable collections have been received from the Museum of Comparative Zoology, Cambridge, Mass., from Prof. H. E. Webster, from Mr. Edward Potts, of Philadelphia, and from Messrs. McKesson & Robbins, New York. Professor Verrill, who is in charge of the marine research work of the Fish Commission in New England waters, has delivered to the Museum considerable quantities of material, upon which investigations have been completed. Important collections have also been received from the Fish Commission steamer "Albatross." Interesting accessions to this department have been a series of foraminifera from the deep sea, collected by the "Challenger" expedition, and presented by Prof. William B. Carpenter, being the types of his official report.

Extensive collections of echinoids and crawfishes have been received from the Museum of Comparative Zoology; of marine annelids in alcohol from Prof. H. E. Webster; an exhaustive exhibit of the Florida commercial sponges, from McKesson & Robbins; important accessions from Alaska, obtained by Dr. Stejneger, Lieutenant Ray, and Mr. John Murdoch; and a series of the edible crustacea of San Francisco, from Prof. R. E. C. Stearns.

XIII. *Department of Invertebrate Fossils.*

This department is now divided into two sections, Dr. C. A. White, honorary curator of the department, retaining charge of all except the palæozoic fossils, which are in the hands of Mr. C. D. Walcott, honorary curator of that department. Both Dr. White and Mr. Walcott are officers of the U. S. Geological Survey, and are devoting themselves almost exclusively to the re-arrangement of these collections for purposes of study and preparation of reports. The two laboratories attached to these departments have been fitted up as thoroughly as possible, and a considerable portion of the specimens are arranged therein. The accessions have been of great magnitude, and include the extensive gatherings of the various exploring parties of the Geological Survey.

DIVISION OF BOTANY.

XIV. *Department of recent Plants.*

The collections of recent plants, for many years in the custody of Dr. John Torrey, of New York, and afterwards deposited in the Department of Agriculture, have been kept in excellent condition by Dr. Vasey, curator of the department. The Museum has recently received a very extensive accession of European, Asiatic, and African plants, composing the herbarium of the late George Joad, esq., of London, the gift of the Royal Botanic Gardens at Kew, through Dr. Asa Gray. This collection is still in the custody of Dr. Gray, who has kindly assumed the direction of the work of mounting and labeling. Cases have been prepared for its reception in the laboratory of the curator of materia medica. The exhibit of living aquatic plants, under charge of Dr. Rudolph Hessel, superintendent of the Government carp ponds, is assuming considerable importance.

XV. *Department of Fossil Plants.*

This department is administered by Prof. Lester F. Ward, honorary curator, who, like the curators of fossil invertebrates, is an officer of the Geological Survey. Additional space has been assigned to the laboratory and a large number of storage cases supplied. With the assistance of Ensigns E. E. Hayden and C. C. Marsh, U. S. N., the curator has accomplished much in reducing the Museum specimens to systematic order. Extensive additions have been made during the summer through the explorations of Professor Ward in the West.

DIVISION OF GEOLOGY.

XVI. *Department of Mineralogy.*

Since the death of Dr. George W. Hawes, curator of this department, Mr. W. S. Yeates, aid in the Museum, has had charge of the mineral collections, and has nearly completed the task of rearranging and classifying the material. Prof. F. W. Clarke, chemist of the U. S. Geological Survey, was appointed honorary curator on December 3. An exhibition floor space of 2,000 square feet has been assigned, and show-cases are in process of construction. Mr. Joseph Willcox, of Philadelphia, has deposited his cabinet of North American minerals, and has placed 1,000 of the choicest specimens on exhibition. A considerable number of acquisitions have been made during the year. The Abert collection of minerals, for a long time the property of the Museum, has been unpacked and proves to be of great value. During the year, Ensigns H. S. Knapp and O. G. Dodge, U. S. N., were appointed, and Ensign Wilkinson, U. S. N., re-assigned, to this department.

XVII. *Department of Lithology and Physical Geology.*

The collection of building stones, under the charge of Mr. George P. Merrill, assistant, acting as curator, presents each month a more imposing appearance in the exhibition gallery. The space assigned to it has been considerably increased during the year. Owing to the expense of preparing the specimens, little has been done towards getting ready for exhibition the great hoard of material which lies at present unutilized in the southwest court. The curator of this department has recently undertaken the development of the collections in physical geology, but has not yet had opportunity to seriously begin work. The laboratory has been supplied with some important pieces of apparatus during the year, notably a machine for sawing rocks, made by E. T. Jenks, of Middleborough, Mass. The saw-blade is simply a thin plate of soft iron, which swings back and forth across the stone and is fed with wet emery or sand. Besides this, has been furnished a small diamond circular saw for cutting thin sections of rock. This was made by Kerr, of Providence, R. I., and set up by Mr. Jenks. Ensign J. H. Fillmore, U. S. N., is now attached to this department.

XVIII. *Department of Metallurgy and Economic Geology.*

Mr. Frederick P. Dewey has been appointed full curator in this department. Until within a few weeks nothing had been done towards developing the exhibition series, the time of the curator and his assistant having been devoted to overhauling and cataloguing a portion of the great mass of unassorted metallurgical material acquired by the museum at the close of the Philadelphia Exhibition. There is still an immense quantity of ores and metallurgical products stored away in the original packing boxes within the Museum building, and also in a temporary shed attached to the Armory building. This latter was obtained by Mr. Thomas Donaldson at the close of the so-called "permanent exhibition" on the Centennial grounds in Philadelphia. Work in this department, as in that of minerals and lithology, has been very much trammeled by the fact that until very recently there have been no full curators in the division of geology. This deficiency having now been supplied, the work in these three departments is rapidly progressing, and during 1884 the inorganic collections will undoubtedly begin to assume the importance which they deserve on account of the wealth of the material already in the possession of the Museum.

DIVISION OF EXPLORATION AND EXPERIMENT.

XIX. *Department of Exploration and Field work.*

Very much has been accomplished in this department; not, however, by the direct efforts of the Museum, whose appropriations cannot be applied to this purpose, but through the efforts of the Smithsonian Institution and its Bureau of Ethnology, the Fish Commission, the Geological Survey, and also through the valuable assistance of the U. S. Signal Service and the U. S. Navy. Mr. Pierre L. Jouy, of the Museum staff, has been for some years in China and Japan, and recently, at the expense of the Institution, has been attached to the embassy in Corea, where he is making mineralogical and ethnological collections in the vicinity of Seôul. Ensign J. B. Bernadou, U. S. N., having volunteered his services in that country, was detailed by the Navy Department for two years' work in studying the mineralogy and ethnology of this new land.

XX. *Department of Chemistry.*

The work of the chemical laboratory has been carried on in the usual manner, and considerable additions have been made to the fittings of the laboratory. Mr. Frederick W. Taylor, chemist, has on account of illness received five months' leave of absence, and has gone to Colorado.

Prof. F. W. Clarke, as an officer of the Museum, has, with his assistant in the Geological Survey, Dr. T. M. Chatard, been allowed the use of the chemical laboratory for the investigations connected with his official position. Dr. Jerome H. Kidder, U. S. N., of the Fish Commission, has been allowed the use of the upper laboratory during the reconstruction of the Smithsonian building.

XXI, XXII. *Departments of Experimental Physiology and Vivaria.*

No changes have been made in these departments, their conditions being much the same as described in the report for 1882.

SECTION OF MATERIA MEDICA, DEPARTMENT OF ARTS AND INDUSTRIES.

J. M. FLINT, Curator.

In the establishment of a Museum designed to illustrate man and his environment it is proper that the materials and methods used for the prevention and cure of disease should have a place. Medicine, like food, clothing, and habitation, has a direct and important relation to the welfare, progress, and longevity of man, and the remedial measures in use by a people may be as indicative of the degree of their intellectual development as is the nature of their food, or the character of their dwellings, or their social and religious customs. A collection of medicinal substances, of medical, surgical, and pharmaceutical instruments and appliances, may not only be instructive to the specialist, physician, pharmacist, or anthropologist, but ought also to possess a general interest for the public, since none may escape the occasion for their use.

So much in brief explanation of the presence of a materia medica exhibit in the U. S. National Museum.

In the comprehensive scheme of Museum classification which has been devised, a place for such a collection has been provided in the *Division:* "Ultimate Products and their Utilization." *Class:* "Medicine, Surgery, Pharmacology, Hygiene," &c.

For the objects belonging to this *class* the general term "materia medica" has been adopted, extending the common definition to include everything, medical or surgical, used in the treatment of disease.

In determining upon a classification for this department of the Museum it was necessary to consider the subject from various points of view. 1. The historical, as relating to the origin and progress—the evolution of medical and surgical science and art. 2. The ethnographical, regarding the medicines and methods peculiar to different races and nations. 3. The therapeutical, which considers drugs in relation to their effects on the animal economy. 4. The physical, having regard to the sources, physical characters, and natural relations of the specimens.

The first method is obviously not adapted for a general classification of a large collection, but should always be kept in view and may be emphasized, particularly in the development of the section of surgical instruments and appliances. The second may be carried out in part, as in separate exhibits of Chinese and Corean medicines and the medicines of the North American Indians. The third, though perhaps the most instructive method to the student, presents insurmountable difficulties in the way of accomplishment. The physiological action of a drug may so vary with the dose as to make its assignment to a class purely arbitrary, and the very classification would give a wrong impression as to its properties. Moreover, the investigation of many drugs has been so limited as to leave their therapeutical qualities in great doubt, so while the medical properties, as far as known, should be briefly stated on the label for each specimen, yet, they cannot properly be used as a basis of classification.

There remain, then, only the physical relations of drugs to be considered, and of these the natural sources from which derived furnish the most readily available, and the most comprehensive ground for a classification.

In view of these considerations the following has been adopted:

Classification and Arrangement of the Materia Medica Collection.

I. Organic materia medica: (1) Animal products; (2) vegetable products; (3) products of fermentation and distillation.

II. Inorganic materia medica.

1. The animal products are arranged according to the zoological position of the animal from which the drug is derived, following the usual classification, and beginning with the *class* Mammalia, *order* Carnivora.

2. Vegetable products are classified to the botanical affinities of the plant furnishing the drug, and the authority followed is that of Bentham and Hooker's "Genera Plantarum" for the Phænogamous plants, and Luerssen's "Medicinisch Pharmaceutische Botanik" for the Cryptogams.

3. Products of fermentation and distillation include the products of the acetous and vinous fermentations, and the derivatives, chloroform, ether, &c., as well as distillates, such as carbolic acid, pyroligneous acid, &c. This division is not subdivided.

4. Inorganic products are arranged according to their fundamental elementary constituents, following the classification of the chemical elements given in Roscoe and Schorlemmer's "Treatise on Chemistry."

In each of the four divisions, under each natural order or elementary title, are brought together the drugs of that order, and each drug is represented in its various natural and commercial varieties and its important preparations.

The collection as actually presented for study begins with a series designed to illustrate the forms in which medicinal substances appear in commerce or are prepared for administration by the pharmacist. In this series the effort has been made to present representative specimens of each class; and what is considered to be of greater importance to attach thereto labels giving concise and accurate definitions of the classes.

Following this exhibit of medicinal forms is arranged the general collection according to the classification given above, beginning with animal products in their zoological order, succeeded by vegetable products in botanical order, &c. The succession of specimens is from left to right and top to bottom of each section of the exhibition cases in which the collection is presented. Each order and its limits are indicated by symbol and name on the case.

Succeeding the general collection is an exhibit of some of the most popular mineral waters. Each of these is shown in the quantity of 10 liters and with it each of its saline constituents, in the exact weight which analysis has shown to be present in that volume of the water; thus representing to the eye the quantity of each constituent salt ingested with a given quantity of water, and furnishing a quantitative table, without the use of figures, for comparison of the different mineral waters.

Finally is presented, as a distinct exhibit, a considerable collection of Chinese drugs, which were gathered by the Chinese Imperial Customs Commission for the Centennial Exhibition at Philadelphia in the year 1876, and subsequently presented to the United States Government.

The whole number of specimens, including the Chinese collection, registered in the books of this department of the Museum, up to December 31, 1883, is 4,037. Of these, after rejection of duplicates and unidentified and injured drugs, there have been classified and placed on exhibition 3,240.

The sources from which they have been obtained are, (1) contributions from large commercial houses engaged in the wholesale drug trade, notably the firm of W. H. Schieffelin & Co., New York, and generously, but less lavishly, Park, Davis & Co., of Detroit; McKesson & Robbins, of New York; and Wallace Brothers, of Statesville, N. C.; (2) exchanges with foreign museums, as the Kurrachee, India, the museum of the Pharmaceutical Society, London, and the Royal Gardens of Kew and Calcutta; (3) collections of cinchona barks, made under direction of the English Government from the plantations in India; (4) remains of the drug exhibit of several countries, at the Centennial Exhibition at Philadelphia in 1876, which were presented to the United States by the authorities of those countries.

As a whole the collection already represents the principal drugs in most of their commercial varieties in present use among the civilized people of the world, including most of the new remedies that have been lately introduced to the notice of the profession.

An alphabetical index to the collection has been prepared and printed, giving the details of the classification and the position therein of every specimen on exhibition.

The collection of cinchona barks is especially complete, comprising specimens of nearly all the natural barks of South America, and every variety of the cultivated product from the Government plantations of India, with many from Java, Ceylon, Mexico, and Jamaica.

The India and Jamaica barks are accompanied by herbarium specimens of the leaf and flower, and in some cases the fruit, of each variety of cinchona tree from which the bark is taken.

For the proper preservation and exhibition of the whole collection great care has been taken. Every specimen is inclosed in a clear glass bottle or jar, furnished with a well-fitted glass stopper. The bottles have been made of uniform shapes and sizes according to the standard established for the Museum. Care has been exercised that every specimen should be thoroughly dry before being inclosed, and, if liable to attacks of insects, has been enveloped in an atmosphere of chloroform by introducing into the bottle a small slip of blotting-paper wetted with the insecticide. The cases in which the collection is exhibited are of Mexican mahogany, 7 feet high and 8½ feet long, with plate-glass doors, the door-frames being rabbeted so as to make the cases practically dust-proof. The cases contain each four shelves, the lowest 18 inches, and the highest 5 feet, from the floor, thus bringing every specimen within easy range of vision. Each bottle stands upon a wooden pedestal 4 inches square and 1 inch high, and to this pedestal is attached the label.

Without doubt the most important duty connected with the installation of the collection is the preparation of the labels. Monotonous rows of bottles bearing only the name of the drug inclosed would furnish little interest and less of information to the general visitor. Indeed, the exhibition of many articles which present no physical peculiarities discernible by the naked eye, is only to be justified by the fact that the specimen calls attention to and gives support for a label which interprets it.

In the preparation of these labels more difficulty has been encountered than was expected, chiefly in making choice from the mass of information at hand of those facts most important to be presented, that could be concentrated into the few lines of type to which the label must be restricted, at the same time keeping in mind the popular as well as scientific use of the collection. Such physical characters as are presented to the eye by the specimen itself have been in all cases omitted, and such facts selected, relating to source, habitat, mode of production, constituents, medical properties, &c., as seemed to the writer to be of greatest public as well as professional interest. Two kinds of labels are used: (1.) Generic labels, applicable to series of specimens comprising natural and commercial varieties, and preparations of given drugs. These are not strictly limited as to size, are printed in large type, and contain general information relating to the substance in question. (2.) Specific labels. These are attached to every specimen, are limited in size to 4 inches by 1½ inches, are printed in ordinary clear type, and contain the name and synonyms, source, medical properties, dose, and other facts that can be considered within the given limits.

The number of specimens already furnished with printed labels is 575; copy for 530 labels is ready for the printer.

Arrangements have been made, or are in progress, by which the natural sources of the drugs of commerce may be very fully illustrated. Models or stuffed specimens of the animals furnishing substances used in medicine may be found in the different sections of the zoological department of the Museum; the chemical elements, ores, &c., in the chemical and mineralogical departments. For the plants furnishing the vegetable medicinal products a large series of colored plates and photographs have been obtained. Upwards of 1,000 medicinal plants can thus be illustrated by colored lithographs taken from works on medical botany and by photographs now in the possession of this section of the Museum. More than half of these are already mounted in swinging frames where they are easily accessible to all visiting the Museum. The nucleus of an herbarium has already been formed and arrangements are complete for its rapid development so soon as the necessary dispositions have been made for its care and exhibition.

Early in the organization of this section of the Museum effort was made to obtain the latest editions of the Pharmacopœias of all nations, in order that from them a list might be compiled of the drugs in principal use among the civilized people of the world. Nearly all the latest Pharmacopœias have been obtained, and, besides furnishing mere lists of medicines, they have supplied much interesting material for study and comparison. Some of the results of this comparative study have been presented in a report to the Surgeon-General of the Navy.* The work of comparison has been carried much further, and the attempt is being made to prepare a compend which shall contain a full official synonomy of each of the drugs mentioned in any of these Pharmacopœias and tables giving composition and strength of every preparation. More than half of this compilation has already been made, but being considered of secondary importance to the work of the collection proper progress upon it has been irregular and slow.

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*Report of the Surgeon-General of the Navy for the year 1881, p. 600, "Report on the Pharmacopœias of all Nations."

To summarize what has been accomplished, it may be said that the organization of the materia medica section of the Museum is complete; the classification has been established in its details; over 4,000 specimens have been received, examined, and registered, and most of them bottled and arranged according to the classification; the whole collection has been provided with temporary labels, and 575 specimens with permanent labels, each requiring a study of the specimens and of the literature regarding it; illustrations of most of the medical plants have been obtained and more than 500 of them mounted and on exhibition; a medical herbarium has been commenced and its development assured; a complete catalogue of this collection has been made by means of which any specimen on exhibition may be readily found, and a considerable library of references has been formed; the Pharmacopœias of nearly all nations have been obtained, and half the work of compiling a compend of sixteen of them is done.

In the future development of this section of the Museum a wide field is clearly open for interesting and valuable work. The collection as it now stands includes samples of the great majority of the drugs found in the commerce of the country, as well as many specimens of rare drugs or varieties known only to foreign medical practice. It remains now to make use of the prestige of the scientific institution with which the Museum is connected, and of the ready means at the disposal of the National Government, through its naval and consular services, supplemented by personal correspondence with importers and their agents, and foreign scientists and travelers, to gather materials and information which shall be rare and valuable. There is still much to be learned regarding the source and mode of production of many of our standard drugs, and new remedies of doubtful origin are constantly appearing in the market. For the increase of our knowledge of these substances, for the investigation of these questions of doubt, no more favorable conditions can be conceived than those here existing, namely, a great Museum under the patronage of the nation, associated with a scientific institution of world-wide renown, having correspondence with all parts of the world, and friendly relations with scientific establishments in all countries.

SECTIONS OF FOODS AND TEXTILE INDUSTRIES, DEPARTMENT OF ARTS AND INDUSTRIES.

ROMYN HITCHCOCK, Curator.

Owing to the short time I have been connected with the Museum, it is not possible to know precisely what donations have been received during the year, since they are recorded in different catalogues, the special catalogues of the section having been opened in November. So far as I am able to learn however there have been no donations to the textile collection of special importance during the year, unless some valuable specimens promised by certain parties in London have been received by Mr. Earll, and are on the way with the other collections.

In the collection of foods, I am likewise at a loss to know just what has been received during the year. Since November however I have a perfect record of all that has come in, and among other donations one fine set of specimens in duplicate, illustrative of the manufacture of cocoa and chocolate, is worthy of especial mention. This set was received from Messrs. Cadbury Brothers, of Brownville, near Birmingham, England. There are 18 different specimens, embracing cocoa pods, cocoa beans from seven different localities, and specimens showing the various stages of the manufacture of cocoas and chocolates. Labels for this collection have been written, and are ready to be printed.

Messrs. Burgoyne, Burbidges & Co., wholesale druggists of London, have also presented 6 specimens of pure vegetable colors used in confectionery.

Mr. Charles R. Orcutt has presented 3 specimens of Indian foods from California, among which is a fine cake of "mesquite" meal.

A number of specimens of articles of food used in England have been added to the collection by purchase.

The work of arranging the food collections has been done mainly by Mr. Towne, who has been almost steadily engaged upon the collection of Indian foods for some time past. This part of the work should be completed in a short time, when it will be possible to label and classify the specimens.

My own work in installation has been mostly confined to the textiles, and particularly directed to exhibiting the different varieties of fibers.

It is proposed to separate all the textile material, as the work of arrangement progresses, into three parts: (1) For exhibition, (2) for study series, and (3) for exchanges. This plan has been carried out thus far; but no attempt has yet been made at a systematic classification of the specimens in either series, for the reason that not a sufficient number of specimens is yet in the cases to make it either practicable or useful.

There are on exhibition in the collection of fibers and textiles 318 specimens (including 72 specimens of cotton), and 37 specimens of furs. In addition to these there are a number of old forms of spinning and weaving machinery placed on top of the cases and on the floor, awaiting cases which are to be made for them.

It is impossible to state the number of specimens now in the collection which will be placed in the series for study or among the duplicates. All of the material would require to be looked over and classified, which would require weeks of labor to do in a proper manner before the number could be even approximately known.

In the collection of foods there are, by actual count, 742 specimens in the cases. Besides these there are 270 specimens of seeds, barks, and other unclassified material, 74 paints and pigments used by the Indians, and 158 specimens of oils, making a total of 1,244. It is probable that this number will be materially reduced when the collections are properly arranged and duplicates or imperfectly known materials are taken out.

Among the duplicates there are 14 different specimens of foods from Siam, in most cases 5 or 6 specimens of each kind, now ready to be exchanged, 27 of Chinese foods, 33 Indian foods, and 10 miscellaneous samples.

There are also 106 specimens of different oils in the duplicate series, of which there are, in many instances, several duplicates.

To conduct the work of this section in a creditable manner, a certain number of books of reference are absolutely required. The only work that can be done without books is preparing specimens for exhibition, and even this, without a system of classification, is only practicable to a limited extent.

The food collections will be arranged upon the scheme worked out by yourself. The system for textiles requires much further study. The routine work of preparing the specimens now in the Museum demands from the acting Curator an expenditure of time which might be used to much better advantage for the Museum, if an assistant or preparator were appointed to work in the textiles division. It would then be possible to devote more time to study, and to the perfection of the classification, the preparation of labels, and to what is, in fact, the most important part of the Curator's duties.

The exhibition of a series of food stuffs becomes of value only when the specimens are named and explained. The same may be said of every other set of specimens, but to write labels requires more knowledge than any person can acquire without access to books of reference. In the textile division, however, a kind of knowledge is required which cannot be acquired from books alone. It would be a great advantage to the section if the acting curator could spend a short time visiting some of the large spinning and weaving establishments to become practically familiar with the processes.

Although it is very desirable that the microscope should be brought into use in the study and identification of the fibers and fabrics, foods and adulterants, the opportunities for such examinations are extremely limited at present. They are certainly important, and the credit of the Museum demands that its officers should be competent to treat any question of importance that is presented intelligently, and with adequate knowledge of the work and methods of others. To do this requires much study and experimenting. At present the acting Curator in this section is uncertain whether it would be better to devote his time principally to study and investigation, or to the display of specimens without order or reason. In the one case the benefits would be seen in the future, in the other the activity of the section would be seen now. The appointment of an assistant, as suggested, would solve the difficulty in the most satisfactory way by permitting the work of installation to go on steadily while the other work is progressing.

There is one part of the work of this section that has not received any attention as yet, but which can doubtless be begun early in the year, as soon as the material now being worked up in the food collection is out of the way. This is the arranging of series illustrative of the process of nutrition, showing the relative value of foods, drinks, etc.; and various other illustrative collections which have already been mentioned in a previous communication.

It is also desirable that specimens showing the process of spinning and weaving should be obtained for the textiles division, and these can doubtless be readily obtained by a personal visit to the mills.

It is with no little diffidence that the needs of this section are set forth thus at length, knowing the personal interest you have manifested in its progress and development, and your willingness to advance its interests by every possible means. Nevertheless, since you have asked for "recommendations and remarks," it has seemed a proper occasion to indicate what the experience of two months has clearly shown to be essential needs for the proper conduct of the work of the section.

DEPARTMENT OF ANTIQUITIES.

CHARLES RAU, Curator.

The classifying and preparing for exhibition of the collections received has been continued in accordance with the plan indicated in my annual report for 1882. The general collection of typical objects in the Museum is now so large, that more space can be given to special collections, and when enough specimens have been received from one locality to fill one or more trays, they are separately exhibited.

Character of routine work.

The following is a list of special collections which have been placed on exhibition during the year:

Where from.	By whom sent.	Where from.	By whom sent.
Wisconsin	J. E. Gere.	Arkansas	J. E. Adcox.
New York	Ira Van Ness.	Florida	G. B. Frazar.
Alabama	C. L. Herrick.	Illinois	E. C. Brown.
Kentucky	W. T. Knott.	Pennsylvania	W. C. Brown.
Ohio	J. S. Robinson.	Do	F. G. Galbraith.
Indiana	A. C. Black.	Ohio	Dr. A. M. H. DeHaas.
Louisiana	J. M. Roberts.	Massachusetts	U. S. Fish Commission; W. Nye, jr.
Illinois	Brainerd Mitchell.		
Tennessee	C. S. Grigsby.	Ometepec Island, Lake Nicaragua	C. C. Nutting.
Virginia	Dr. E. R. Reynolds.	India	J. H. Rivett-Carnac.
North Carolina	J. A. D. Stephenson.		
Alabama	Frank Burns.		

A series of North American stone and bone weapons and implements in their original shafts and handles has been carefully arranged for permanent exhibition. Visitors frequently make inquiries concerning the hafting of stone implements, and this series has been brought together for the purpose of illustration.

A collection of 116 North American stone relics was made to be sent to the Museum at Havre, France, in exchange for flint objects received from that Museum.

A collection of North American relics and casts, embracing 358 objects, was made for the American Antiquarian Society, Worcester, Mass. This collection is given in exchange for the well-known "Kentucky mummy."

One thousand three hundred and twenty-nine specimens of stone implements, &c., collected under the auspices of the Bureau of Ethnology during the fiscal year ending June 30, 1883, were transferred from the new Museum to the Smithsonian building. They have been placed temporarily under table-cases, but will be assorted and exhibited early this year.

Four boxes containing Californian specimens collected during the Wheeler survey were received in this department, but could not be opened for want of time.

Researches prosecuted upon material belonging to the Department.

The composition of my work on prehistoric fishing necessitated a careful study of all articles bearing on fishing. Dr. J. F. Bransford, U. S. N., was occupied during a part of the year in writing an account of his latest explorations in Central America, and describing the specimens there collected. Mr. W. H. Holmes, of the Bureau of Ethnology, has, for literary purposes, examined the shell objects and ceramic specimens in this department.

I have devoted all my time not spent in routine work to my publication on fishing, and have therefore not composed smaller articles, excepting one on "Indian Stone Graves," which appeared in the American Naturalist for February, 1883, pp. 130–134.

Present state of the collection.

NUMBER OF SPECIMENS.

1. In reserve series	8,043
2. On exhibition	24,731
3. Duplicates	7,717
4. Total	40,491

ACCESSIONS DURING THE YEAR 1883.

1. Exhibition	3,514
2. Reserve or study series	655
3. Duplicates	1,170
4. Total	5,339

Important additions during 1883.

R. E. C. Stearns, Berkeley, Alameda County, California.—Collection of pestles, mortars, and baking-stones from Yuba, Nevada, Placer, and Alameda Counties, California.

James Harrington, City of Mexico.—Three stone sculptures, one (monkey-shaped) from Tamiahua, and the others (human figures) from Tampico, Mexico. Very fine specimens, and a valuable addition to the collection of Mexican antiquities.

J. H. Rivett-Carnac, Allahabad, India.—Collection of nuclei and flakes of flint and chalcedony, and chipped and polished celts, from the Banda district, Northwest Provinces of India. Two of the celts were sent through Dr. E. Meyer, Wilkesbarre, Pa.

Albert I. Phelps, Damariscotta, Lincoln County, Maine.—Collection of flint flakes, rude implements, arrow-heads, bone implements, fragments of pottery, &c., from shell-heaps in Lincoln County.

U. S. Fish Commission, assisted by Willard Nye, jr.—Collection of rude implements, cutting tools, perforators, scrapers, arrow-heads, sinkers, bone implements, fragments of pottery, &c., from Menemsha Pond and Roaring Brook, Martha's Vineyard, and from Nonamesset Island, and Wood's Holl, Massachusetts. This collection is of special interest, as it shows the stages in the manufacture of stone implements in those localities.

J. E. Gere, Riceville, Washington County, Wisconsin.—Collection from the vicinity of Riceville: Rude and leaf-shaped implements, cutting tools, scrapers, arrow- and spear-heads, grooved axes, and a copper spear-head or knife. In this collection are some fine types of arrow and spear-heads, and the grooved axes exhibit unusual forms. The copper spear-head (or knife) is a valuable addition to the series of objects of that metal thus far acquired.

August Shmedtie, Washington, D. C.—A stone sinker (notched), from a cave near Santo Domingo, Isthmus of Tehuantepec, Mexico.

Dr. D. S. Kellogg, Plattsburg, Clinton County, New York.—Collection of rude scrapers, leaf-shaped implements, arrow-heads, fragments of pottery, and of bones of birds and quadrupeds, from old refuse-heaps at Plattsburg. The implements and pottery show nearly the same degree of skill in workmanship as those from the shell-heaps on the northern Atlantic coast. The animal bones have been identified as belonging to the deer (*Cervus virginianus*), and to some carnivore, probably the bear (*Ursus americanus*).

C. L. Herrick, Minneapolis, Minn.—Collection of hammer-stones, chips, and flakes of flint, chipped celts, arrow and spear-heads, shells and fragments of pottery, from a shell-heap on the Tennessee River, near Decatur, Ala.

C. S. Grigsby, Fayetteville, Lincoln County, Tennessee.—The collections sent at different times during the past year comprise: Rude and leaf-shaped implements, scrapers, cutting-tools, perforators, arrow and spear-heads, hammer-stones, pitted stones, chipped and polished celts, grooved axes, discoidal stones, gaming discs (?), a pierced ceremonial weapon, and pierced tablets, all from the vicinity of Fayetteville. Representative specimens of each class of objects have been placed on exhibition. Worthy of special mention are a leaf-shaped implement, partially "glazed," a fragment of a large flint implement, showing patina of considerable depth, and some perforators, spear-heads, and a discoidal stone of very fine workmanship.

J. M. Roberts, Clinton, East Feliciana Parish, Louisiana.—Collection from the vicinity of Clinton: Perforators, cutting tools, arrow and spear-heads, a hammer-stone (?), a small paint-mortar of remarkable form, a pestle, a small boat-shaped article, a large bead of compact quartzite, a pebble showing a slight cavity, and a fragment of a polished celt. Altogether a good collection.

Dr. H. C. Yarrow, Washington, D. C.—A clay vessel with handles, from a child's grave in Caldwell County, North Carolina. The grave was half filled with ashes intermixed with hair and teeth. On top of the vessel lay a round cover of native copper.

W. T. Knott, Lebanon, Marion County, Kentucky.—Collection of copper articles from a mound in Marion County: a celt, a breast-plate (?), 4 spool-shaped objects, and 2 concavo-convex discs. There were also found pieces of galena, one of which was sent by Mr. Knott.

James S. Robinson, M. C., Kenton, Hardin County, Ohio.—Collection of copper and stone implements and ornaments from a mound in Hardin County: 2 copper celts, a breast-plate (?), in 3 pieces, a fluted ornament with silver plating, and a crescent-shaped ornament, a thin sheet of silver, 9 sheets of mica, a flint scraper, an arrow-head, and a pierced tablet. The mound is situated on a slight rise of ground, about 10 rods south of the Scioto River, in Lynn Township, Hardin County, and on lands owned by Lester T. Hunt and General James S. Robinson. It is about 30 feet in diameter and 4 feet high, and was overgrown by large forest trees of white ash, beech, and oak. The mound has not been fully explored, but is believed to contain the remains of at least three persons. A quantity of charred corn was found near the place where the relics were taken out.

Alexander C. Black, Surgeon-General's Office, Washington, D. C.—Collection from Randolph County, Indiana: Flakes, scrapers, cutting-tools, leaf-shaped implements, arrow- and spear-heads, polished celts, notched and grooved axes, mauls, pestles, one ceremonial weapon, partly drilled, and two pierced tablets. The character of this collection, which consists of surface finds, is above the average, care having been taken to preserve the specimens in the condition in which they were found.

W. Emmet Gatewood, Stockport, Morgan County, Ohio.—A large stone mortar with funnel-shaped cavity, taken from the foundation wall of a building at Stockport; originally from an Indian camp.

Tennessee Historical Society, Nashville, Tenn.—A cast of an image of potstone, found in Bartow County, Georgia, and described by Col. Charles C. Jones in his work entitled "Antiquities of the Southern Indians," p. 432, &c.; a cast of a stone image representing a woman, locality where found not yet known; a cast of a smoothing tool with handle. The original made of clay, was dug up in North Nashville, in 1866, by James Wyatt, superintendent of water-works. The originals were loaned, with other relics, by the above-named society, and the casts made in the National Museum.

Peabody Museum, Cambridge, Mass.; through Prof. F. W. Putnam.—A cast of a fish carved from slate; original found near Ipswich, Mass.

F. G. Galbraith, Bainbridge, Lancaster County, Pennsylvania.—Collection of relics found on the surface near Bainbridge: Flakes of porphyry, jasper, quartzite, and slate, trimmed flakes, rude and leaf-shaped implements, arrow and spear-heads, chipped celts with ground cutting edges, a chisel (small), grooved axes, large unfinished maul, a grinding-stone, notched sinkers, fragments potstone, clay vessels and sherds, and a paint-stone. Collection from Red Hill Cave, near Bainbridge: Fragments of animal bones and teeth, a rude stone implement, arrow and spear-heads, fragments of pottery, and a shell ornament. Collection from Haldeman's shell-heap, 2 miles south of Bainbridge: Jaws, bones, and teeth of animals, fragments of a human skull, fragments of quartz and other stone, fragments of pottery and of shells. Collection from Northumberland, Lancaster, Perry, and York Counties: 28 grooved axes, 6 polished celts, a cutter (chipped), a pestle, a mortar, a moccasin-last, a cup-stone with cavities on both sides, 3 unfinished ceremonial weapons, 4 small stone sculptures, a stone ball, and a hematite paint-stone. A number of the axes show the oblique groove often characterizing Pennsylvanian specimens of this kind. The moccasin-last is a remarkable specimen—a natural formation modified by pecking.

S. T. Walker, Milton, Santa Rosa County, Florida.—Two arrow-heads, 2 fossil oysters, and 3 fragments of fossil bones from a clay bluff at the head of Tampa Bay, Fla.

W. W. Evans, New Rochelle, Westchester County, New York.—Collection of Peruvian relics: a bronze mace-head (star-shaped), a bronze spoon with ornamented handle, 4 bronze figures (human), a small group of 3 figures (human), one of bronze and two of gold, and 2 silver figures (human). In addition, a small terra-cotta head from the Isthmus of Tehuantepec, Mexico.

Eugene A. Smith, Tuscaloosa, Ala.—Casts of an animal-shaped pipe and an engraved stone plate, from Hale County, and of a scraper-like implement, from Tuscaloosa County, Alabama. The originals, on exhibition at the University of Alabama, were loaned, with other specimens, through the agency of Mr. Smith, and the casts made in the National Museum. The material of the pipe is pale-gray limestone, and that of the engraved plate, gray sandstone with particles of mica. The scraper-like implement is also composed of gray sandstone with mica.

Frank Burns, Blountville, Blount County, Alabama.—Collections received during the past year: A large stone mortar, found 50 years ago in a creek, 5 miles from Blount's Springs, Blount County, Alabama. Collection from Blount and Winston Counties, Alabama: Arrow and spear-heads, celts, grooved axes, hammer-stones, discoidal stones, a paint-mortar, paint-stones, a hematite sinker, fragments of potstone vessels, and of pottery, a silver ornament (perhaps Spanish), and human and animal bones. Collection (surface-finds) from Blount and Colbert Counties, Alabama: Leaf-shaped implements, perforators, arrow and spear-heads, hammer-stones, chipped and polished celts, pestles, a stone bead, a bone implement, fragments of potstone vessels and of pottery. Collection from Colbert, Lauderdale, Saint Clair, and Blount Counties, Alabama: Rude and leaf-shaped implements, trimmed flakes, cutting tools; arrow and spear-heads, a muller, 2 boat-shaped objects, 2 polished celts, and 2 large stone mortars; a handled clay vessel, from a mound on the banks of the Tennessee River, near Florence, Lauderdale County, and fragments of large wooden troughs, from a cave in Blount County, locally known as the Crump Cave. Concerning this cave, I copy the following statements from a communication by Mr. Burns: "When the cave was first discovered (in 1840) there were 8 or 10 of these troughs, but now they are all more or less split or injured, except this one. It is about 7½ feet long, 10 or 20 inches wide, and 6 or 7 inches deep. It has been hollowed out by the use of fire, and stone or copper chisels, one of the latter having been found with the troughs when the cave was first examined. There were also found 12 or 15 skulls and a large number of other bones; 6 small wooden bowls, tolerably well polished, 5 or 6 wooden trays, somewhat like a modern bread-tray, but very rough and unpolished; a small copper hatchet, a copper chisel 5 inches long, 20 copper ornaments, 6 or 7 large shells, some of which are said to hold a gallon of water; some shell discs or beads, and pieces of bark or cane-matting, 6 inches square, but very much decayed. Scattered among the bones were about 200 pounds of very fine lead ore. The troughs did not contain any bones, but some of the lead ore was in one of them. The ornaments mentioned were of native copper and perhaps beaten out with stone hammers, as the workmanship was very rude. The chisel and one of the ornaments are now at the residence of the late Rev. William Crump, in this county."

William Pengelly, Torquay, England.—Collection of bones, teeth, &c., from Kent's Cavern, near Torquay; 23 finds from the cave-earth or hyenine deposit, and 7 from the breccia or ursine deposit, the oldest in the cavern; in all, 1,270 specimens. It is to be regretted that Mr. Pengelly has sent the bones undetermined. They were for the present placed on exhibition according to the layers in which they occurred.

L. Belding, Stockton, San Joaquin County, California.—Collection from the neighborheod of La Paz, Lower California: Arrow and spear-heads (some very fine), and a human skull and 10 bones. I take from the letter of Mr. Belding the following: "The skull and bones (which are probably those of the ancient Pericúes) were dug out of coarse, dry, granite sand in a cave, or overhanging rock, at a rancho called Zorillo, 20 miles north of Cape Saint Lucas. They were neatly wrapped in cloth made from the fibre of the agave—three-ply cord, made as sailors plait sennit."

H. F. Emeric, Guaymas, State of Sonora, Mexico.—Two celt-shaped implements, 2 shuttle-shaped objects, an ornamented reel (?), carved from slate, and an amulet of alabaster (animal-shaped), found 6½ feet under loose rock and on the original surface. The Indians here do not know anything concerning the relics, and there are no signs of a mound where they were found.

Rev. Samuel Lockwood, Freehold, Monmouth County, New Jersey.—A cast of a human head carved in stone. The original, found within a mile of the shore of Raritan Bay, Monmouth County, N. J., was loaned by Mr. Lockwood for the purpose of making a cast at the National Museum. For a detailed account see "American Naturalist," October 1882, p. 799.

A. Fairhurst, Lexington, Ky.—Collection from Knox County, Indiana, and from Clark and Bourbon Counties, Kentucky: Arrow and spear-heads, hammer-stones, polished celts, grooved axes, a pierced tablet, and a ceremonial weapon. Mostly very good specimens.

John E. Younglove, Bowling Green, Warren County, Kentucky.—Collection from the vicinity of Bowling Green: Leaf-shaped implements, a cutting tool, a notched scraper, a perforator, arrow and spear-heads, and small pierced shell discs.

Robert Ridgway, U. S. National Museum.—Small collection from Wheatland, Knox County, Indiana: Flakes, rude and leaf-shaped implements, arrow-heads, a spear-head, and fragments of pottery. The spear-head mentioned is of exquisite workmanship, being strongly barbed and having very thin edges; length, 4 inches.

S. W. Greer, Eddyville, Lyon County, Kentucky.—Collection from different localities in Kentucky and Tennessee: Large flint implements, chipped celts and chisels with polished cutting edges, cutting tools, scrapers, perforators, arrow and spear-heads, hammer-stones, sinkers, discoidal stones (a very fine specimen from a mound in Tennessee), mullers, gaming discs, stone beads, paint-stones, a small stone carving (human face), animal teeth (one notched), clay vessels and handles of such in the form of birds, &c. Owing to a pressure of other work Mr. Greer was unable to copy from his note book the localities where the specimens were found, except in a general way, but will send a full report later.

Dr. G. H. Taylor, Mobile, Ala.—Collection from shell-heaps near Mobile: Fragment of a large chipped celt, and handles of clay vessels in the form of bird-heads, &c.

C. C. Nutting, U. S. National Museum.—Collection from Ometepec Island, Lake of Nicaragua: Round and shoe-shaped burial urns, small vessels of various shapes, some painted and others ornamented with incised lines or with figures in relief, toy vessels found in burial urns, clay sinkers, legs of tripod vases, rude stone carving (human head), flint flakes, an arrow-head, a shell implement, and a number of fragments of human skulls and bones. Also a large stone figure (human), to be described in Mr. Nutting's report. The clay vessels arrived in a very fragmentary state, especially the large ones, but they have partly been restored. Among the painted vessels are some very fine specimens.

José Zeledon, Costa Rica.—A stone carving (human head), a stone figure (animal-shaped), a small metate, a pestle, and 10 clay vessels, some painted, others ornamented with raised figures. There is no statement concerning the localities where the specimens were found, although (with the exception of one vessel, which is undoubtedly of Peruvian origin) they do not differ in character from other Costa Rican objects sent by Mr. Zeledon last year.

Samuel Johnson, Parkersburg, Wood County, West Virginia.—Eight arrow-heads found in the vicinity of Parkersburg. Very good specimens.

Ernest E. T. Seton, De Winton Farm, Carberry, Manitoba, Canada.—Two grooved mauls and 27 chips of chalcedony, jasper, &c., found on Big Plain, Carberry, Manitoba. Also 2 arrow-heads from Galt, Waterloo County, Ontario, Canada. The mauls are very good specimens.

Minor C. Keith, Limon, Costa Rica.—Twelve large sculptures representing men and animals, and 3 small fragments. From Dos Novillos, on the line of the Costa Rica Railroad, about 49 miles from the coast. A valuable addition to the collection of antiquities from Costa Rica.

Dr. J. F. Bransford, U. S. Navy.—Two small stone sculptures (human) from the Pacuare Cut, Limon Railroad, Costa Rica.

Capt. A. Briand, Havre, France.—A hammer-stone and 16 flint scrapers (neolithic), from Elbeuf, Department of Seine-Inférieure, France.

James Harrington, Tampico, Mexico.—Two stone sculptures in human shape.

A. R. Beck, Lititz, Lancaster County, Pennsylvania.—A carved stone pipe (obscene). Said to have been brought from South America, but probably of Northwest Coast origin.

J. A. D. Stephenson, Statesville, Iredell County, North Carolina.—A scraper and 96 arrow-heads, from a deposit in Alexander County, North Carolina. I take from Mr. Stephenson's letter the following statements: "This deposit was found recently by some quarrymen near the Catawba River, in the southeast corner of Alexander County, buried in the soil against the side of a large rock. I know of no locality nearer than 70 miles from which the material composing the specimens could have been obtained."

E. Stanley Gary, Baltimore, Md.—A ceremonial weapon, from Elk Ridge, Howard County, Maryland.

J. B. Aldrich, Memphis, Tenn.—A New Zealand war-club (mery), taken from a mound in Bent County, Colorado. Original loaned, and cast made in the National Museum. This specimen is identical in material and shape with a New Zealand war-club in the collection of the National Museum, and belongs to the class of so-called "intrusive relics," sometimes found in this country.

Trocadero Museum, Paris, France.—Collection of large casts taken by M. Désiré Charnay from sculptures in Mexico and Central America. The importance of this collection can hardly be overrated. The casts, entered under 57 heads, fill a large hall in the National Museum, and embrace the important bas-reliefs and glyphic inscriptions described and figured by Del Rio, Dupaix, Waldeck, Stephens, and other explorers. They offer to the investigator facilities for study which otherwise could only have been pursued in the far-distant regions of this continent, where the traces of a higher aboriginal civilization are found. The casts are the duplicates of those exhibited in the Trocadero Museum at Paris, the visible tokens of Mr. Lorillard's munificence.

J. C. Howell, U. S. Navy.—A tombstone from the plains of Troy.

Charles J. Turner, Brunswick, Chariton County, Missouri.—Collection from Chariton, Linn, Saline, Boone, and Howard Counties, Missouri. An arrow-head with strongly jagged edges, stone sinkers (some of hematite), hematite celts and axes, a polished cutter, a sickle-shaped natural formation, prepared for cutting purposes, a grooved double-pointed head of a war-club, carved pipes, ceremonial objects, a shallow stone dish, a stone ring with incised lines, a rubbing stone, a large grooved adze-head, a large stone slab with foot-shaped depression and cup-formed cavities placed around it, natural formations (clay iron ore), prepared to serve as receptacles, and a copper axe. This is one ot the best collections ever acquired by the National Museum.

J. E. Adcox, Benton, Saline County, Arkansas.—Collection from Saline County: Rude implements, cutting tools, scrapers, perforators, arrow and spear-heads, a hammer-stone, celts, notched and grooved axes, and a muller.

C. L. McKay (deceased).—Collection from Alaska: Six cutters (slate), 4 spear-heads, 4 chipped celts, a chisel (?), 2 adzes (one very fine), a piece of worked argillite, 2 oval pebbles, one with polished cavity, an unfinished bone socket for harpoon-head, and 2 clay vessels.

J. F. Kummerfeld, Long Grove, Scott County, Iowa.—A grooved axe (very fine), from Pottawattamie County, Iowa.

C. T. Wiltheiss, Piqua, Miami County, Ohio.—Cast of an animal-shaped pipe. The original was found 3 miles from Piqua, near the Miami River, having been washed out by high water. Material, pale-gray limestone.

G. B. Frazar, Mount Auburn, Middlesex County, Massachusetts.—Collections from shell-heaps at Old Enterprise, Mellonville, Lake Munroe, Lake Harney, and Spear's Landing, Saint John's River, Florida: 32 shell adzes, 14 fragments of shell adzes, a shell chisel or gouge, a shell sinker, a shell bead, 23 fragments of pottery, 3 fragments of potstone vessels, a grinding-stone, 2 worked prongs of antlers, 3 bears' teeth, and a small piece of galena.

Ernest C. Brown, Warren, Jo Daviess County, Illinois.—Collection from mounds and their vicinity in Jo Daviess County: a large digging-tool, leaf-shaped implements, scrapers, perforaters, arrow- and spear-heads, polished celts, grooved axes, a pierced stone object of unknown use, a fragment of a platform-pipe, and fragments of pottery. I take from Mr. Brown's letter the following: "The mounds are situated on a bluff about 100 feet high. So far as opened they appear to be sepulchral, the bodies lying with the heads to the south. They were all encased in Trenton limestone slabs of about 8 inches in thickness and from 2 to 5 feet long. Relics are very rare."

W. C. Brown, Liverpool, Perry County, Pennsylvania.—Collection from Perry County: Rude chipped implements, arrow-heads, rude celts, 1 pestle, notched sinkers, and fragments of pottery.

G. W. Emrich, Northumberland, Northumberland County, Pennsylvania.—Collection from Northumberland County: Flakes, rude and leaf-shaped implements, scrapers, perforaters, cutting tools, arrow-heads, rude celts, an unfinished grooved axe, rude grooved axes, pestles, notched sinkers, fragments of ceremonial weapons, and a carved stone pipe. The pestles and grooved axes are good examples of aboriginal methods in working stone, being natural formations somewhat approaching in shape the implement desired, modified by flaking and pecking.

DEPARTMENT OF MAMMALS.

FREDERICK W. TRUE, Curator.

Accessions.

The accessions of the Department of Mammals during the past year were numerous, varied, and important. The number of specimens received from the collectors of the Smithsonian Institution and those of other Departments of the Government, and by gift, purchase, and exchange, amounts to no less than 365. The numerical relations of the accessions from each of these sources are indicated in the subjoined table:

Table of accessions in 1883.

		By donations.	By exchange.	By purchase.	From Smithsonian Institution collectors.	From collectors of other Departments.	By deposit.	Total.
Accessions..	Total	69	11	3	11	8	....	102
	Skins	48	9	3	10	6	76	
	Osteological specimens	21	2	0	1	2	26	
Species.....	Total	71	45	4	48	12	....	180
	Skins	50	43	4	41	9	147	
	Osteological specimens	21	2	0	7	3	33	
Specimens..	Total	86	70	6	150	53	....	365
	Skins	55	64	6	88	47	260	
	Osteological specimen	31	6	0	62	6	105	

It appears from this table that more than two-fifths of the entire number of specimens received were obtained from the collectors employed by the Smithsonian Institution, somewhat less than half that proportion by gift and exchange, respectively, and a still smaller number from collectors of the various departments of the Government. The accessions from the latter source, however, are of high value.

The influx of important specimens of aquatic mammals during the past year was remarkable. The recently perfected arrangement between the United States Life-saving Service and the Smithsonian Institution, for the telegraphic announcement of the stranding of large aquatic animals, the activity of the friends of the Museum at various points on the coast, and the explorations of Dr. Leonhard Stejneger in the Commander Islands, have all conspired to cause the accumulation of an exceedingly interesting series of cetaceans, the majority of which are new to the collections, some additions to the fauna, and some apparently new to science. The specimens of Ziphioid and Physeterine whales are especially worthy of attention.

In April a specimen of an apparently new species of *Kogia*, which has been provisionally called *K. Goodei*, was received from the life-saving station at Spring Lake, New Jersey. In October the curator assisted in making a cast and securing the skeleton of a specimen of *Ziphius cavirostris*, stranded near the life-saving station at Barnegat City, N. J. Both these specimens are the first of their kind reported from the northwestern Atlantic. Among the specimens collected by Dr. Leonhard Stejneger in Bering Island are the skulls of two ziphioid whales, which have been described by that gentleman under the names of *Berardius Bairdii* and *Ziphius Grebnitzkii*, and are, so far as I am aware, the first ziphioids from the northern Pacific. In August a large number of sperm-whale bones was received from Cape Canaveral, Florida, where a small school of individuals of different ages stranded in the fall of 1882. Mr. Almont Barnes, United States consul in Venezuela, transmitted from Messrs. Fairup and Gorsira, a collection of bones of killer whales, *Orca* sp., from the Aves Islands. It will be an interesting task to clear up the history of these remains, which are represented as occurring in great quantities on the islands referred to. In July the skeleton and fine set of whalebone of a Lesser Rorqual, *Balænoptera rostrata*, stranded at Monomoy Point, Cape Cod, were received from Mr. William Bloomer.

Other interesting cetaceans, including specimens of *Phocæna communis*, *Phocæna lineata*, *Delphinus delphis*, and a dolphin, apparently new, and which was provisionally named *Tursiops subridens*,* were received and are recorded in the list of accessions.

Some important sirenians have also been received. The Linnean Society of New South Wales, through Dr. Macleay, presented a specimen of the Dugong of Australian waters, *Halicore dugong*, a species which was wanting in the collections. By exchange with the British Museum the Institution obtained a skin and skeleton of the African manatee, *Trichechus senegalensis*. These, with the specimens of American manatees received during the last and previous years, complete the collection of sirenians, which now includes every existing species.

The Museum is indebted mainly to Dr. C. Hart Merriam and Dr. Philipe Poey, of Havana, for the majority of the important additions to the collections of seals received in 1883. Through Dr. Poey's disinterested action the Institution was enabled to purchase for the Museum a mounted skin and skull of the rare West India seal, *Monachus tropicalis*, which, with the exception of a skin now or until recently existing in the British Museum, is the only specimen in any scientific collection in the world.

The seals obtained by Dr. Merriam during his expedition to Labrador, although not rare species, are very important, in that they exhibit the changes incident upon growth and the differences of males and females of the same species. The species included in the collection are *Phoca*

* This species is now known to be synonymous with *T. tursio*.—F. W. T.

grœnlandica, *Cystophora cristata*, and *Erignathus barbatus*. The specimen of *C. cristata*, mounted according to the observations of Dr. Merriam, presents a strong contrast to the usual representations of this species, at least so far as the form and position of the "bladder" is concerned. In addition to these specimens the department received from Mr. A. G. Brown a fine specimen of a young Californian sea-elephant, *Macrorhinus angustirostris*, which was one of several brought alive from California for exhibition in Philadelphia. The collection of pinnipeds is now in excellent condition, but good skins of the Atlantic and Pacific walruses and most of the Stenorhyncine seals are still wanting.

Among the indigenous terrestrial mammals, the most interesting specimen received in 1883, was a black-footed ferret, *Putorius nigripes*. This species, which could not be obtained by Professor Baird when engaged upon his monograph of North American mammals, is at present represented in the collection by several skulls, and by at least eight skins, two of which were rceived in 1883.

Of the accessions of exotic mammals the collections of Mr. P. L. Jouy in Japan, and from the museum of Kurrachee, India, rank first in interest. Mr. Jouy's collection includes 36 specimens of Japanese mammals, all of which were previously unrepresented in the Museum. From the Kurrachee Museum were received 36 specimens of Indian mammals, nearly all of which are also new to our collections.

Administrative work.

Museum registers.—The number of entries made in the two registers, at present in use in the department, is as follows:

Entries in the register of skins in 1883	349
Entries in the register of bones in 1883	198
Total	547
Whole number of entries in the register of skins	14,003
Whole number of entries in the register of bones	21,075
Total	35,078

The number of entries in these catalogues during the past two years has considerably exceeded the number of specimens received during that period, since an effort has been made to record the specimens which have accumulated in the storerooms of the Museum. At present the number of unentered specimens is very small, and will probably be reduced to zero before the close of this year. With some exceptions all the accessions of 1883 were recorded within a few days after receipt, and it is understood that this work shall take precedence over all other. The records of distributions made in past years have been examined, and the names and addresses of the recipients of specimens copied into the registers opposite the original records of the same. Reference to the registers, therefore, reveals not only what specimens are actually in the collection, but also the disposition of those distributed.

It was possible during the summer of 1883 to have the work of copying the original registers taken in hand. Up to this time three volumes of the register of skins have been copied, and the originals filed with the registrar. It seems very desirable that this work should continue. The original records date back to the foundation of the Museum, and contain a vast amount of information relative to the collections, which, as is well known, have formed the basis of the principal monographic works upon mammals published in this country during the last half century.

Card catalogues.—The preliminary card catalogue of skins, mounted and unmounted, has been copied upon the printed cards provided for the purpose. The arrangement is, as before, an alphabetical one by genera. The work of checking the specimens actually in the collections upon the preliminary catalogue of bones has not yet been completed, and the permanent copy of that record has not been made.

Work upon the collections.

The osteological collection.—Early in the year the entire collection of bones, with the exception of the mounted skeletons, was removed from the gallery of the lower hall of the Smithsonian building to the east-south range of the Museum. The mass of material in storage was also removed to the same range. Here the specimens were assorted and afterwards arranged by orders upon the temporary shelves in the southeast court. Each specimen was checked in the registers to show its presence in the collection and its identification made sure. This work occupied nearly nine months. When completed, the specimens were once more removed to the east-south range, and arranged in table cases by orders and families. The shelves behind the new wall-case in that range were also filled with specimens, principally of the ruminants and larger cetaceans. A collection of skulls of rodents, insectivores, and bats, consisting largely of type specimens, very valuable for study, has been placed temporarily upon the south balcony. A small number of boxes, containing duplicate specimens of cetacean skulls and the like, have been temporarily stored.

As intimated above, a large exhibition case has been built upon the north side of the east-south range. In this case it is intended to display the mounted skeletons of the larger species of mammals. A few species however such as the giraffe, elk, etc., will be arranged upon a raised base on south side of the range. For reception of the smaller skeletons it is proposed that special cases shall be designed.

The collection of skins.—The entire collection of unmounted skins, with the exception of a series of rodents, was treated with preservatives during the summer. The larger skins, such as those of bears, seals, ruminants, and the like, were placed in an arsenic bath, and afterwards dried. They are thus rendered secure from the attacks of moths. It was thought undesirable to apply this preservative to the smaller species, which are much handled, and they were, therefore, treated with a compound of benzine and other ingredients, and dried. By this method the skins are entirely freed from vermin, but are not rendered absolutely secure from fresh attacks. Against these, the vigilance of the Curator alone will avail.

The skins referred to are at present stored in seven table cases in the south exhibition hall, and in eight large storage boxes, four quarter-unit cases, and twelve small tin herbarium cases, upon the south balcony. Late in the year the work of attaching pasteboard labels to the specimens was begun, and is not yet completed. These labels are intended to contain the name of the species, the name of the donor, and the locality, thus supplementing the metallic numbers hitherto in use. The work of separating the collection into duplicate, reserve, and exhibition series cannot conveniently be commenced until this task is completed.

The exhibition series is displayed in two large wall cases and twenty-one other cases, and upon two large terraced bases, in the south hall. Case-labels have been provided for nearly the entire series, and further experiments have been made in species-labels.

Twenty-five skins have been submitted to the taxidermist during the year for mounting. Of these, 20 specimens have been completed. In addition 6 specimens have been remounted and 5 repaired. Most prominent among the new specimens is a group of 5 orangs of different ages ages and both sexes. It is a very accurate and praiseworthy work, both as regards the mounting of the specimens themselves and the arrangement of the foliage and other accessories. The group occupies a specially-made ash case 12 feet long, 7 feet wide, and 11 feet high.

The seals added to the exhibition-series are principally those received from Dr. C. Hart Merriam during the year. The adult crested seal, no. 13,742, is especially worthy of attention as representing a more accurate imitation of the shape of this species in life than has hitherto been obtained.

The collection of casts.—The collection of cetacean casts has been materially added to. The most important accessions are the casts of *Kogia Goodei* and *Ziphius cavirostris*, the former showing the entire exterior of the animal and the latter of half the same. The complete list of casts made in 1883 is as follows: *Kogia Goodei*, *Ziphius cavirostris*, *Tursiops tursio*, *Trichechus manatus*, *Macrorhinus angustirostris*, *Canis familiaris* (pug-dog), *Phocœna lineata*.

Experiments have been made with a view of suspending the majority of the cetacean casts from the roof in the south hall. These casts are very light in weight and will bring no strain upon the roof, while their appearance when suspended is more pleasing to the eye than when they are placed upon supports.

The alcoholic collection.—The alcoholic collection is contained in 940 bottles and 13 tanks, and is still kept in a small room in the south tower. The collection includes about 103 anatomical specimens, properly speaking, the remainder being adult animals, fœti, and the like, preserved whole. It is doubtful whether it would be desirable to exhibit any of the latter in bottles, but the skins can be mounted in the dry way quite as readily as those of fresh animals. The collection includes a great number of duplicates, all of which will be separated before the close of the present year.

The anatomical specimens are in excellent condition and can be displayed with advantage in the exhibition halls when suitable cases and jars have been designed.

Distribution of duplicates.—The number of distributions during the year 1883 was 8, of which 3 were gratuitous distributions and the remainder exchanges. The whole number of specimens distributed was 14, 7 gratuitously, and the remainder in exchange for other specimens.

Assistance.—The operations of the department were carried on during the larger part of the year by the Curator and two copyists. The services of the osteological preparator were also received in connection with the re-arrangement of the osteological collection. The work of poisoning the collection of skins was performed by another preparator of the Museum.

The work of the chief taxidermist in building up the exhibition series has already been referred to.

From March to October the Curator held the position of acting assistant director, and was unable therefore to give his entire attention to the department. His duties as librarian have also continued during the year. In December he secured permission from the director to visit certain of the museums of Europe with a view of studying their methods of preparation and installation.

Work in research.

The number of papers and notes based wholly or in part upon the material of the department, published in 1883, was eight. Of these the curator furnished five, Dr. Leonhard Stejneger one, Mr. Charles Nutting one, Dr. G. E. Dobson, of the British Museum, one.

The work of the Curator has been mainly of a preliminary character, and he has directed his attention especially to the cetaceans and pinnipeds. An annotated catalogue of the mammals displayed at the London Fisheries Exhibition was prepared at the request of the Commissioner. The papers contributed to the census report have not yet been published. The papers now in course of preparation relate to the cetaceans and seals recently received, and to a comparative study of a large series of skulls of two other species. A code of instructions for the use of collectors of cetaceans is also in preparation.

The Curator has also furnished to *Science* a series of abstracts of important papers upon the morphology and anatomy of mammals.

Mr. H. L. Todd was engaged during the summer in making a number of drawings to accompany a code of instructions to collectors of cetaceans. Twenty-six species were drawn—24 from selected illustrations, and 2 from photographs and other original sources. He also made four drawings of the Ribbon seal, *Phoca fasciata*, to accompany a paper now in press for the *Proceedings* of the Museum.

A series of photographs of type skulls of North American cetaceans was made for the London Fisheries Exhibition, and the set was afterwards extended to include all the type specimens in the Museum, together with some other representative species. This series includes the following species: *Kogia Goodei*, *Delphinapterus catodon*, *Globiocephalus Scammoni*, *Delphinus Bairdii*, *Kogia Floweri*, *Leucorhamphus borealis*, *Phocæna vomerina*, *Tursiops erebennus*, *D. delphis*, *Sagmatias amblodon*, *Delphinus plagiodon*, and some others.

Present state of the collection.

Number of specimens.—As intimated above, the collection has not yet been separated into exhibition, duplicate, and reserve series. The number of specimens in the collection at the end of 1882, and the additions in 1883, are shown in the following table:

Number of mounted and unmounted skins and alcoholic specimens in 1882	4,660
Number received in 1883	260
Total January 1, 1884	4,920
Number of mounted and unmounted osteological specimens in 1882	3,535
Number received in 1883	105
Total January 1, 1884	3,640
Number of anatomical specimens in 1882	70
Number received in 1883	33
Total January 1, 1884	103

The number of specimens of mounted skins on exhibition on December 31, 1883, was 715. This number will probably remain approximately the same for two or more years, since the condition of many of the specimens now on exhibition is such that it will be necessary to replace them by others.

The condition of the collections is decidedly better than when last reported upon. The application of preservatives to the series of skins, the re-examination of the osteological collection, and all of the other operations referred to in previous parts of this report, have had a most beneficial effect upon the specimens. As has been already stated, the exhibition series of mounted skins needs renewing, a work which has already been begun.

The alcoholic series is in better condition than hitherto, but many of the specimens cannot be introduced into the exhibition series on account of the loss of fur caused by the weakening of the alcohol. To avoid this difficulty in the future it is proposed to seal the bottles with paraffine.

The osteological collection does not deteriorate by neglect so rapidly as the other series, and after some repairs have been made, will be in an excellent condition.

The living mammals exhibited in the rotunda (see Report, 1882, p. 39) have not fared well. The Mexican deer and the two specimens of the tufted marmoset have died. The spermophiles escaped from their cage in the night and for a long time could not be found. At length two of the specimens were discovered among some storage-boxes, and one was recaptured unhurt; the other was hurt during the moving of the boxes, but revived sufficiently to escape once more, and has not since been seen. The owl monkey has remained in good condition. A prairie dog and an opossum have been added to the collection.

Plans and recommendations.

Desiderata.—The collection of mammals is at present most deficient in African species. An expedition to that continent could be profitably made for no other purpose than the collection of mammals. Any of the great number of species of ruminants which abound in that country, as well as of insectivores and bats, would be most acceptable. The mammals of Asia and Europe are also represented in the collections only by a comparatively small number of specimens.

The department is richest in the species inhabiting North, Central, and South America. Good specimens of the Atlantic and Pacific walruses, however, are still prominent desiderata. The series of cetaceans of the northern Pacific presents many gaps. It is probable that a complete skeleton of the gray whale, *Rhachanectes glaucus*, does not exist in any collection, though the species is apparently somewhat more abundant than previously. More skins and skeletons of the American manatees are exceedingly desirable, in order that it may be definitely determined whether the species are one, two, or three in number. Among South American mammals more specimens of the monkeys, bats, and small rodents are much needed.

Plans.—The Curator is of the opinion that it would be best to arrange the exhibition series upon a different principle from that at present adopted whereby it would be attempted to show only single representatives of the various genera. An exception should be made in the case of the species inhabiting the United States, all of which should be exhibited.

The number of families of mammals now recognized by zoologists varies from 86 to 136. Estimating the number of genera at 1,100, if each were represented in the exhibition series by a single species the collection would still be so large as to occupy a very considerable space. Such an arrangement would, I believe, be much superior, from an educational point of view, to that at present adopted.

Species not represented in the exhibition series could be kept in drawers and be conveniently examined by those specially interested in any branch of mammalogy. This view is in no way original, the plan having already been adopted in a number of museums.

It is proposed to substitute for the exhibition cases now in use others specially designed for mammals and which will display the specimens to better advantage.

It is very desirable that specimens which are not in cases should be protected from the constant handling and ruthless mutilation of visitors. To devise a railing which will afford protection but not disfigure the exhibition halls is a very difficult matter. The experiments which have been made in this direction hitherto have not proved successful.

Alphabetical list of accessions during 1883.

Mr. Byron Andrews. A gopher skin (*Geomys talpoides bulbivorus*), from Kingsbury County, Dakota.

Messrs. Barton & Logan, Washington, D. C. A monkey (*Chlorocebus sabæus*) and a raccoon (*Procyon lotor*). Both of these specimens were received in the flesh.

Mr. O. R. Beall, Leeland, Md. An example of monstrosity in the hog.

Mr. L. Belding, Stockton, Cal. A tail of the mule deer (*Cariacus macrotis*).

Mr. E. G. Blackford, Fulton Market, New York. A young South American manatee (*Trichechus manatus*) from Brazil. (Purchased.)

British Museum, London, England. A stuffed skin and skeleton of the Senegal manatee (*Manatus senegalensis*). (Exchange.)

Mr. A. G. Brown, Zoological Gardens, Philadelphia. A specimen of a young California sea-elephant (*Macrorhinus angustirostris*). Received in the flesh.

Mr. J. T. Brown, U. S. National Museum, Washington, D. C. Three ermine skins (*Putorius erminea*); one spermophile (*Spermophilus empetra*, var. *empetra*), from Hudson Bay, British America.

Mr. E. C. Bryan, U. S. National Museum, Washington, D. C A bat skeleton (*Vesperugo serotinus*).

Mr. O. Burnham, Cape Canaveral, Florida. A collection of bones and a number of teeth of the sperm whale (*Physeter macrocephalus*). These specimens represent the remains of a small school of sperm whales which stranded in the fall of 1882.

Mr. Stephen Calverley, Barnegat City, N. J. Three albino mice (*Mus musculus*).

Mr. Alvin Chapin, Loudon County, Virginia. A fox squirrel (*Sciurus niger*, var. *ludovicianus*).

Capt. James E. Coleman, Provincetown, Mass. A fœtus of a fin-back whale.

Mr. T. H. Collins, Washington, D. C. An example of monstrosity in the dog and cat.

Dr. Elliott Coues, Washington, D. C. A specimen of an albino fox squirrel (*Sciurus niger*, var. *niger*).

Mr. John S. Crary, Knoxville, Tenn. Human skull from the farm of Mr. H. Fraser.

Mr. Henry L. Dawes, Texas. A pair of ox horns (*Bos taurus*).

Miss Maud Diemann, Washington, D. C. An Angora cat.

Mr. Vinal N. Edwards, Wood's Holl, Mass. An abnormal deer skull (*Cariacus virginianus*) from Naushon Island, Massachusetts.

Messrs. Fairup and Gorsira, Aves Islands, Venezuela (through Mr. Almont Barnes, United States consul). Fragments of skulls and skeletons of a killer whale (*Orca* sp.). A number of vertebræ of a whalebone whale.

Lieutenant Julian Fillette, U. S. Navy. A skull of a chief of the Marquesas Islands, Pacific Ocean. (Deposited.)

Mrs. Haag, Washington, D. C. A Mexican hairless dog (*Canis familiaris*).

Mr. E. H. Hawley, U. S. National Museum, Washington, D. C. An albino rat (*Mus decumanus*).

Mr. George S. Hobbs, U. S. National Museum, Washington, D. C. A fœtus of a Maltese cat.

Mr. J. Hoffman, keeper U. S. life-saving station, Turtle Gut, Cape May, N. J. A dolphin (*Tursiops tursio*) in the flesh. This specimen was made the basis of a new species, called *T. subridens*, but is now known to be identical with *T. tursio*.

Dr. W. J. Hoffman, Petoskey, Mich. A melanistic woodchuck (*Arctomys monax*).

Mr. Wm. T. Hornaday, U. S. National Museum, Washington, D. C. Specimen of a bat.

Mr. H. S. Howland, keeper U. S. life-saving station, Spring Lake, N. J. A pygmy sperm whale and fœtus (*Kogia Goodei* sp. n.). This valuable specimen is the first of the genus recorded from the North Atlantic. Another specimen, however, is known to have been taken off the coast of Florida.

Messrs. S. R. and D. S. Hubbard, keepers U. S. life-saving station, Fire Island, New York. A dolphin (*Tursiops tursio*).

Mr. Wm. Bloomer (through Mr. Asa L. Jones, light-house keeper, Monomoy Point, Harwich Port, Mass.). The skeleton and whalebone of a finback whale (*Balænoptera rostrata*): This is one of the few specimens of this species taken on the east coast of the United States.

Mr. P. L. Jouy, Japan. A number of mammal skins and skeletons from Japan. A valuable series, mostly new to the collection.

Mr. Anton Karr, Washington, D. C. A pug dog.

Mr. F. H. King, Wisconsin. A specimen of the shrew (*Blarina talpoides*).

Kurrachee Museum, Kurrachee, India. A collection of thirty-six mammal skins and skulls from India. A valuable series, mostly new to the collection.

Mr. Charles P. Lincoln, Washington, D. C. A Siamese cat (*Felis domestica*), from Bangkok, Siam.

Mr. Jos. Lorange, Stavenger Museum, Sweden. A European moose (*Alces machlis*).

Mr. Wm. Macleay, Linnean Society, Sydney, Australia. A dugong skin (*Halicore dugong*).

Mr. H. C. Mais (through Mr. W. W. Evans), Australia. A number of fossil teeth of the genus *Diprotodon*. A very interesting collection of the teeth of this fossil marsupial.

Mr. C. L. McCormick, Falls Church, Va. A fresh specimen of a cat.

Dr. C. H. Merriam, Locust Grove, N. Y. A collection of skins and skulls of the hooded seal (*Cystophora cristata*), the Greenland seal (*Phoca grœnlandica*), and a fœtus of the bearded seal (*Erignathus barbatus*).

Mr. George P. Merrill, U. S. National Museum, Washington, D. C. A bat (*Vesperugo noctivagans*) from Auburn, Me.

Mr. David Miller, Camp Hill, Pa. A star-nose mole (*Condylura cristata*).

Dr. J. C. Neal, Archer, Fla. A collection of fossil mammal bones from Florida.

Commodore H. E. Nichols, U. S. N. A tuft-tailed pocket mouse (*Perognathus penicillatus*) from Sonora, Mexico.

Mr. George Y. Nickerson, New Bedford, Mass. Carpal bones of a whale (*Balæna* sp).

Mr. C. C. Nutting, Ornetepe, Nicaragua. A monkey and an opossum (*Mycetes palliatus* and *Didelphys quica*).

Mr. C. R. Orcutt. A ground squirrel (*Tamias asiaticus* var. *quadrivittatus*) from the Cantiles Mountains, northern Lower California.

Prof. Felipe Poey, Havana, Cuba. Seal (*Monachus tropicalis*); a mounted specimen containing skull and leg bones. This specimen of the West Indian seal is the only one known to exist in any scientific collection, with the exception of the British Museum. This museum contains or did contain a single imperfect skin received from Jamaica a number of years ago. The skull is especially interesting as affording characters by which the genus has been determined. The generic identity of this animal has long been in question.

Mr. J. P. Puckett (through Mr. J. P. Caldwell), New Statesville, N. C. Horse's tooth (*Equus caballus*).

Mr. J. H. Ridgway, keeper U. S. life-saving station, Barnegat City, N. J. A bottle-nosed whale (*Ziphius cavirostris*). This specimen is the first of its genus and species taken in the Northwestern Atlantic, unless that in the museum of the college of Charleston, forming the type of *Hyperoodon semi-junrtus* proves to be a *Ziphius*, which seems very probable.

Mr. Robert Ridgway, U. S. National Museum, Washington, D. C. A collection of twenty-five mammal skins, mostly rodents, from Illinois.

Mr. Charles Ruby, Wyoming. A specimen of the black-footed ferret (*Putorius nigripes*) from Duck Creek, 12 miles Cheyenne, Wyo.; two human skulls (*Homo sapiens*) from Fort Robinson, Nebr. This specimen of *Putorius nigripes* is the second recorded this year, and is the seventh skin in the collection of the Museum.

Dr. R. W. Shufeldt, U. S. A. A collection of mammals, principally bats. from Louisiana.

Mr. Alexander Skinner, Washington, D. C. A jumping mouse (*Zapus hudsonius*) from Arlington, Va.

Mr. R. E. C. Stearns, Berkeley, Cal. A bat (*Anthrozous pallidus*) and a mole, from Berkeley, Cal.

Dr. L. Stejneger, Smithsonian Institution, Washington, D. C. A collection of mammals from Bering Island and Kamtchatka, including the mountain sheep, fur seal (*Callorhinus ursinus*), the harbor seal (*Phoca vitulina*), and the sea-lion (*Eumetopias Stelleri*).

Mr. George Stolly, Texas. Two bats (*Atalapha noveboracensis* and *Nyctinomus brasiliensis*).

Mr. George L. Taylor, Wyoming. A specimen of the black-footed ferret (*Putoris nigripes*). Another specimen of this rare species was received from Mr. Charles Ruby.

Mr. William J. Taylor, Allapaha, Ga. A gopher (*Geomys tuza*) and another rodent.

Mr. Aurelius Todd, Coquille, Oreg. Two fine specimens of the sewellel (*Haplodon rufus*).

Mr Frederick W. True, U. S. National Museum, Washington D. C. Two bats (*Atalapha noveboracensis*), a muskrat (*Fiber zibethicus*) in the flesh, and a mandible of the same animal.

U. S. Fish Commission, Washington, D. C. Five specimens of the skunk (*Mephitis mephitica*), from Woo d's Holl, Mass.

U. S. Life-Saving Service, Hon. S. I. Kimball, Superintendent (see *Messrs. J. H. Ridgway, S. R. & D. S. Hubbard, H. S. Howland*, and *J. Hoffman*).

Dr. C. H. Van Patten, San José, Costa Rica. Several species of the mammals of Cost Rica, including a young specimen of *Tapirus Bairdii*.

Mr. S. W. Very. A skull of a puma (*Felis concolor*) from Santa Cruz, Patagonia.

Mr. W. D. Watkins, Akron, Ohio. Lower jaw and teeth of a horse (*Equus caballus*); tooth of a hog (*Sus scrofa*).

Mr. W. C. Weedon, U. S. National Museum, Washington, D. C. Specimen of an albino rat (*Mus decumanus*); Guinea pig (*Cavia cobaya*).

Prof. Burt G. Wilder, Cornell University, Ithaca, N. Y. A skin and leg bones of a baby orang-utan (*Simia satyrus*). (Exchange.)

Miss Nellie Williams, Washington, D. C. Bat (*Vesperugo serotinus*).

Mr. George Y. Wise, Genito, Va. The skull of a beaver, the trap which caught the beaver, and the tree which the beaver had gnawed.

Mr. J. W. Wood, Baraboo, Wis. A specimen of a shrew (*Sorex* sp.).

Mr. George Woltz, U. S. National Museum, Washington, D. C. A specimen of the domesticated rabbit (*Lepus cuniculus*).

Mr. John Yarrow, U. S. National Museum, Washington, D. C. A gray squirrel (*Sciurus carolinensis* var. *leucotis*).

Mr. José C. Zeledon, San José, Costa Rica. Skin of a sloth (*Cholopus Hoffmani*); skull of a paca (*Cœlogenys paca*).

DEPARTMENT OF BIRDS.

Robert Ridgway, Curator.

Accessions.

The accessions to the collection of birds during the year 1883 number 134, including all that were entered in the Museum register during the year.*

The total numer of specimens entered in the Museum register of birds for 1883 is 3,651, the last number of the catalogue being 93,091.

Following are the more important lots received during the year:

(*a*) ACCESSIONS OF STUFFED BIRDS.

L. Belding. Three lots, as follows: (1) 35 specimens, 24 species, from Laguna and San José del Cabo, Lower California; (2) 57 specimens, 34 species, from Guaymas, Sonora, and various localities in Lower California; (3) 59 specimens, 38 species, from various localities in Lower California. (S. I.)

Capt. Charles Bendire, U. S. A. 223 specimens, 72 species, from Fort Klamath, Oreg. (Gift.)

Amos W. Butler. 11 specimens, 4 species, of warblers, from Brookville, Ind. (Exchange.)

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* Some accessions entered during January, 1883, were in reality received in the latter part of 1882; while other specimens received in December, 1883, were not entered until January, 1884. These are not included in the above statement, as is likewise the case with specimens which had lost their labels and been re-entered, and a few others which, although in the collection for a number of years past, appear never to have been catalogued.

Charles B. Cory. Two lots: (1) 3 newly-discovered birds from Santo Domingo. (Exchange.) (2) 7 specimens, 5 species, chiefly from Santo Domingo. (Exchange.)

William Dutcher. 12 specimens, in flesh, of *Passerculus princeps.* (Gift.)

George F. Gaumer. One adult ♀ of *Phœnicopterus ruber* Linn. (Gift.)

N. S. Goss. 37 specimens, 37 species, from Guatemala. (Gift.)

P. L. Jouy. 312 specimens, 131 species, from Japan. (S. I.)

C. J. Maynard. 27 specimens, 18 species, from Dominica. (Purchased.)

C. L. McKay (deceased). Two lots: (1) 117 specimens, 61 species, from Nushagak River, Alaska; (2) 40 specimens, 22 species, from same locality. (Signal Office.)

Lieut. Jeff. T. Moser, U. S. N. 2 fine specimens of *Ossifraga gigantea*, and 4 of *Daption capensis*, from the Rio de la Plata, the former mounted for the exhibition collection. (Gift.)

Prof. William Nation (Lima, Peru). 1 specimen each of *Buarremon nationi* Scl., and *Porzana erythrops*, Scl., both new to the collection. (Gift.)

Norwich Museum (England). 3 species of Falconidæ new to the collection. (Exchange.)

C. C. Nutting. Four lots from Nicaragua, as follows: (1) 100 specimens, 53 species, from San Juan del Sur; (2) 199 specimens, 75 species, from Sucuyá; (3) 136 specimens, 45 species, from Ometepec; and (4) 167 specimens, 76 species, from Los Sábalos. (S. I.)

R. Ridgway (Curator Department of Birds). Three accessions, as follows: (1) 221 specimens, 95 species, from Wheatland, Ind.; (2) 99 specimens, 50 species, from Richland County, Illinois; (3) one adult bald eagle (*Haliœtus leucocephalus*) in flesh; purchased for Museum and mounted for exhibition series. (S. I.)

O. Salvin and F. Du Cane Godman. 156 specimens, 145 species, of neotropical birds, nearly all new to the collection. (Exchange.)

P. L. Sclater. 14 specimens, 11 species, of Accipitres, from British Guiana. (Exchange.)

Ernest E. T. Seton. Two lots: (1) 22 specimens, 18 species, from Manitoba; (2) 51 specimens, 36 species, from Manitoba. (Gift.)

George Shoemaker. 40 specimens, 24 species, from Gainesville, Fla. (S. I.)

Dr. R. W. Shufeldt, U. S. A. 58 specimens, 24 species, from New Orleans, La. (Gift.)

Dr. L. Stejneger. 486 specimens, 126 species, from Commander Islands and Petropaulski, Kamtschatka. (S. I.)

Charles H. Townsend. Four lots, from Shasta County, California, as follows: (1) 198 specimens, 76 species; (2) 102 specimens, 44 species; (3) 161 specimens, 49 species; (4) 198 specimens, 76 species. (S. I.)

Dr. H. Van Patten. 51 specimens, 38 species, from Costa Rica, including 2 species (*Selasphorus torridus* and *Leucopternis princeps*) new to the collection. (Gift.)

J. Wallace. 13 specimens, 13 species, 6 species new to the collection. (Purchased.)

C. W. Ward. 11 specimens, 8 species, of herons, &c., from Southwestern Florida. (Gift.)

H. A. Ward. 1 skin of adult *Ardea occidentalis.* purchased for exhibition collection.

Prof. H. E. Webster. 1 mounted specimen of the black gyrfalcon (*Hierofalco gyrfalco obsoletus*) from New York. (Exchange.)

Charles K. Worthen. 3 lots, chiefly from Illinois and California, as follows: (1) 21 specimens, 6 species; (2) 22 specimens, 16 species; (3) 9 specimens, 6 species. (Exchange.)

José C. Zeledon. 31 specimens, 28 species, from Costa Rica; 4 species new to science. (Gift.)

(*b*) ACCESSIONS TO THE EGG COLLECTION.

Capt. Charles Bendire, U. S. A. 18 specimens, 16 species (nests only), from Oregon. (Gift.)

James Bell. Eggs of *Aramus giganteus*, from Florida. (Gift.)

Dr. E. Coues. Nests and eggs of *Myiadestes townsendi* and *Parus montanus*, from Colorado.

P. L. Jouy. 17 specimens, 11 species, from Japan.

James A. K. Moore. 1 egg of great horned owl from Loudoun County, Virginia.

R. Ridgway (*Curator Department of Birds*). 3 accessions, as follows: (1) 11 specimens, 8 species, from Wheatland, Ind.; (2) 34 specimens, 15 species, from Richland County, Illinois; (3) 1 egg of Carolina parakeet (*Conurus carolinensis*), laid in confinement. (S. I.)

Ernest E. T. Seton. 16 specimens, 15 species, from Manitoba, including nest and eggs of *Oporornis agilis*, the first discovered. (Gift.)

Livingston Stone. 42 specimens, 19 species, nests and eggs, from McCloud River, Northern California.

Charles H. Townsend. 42 specimens, 18 species, from Shasta County, California.

Mrs. Mary E. Turner. Nest and complement of 11 eggs of Bewick's wren (*Thryomanes bewicki*), from Mount Carmel, Ill.

General routine work, arrangement of collections, etc.

(*a*) GENERAL ROUTINE WORK.

Besides the labor involved in the cataloguing, labeling, and installation of the 3,651 specimens acted on during the year, a large amount of other routine work has also been done, such as the writing of special papers, based on material in the collection, for publication; correction of proof, writing official letters, &c. The exact extent of this work is as follows:

Papers prepared for publication	13
Pages of proof (in Museum publications) corrected	246
Galleys of proof (in Museum publications) corrected	104
Official letters written	190
Official memoranda written	219
Orders for work written	76
Memoranda of packing written	82
Requisitions for material, &c	158

(*b*) DISTRIBUTION OF SPECIMENS.

The total number of specimens sent out during the year was 1,133, of which 759 were exchanges and 374 loaned to specialists for examination; the number of species being 385 exchanged and 127 loaned. There were also exchanged 23 specimens and 17 species of eggs, while 16 specimens and 11 species of skeletons were loaned for examination.

The number of packages sent out was 85, of which 43 were sent by mail, 36 by express, 2 by international exchange, 2 by messenger, and 2 doubtful.*

(*c*) ARRANGEMENT AND CLASSIFICATION OF COLLECTIONS.

A vast amount of work under this heading has been done during the year. The entire reserve and duplicate series of smaller birds, embracing about 30,000 specimens, has been wholly rearranged systematically, in new quarter-unit cabinets, and the drawers carefully labeled. The reserve specimens of larger birds in the west basement have likewise been thoroughly overhauled and rearranged. This part of the collection, although containing less than 10,000 skins, is by far the most bulky, and the handling of it has involved a very great deal of labor. Some dozen or more boxes containing duplicate specimens of the larger birds (chiefly water birds and birds of prey), which have been kept in storage, have been brought out and overhauled; but it was found necessary, on account of lack of drawer space, to repack the duplicates in the same large boxes. They were, however, first classified, and then an invoice made of the contents of each box. Advantage was taken of this opportunity to select specimens for the Indiana State University, the zoological collections of which were completely destroyed by fire in July preceding; but, although the greater part of this work was done in December, 1883, it is not yet finished, and the statistics pertaining to this matter will therefore be deferred until the annual report for 1884.

The cases and drawers containing the reserve series and part of the duplicates have been numbered, and a key to the arrangement prepared that will greatly facilitate ready access to the specimens.

* These two were foreign packages, the manner of sending them not being discretionary with the curator.

(*d*) WORK ON EXHIBITION SERIES.

Owing to the fact that access to the exhibition collection has been, during the entire year, practically cut off by the transfer of the Smithsonian offices to the main hall, no work of any consequence has been done on the exhibition series. About 300 specimens have been mounted during the year, and these have, when possible, been placed in the cases where they properly belong, but many of them have been temporarily arranged in cases in the southwest gallery. The accessions include many birds of great interest, among which may be mentioned the type specimen of Wurdemann's heron (*Ardea wurdemanni*), a fine adult of the great white heron (*Ardea occidentalis*), a fine adult female of the American flamingo, the type specimen of a supposed new sea eagle from the Commander Islands (*Haliaëtus hypoleucus* Stejneger), a fine series of pheasants and other Japanese birds, collected by Mr. P. L. Jouy, and other interesting specimens, too numerous to mention.

Bibliography of publications based upon Museum material.

See Bibliographical Appendix, under the names of L. Belding (4), William Brewster (2), Elliott Coues (2), Pierre Louis Jouy (1), Robert Ridgway (7), Howard Saunders (1), P. L. Sclater (2), and Leonhard Stejneger (2).

The total number of papers published is 31; the number by each writer is indicated by the figures in parentheses following the names in the above enumeration.

Present state of collections.

The present state of the collections is first class, except in the case of the duplicate collection, which is chiefly included within cases affording no protection from insects, but partly packed in large boxes, and thus very inconvenient of access when exchanges are to be made. That portion accommodated in the unsuitable cases above mentioned requires constant watching and frequent use of bisulphide of carbon, a very efficient insecticide when put in tightly closed drawers or cases, but of only temporary utility in open receptacles, on account of its rapid evaporation. The exhibition collection is also in constant peril, the cases being in every respect unsuitable for the safe keeping of specimens. It is, in fact, a great risk to put valuable specimens inside of them.

Number of specimens in the collection.

It is impossible to give at the present time an exact statement of the number of specimens in the several series of the collection, which would require a special inventory. The approximate total can however be ascertained by simply adding to that existing at the end of the year 1882 the number of specimens catalogued in 1883, and subtracting therefrom those distributed. This gives a total of 47,246 specimens to December

31, 1883. An approximately correct estimate of the number of specimens in the several series gives the following result:

	Specimens.
In reserve skin series	28,246
On exhibition	6,000
Duplicates	13,000
Total	47,246

Desiderata.

Since the publication of the "List of species of Middle and South American birds not contained in the United States National Museum," in December, 1881,* more than 200 species of Neotropical birds have been added to the collection, by far the larger number of additions being the direct result of the judicious distribution of the list in question. The greater number of these additional species have been furnished by Messrs. Salvin & Godman in England, and Count von Berlepsch in Germany; but Mr. George N. Lawrence, of New York City, has contributed several. We have already the promise of nearly the same number of species still remaining on our list of desiderata from the gentlemen named above. The great utility of these lists is therefore apparent, and I would suggest, as the best means of still further reducing the number of desiderata of the Museum, that special lists of the most desirable species of those counries of tropical America from which we possess fewest species be drawn up; these lists to be sent to the Governments of those countries with a request for their assistance in obtaining the species wanted.

DEPARTMENT OF REPTILES.

H. C. YARROW, Honorary curator.

As in previous years, the Museum, through the kind efforts of its friends and collectors, has received many and valuable accessions to its different series, amongst the most noteworthy of which are the following:

From Dr. Robert W. Shufeldt, U. S. A., a large and interesting collection from the Mississippi delta, embracing about 678 specimens of about 36 species. While no new or especially rare forms have been secured, it will be of great value in studying the reptilian fauna of the region, and for purposes of exchange with other museums.

Another interesting collection of 126 specimens, from the vicinity of the Potomac River, was received from the late Mr. George Shoemaker, a young naturalist, whose untimely demise must be greatly regretted by all students of natural history who have had the good fortune to be associated with his labors.

Mr. Robert Ridgway, Curator of birds, has found time, notwithstand-

* Proceedings United States National Museum, vol. III, pp. 165-203.

ing his other duties, to collect and present 54 specimens of reptiles from the vicinity of Wheatland, Ind. Some of these were living, and have added greatly to the attractions of the serpent vivarium. Not the least important part of Mr. Ridgway's work has been a careful series of notes regarding his specimens, the value of which cannot be overestimated. Among the very rare serpents were several belonging to the new subspecies described by the curator in the proceedings of the National Museum, 1882, p. 438, under the name of *Ophibolus getulus niger*, and this additional supply of material fully confirms the conclusions reached in the paper mentioned.

Mr. Theodore Roosevelt has presented a collection of 67 specimens, mostly from the State of New York.

We are again under obligations to Mr. L. Belding, of California, for a valuable and rare collection from La Paz, Cal.

The Kurrachee Library and Museum of British India has also presented a fine series of Indian reptiles, numbering 49 specimens. Many of these the Museum did not before possess.

Mr. José Zeledon, of Costa Rica, has also presented a collection of 27 rare and valuable specimens made in the vicinity of his coffee plantation.

A valuable and almost unique collection of reptiles from Mauritius, numbering 47 specimens, has been presented by Mr. Nicholas Pike, of Brooklyn, formerly United States consul to the island. This is only one of the many donations made to the National Museum by this gentleman.

Mr. G. W. Marnock, of Helotes, Bexar County, Texas, has as in previous years added most materially to our collections, and from him have been received a number of specimens of species not before possessed by the Museum.

Other collections have been presented by Mr. James Bell, of Gainesville, Fla., Dr. Garnier, of Lucknow, Canada, Mr. G. M. Merrill, of Auburn, Me., Lieut. J. F. Moser, U. S. N., Dr. J. Schenk, C. H. Gilbert, George Stolley, William J. Taylor, H. F. Emeric, R. E. Earll, Dr. W. Nelson, C. R. Orcutt, Benjamin Miller, B. A. Bean, J. B. Adams, and many others; in fact, we have no cause for complaint as to scarcity of contributions.

The routine work of the department has been carried on by the Curator and two young assistants. It consists in entering promptly in the record book all accessions, the specimens having been previously identified when possible, and tagged with a stamped tin label bearing the current number. They are carefully examined with a view to determining in which series they should be placed, after which a separate record is made so that at any time the specimen may be found without difficulty, according to its classification.

The entire collection of reptiles is divided into two great series, one called the "Reserve series," intended for purposes of study, and from which is selected the exhibition set, the other entitled the "General series," from which selections are made for donations to other museums or to amplify the "Reserve series." It is to be regretted that space will not admit of a proper display of the exhibition set of reptiles, domestic and foreign.

In addition to the official record book of the department the following records are also kept with great care: "Record of reserve series;" "Record of general series;" "Record of letters received;" "Record of letters sent;" "Record of requisitions."

In these may be found recorded every matter of business transacted in the department of reptiles. It should be stated that no inconsiderable labor is involved in giving prompt attention to the official correspondence, which at times is quite voluminous, for many letters of inquiry are received from all parts of the world, which to answer require much time, thought, and labor. During the year 1883, 90 letters have been sent and 100 received.

It has long been the desire of the Curator to have prepared a card catalogue of the entire collection in his care, but up to the present moment it has been found impossible to spare the time from other and more important duties.

The preparation of a Manual of Herpetology, based upon the collections in the National Museum, has been prosecuted as rapidly as circumstances would allow, and the manuscript is now nearly ready for the printer. Nearly all the illustrations of serpents have been carefully prepared by Mr. J. L. Ridgway, and others are now in the hands of the artists.

No special researches have been made by the Curator and his assistants apart from those necessary in the preparation of the manual before mentioned, but material has been furnished Dr. S. Weir Mitchell for his investigation in reptile venoms, to Dr. Mason, of Newport, R. I., and to Dr. R. W. Shufeldt, U. S. A.

The collection may be said to be at the present time in very good condition, as prompt attention is given it whenever needed.

Number of specimens on hand at present.

In reserve series	8,342
In general series	7,918
In exhibition set:	
Domestic	600
Foreign	150
Not classified and exotic specimens, probably	5,000
Total	22,000

Total number of entries in record for the year 1883	965
Total number of specimens received to January 1, 1884	1,535
Total number of entries in record to date	13,745

By the authority of the Director, a number of specimens have been distributed in exchange for others more desirable, but no complete sets of duplicates have been made during the past year. It is hoped, however, soon to be able to arrange sets and in this way get rid of what is superfluous material.

The statement made in the report of the Curator for 1882, regarding want of accommodation for the department of reptiles is again urged, for at the present time it is well nigh impossible to accommodate further accessions; the reserve series shelves are filled and overcrowded, and we are obliged to make use of the adjoining hall to store valuable specimens, which should properly be placed in the curator's room; in fact, the entire collections of Testudinata is outside the laboratory. Any attempt to establish a reserve and general series of foreign reptiles similar to those employed for our American reptiles must be fruitless under existing circumstances.

DEPARTMENT OF FISHES.

TARLETON H. BEAN, Curator.

Important accessions during 1883.

There were 108 accessions during the year, of which 55 were gifts, 37 by Museum collectors, 13 by United States Fish Commission collectors, and 3 by exchange.

Synopsis of the accessions.

Alabama	4
Arkansas	1
California	2
Chesapeake Bay	1
District of Columbia	4
Florida	4
Georgia	4
Indiana	1
Iowa	1
Louisiana	4
Maine	2
Massachusetts	8
Maryland	3
Michigan	2
Minnesota	1
Mississippi River	1
Montana	2
New Jersey	2
New York	8
North Carolina	2
Ohio	2
Oregon	1
Pennsylvania	1
Potomac River	4
Puget Sound	1
Rhode Island	3
South Carolina	2
Tennessee	1
Texas	2
Virginia	4
Washington Territory	2
Wisconsin	1
Deep sea	4

Extra-limital.

Alaska	4
British America	3
Ceylon	1
France	1
Guatemala	1
Indian Archipelago	1
Japan	1
Mauritius	1
New Brunswick	2
Pacific Ocean	1
Panama	2
South America	3
Vancouver Island	1
West Indies	4

By addition we would have a larger number of accessions than 108; but in some cases the accession was partly from one locality and partly from another, and each is credited as one in the synopsis.

Following is a summary of the most interesting accessions catalogued during the year:

S. Albro, Coddington's Cove, Rhode Island. Accession ———; catalogue, 33194. An example, taken October 16, of *Elops saurus*, a species of only occasional occurrence in southern New England.

Tarleton H. Bean, Potomac River, District of Columbia. Catalogue, 32564. A remarkable specimen of *Esox reticulatus* of a pale green color without a trace of dark reticulations.

Capt. Charles Bendire, Cœur d'Alene Lake. Catalogue, 32576. In a large collection of *Salmonidæ* taken in Oregon and Washington Territory was included the type of *Salmo purpuratus*, var. *bouvieri*, Bendire, which may be only a color variety of Clark's trout. Typical *Salmo purpuratus* was also forwarded, and *Salmo gairdneri*, *Oncorhyncuus nerka*, *O. chouicha*, and *Salvelinus malma.*

E. G. Blackford, New York Market. Accession 13065; catalogue, 32753. A specimen of mackerel *Scomber scombrus* (?) without any traces of black half bands. It does not seem to differ otherwise from *scombrus.*

E. G. Blackford, Fort Pond Bay, Long Island. Accession 13539; catalogue, 33158. A very fine example of *Seriola lalandii*, measuring more than 30 inches in length. Complete measurements have been taken. This is unquestionably the *S. lalandii* of Bull. 16, U. S. Nat. Mus., p. 912, a species hitherto known on our coast from Florida only.

E. G. Blackford, West Indies, South America, &c. Accession 13737; catalogue, 33222–33265, 33589–33780. This is part of a full series of the fishes formerly belonging to J. C. Brevoort, which Mr. Blackford has presented to the National Museum. Besides the tank specimens there are four barrels full of jars containing fishes in alcohol. I have not yet been able to identify the species, but will report upon them more fully hereafter.

California Fish Commission, Paper Mill Creek, California. Accession ———; catalogue, 32588-9. Number 32589 is a remarkably large *Salmo gairdneri*, weighing 16 pounds, of which a cast and the skeleton are preserved in the Museum.

Malachi Corbel, "The Cape," North Carolina. Accession 13073; catalogue, 32754. An example of the comparatively rare *Astroscopus anoplus*, of which this Museum has only a few individuals.

D. C. Cordery, Atlantic County, New Jersey. Accession, 12949; catalogue, 32580. An adult example of *Cyclopterus lumpus*, which is unusual so far south.

J. E. Curtis, Gallatin and Madison Rivers, Montana. Accession 13122; catalogue, 32799. The whitefish sent by Mr. Curtis is *Coregonus williamsoni.* As this species is supposed not to occur in any streams except those of the Pacific watershed, the locality should be verified.

Thomas S. Doron, Montgomery, Ala. Accession 12998; catalogue, 32629. A fine large rock-fish, more nearly related to *Roccus septentrionalis* than to the *chrysops* of the Mississippi Valley. The fish is a gravid female nearly 3 feet long and remarkably deep-bodied. A cast was made and the example then preserved entire.

J. B. Edwards, Amagansett, Long Island. Accession 12701; catalogue, 32516. Mr. Edwards, keeper of the life-saving station at Amagansett, sent a shark belonging to the family *Scylliidæ*, the *Pseudotriacis microdon*, Capello, a species never before known in our waters, which was described from a single example taken in the deep water off the coast of Portugal by a deep-line fisherman. Casts of one side and of the head were obtained. A good drawing was made by Mr. H. L. Todd, and Mr. F. A. Lucas has prepared a skeleton. The skin will be mounted.

Wm. J. Fisher, Kodiak, Alaska. Accession 12209; catalogue, 32537–8. In Mr. Fisher's collection were two very large specimens of *Cottus niger*, Bean, first found at Saint Paul Island, Bering Sea, and now known to occur also in the Gulf of Alaska.

James Fletcher, coast of British Columbia. Accession 13039; catalogue, 32664. Mr. Fletcher sent, through Dr. Robert Bell, a fine example of *Rhamphocottus richardsoni*, Gthr., a curious and rare Cottoid, of which we now have three specimens, the other two being from Kodiak and Monterey Bay.

Prof. C. H. Gilbert, Charleston, S. C. Accession ——; catalogue, 33161–8. This small portion of Professor Gilbert's collection included the following species, which are not well represented in the Museum, and seem to be rare: *Larimus fasciatus*, *Stelliferus lanceolatus*, *Rhinobatus lentiginosus*.

Dr. J. A. Henshall, Jupiter Inlet, Florida. Part of accession 11429; catalogue, 33213. Among other valuable species Dr. Henshall obtained *Fundulus confluentus*, which was known from the single type only.

W. P. Hillyer, Cherrystone, Va. Accession 13599; catalogue, 33160 *Fistularia tabaccaria*, a rare species in our waters.

Jordan and Stearns, Pensacola, Fla. Part of accession 12991; catalogue, 33173. A remarkable species of pipe-fish, *Siphostoma crinigerum*, Bean and Dresel MSS., allied to *S. crinitum* (Jenyns), which inhabits the coast of Northern Patagonia. It has an extremely short snout (shorter than the eye), and the dorsal rays are only 16 to 17. The name refers to the minute filaments found upon the head and sides of the body. Two males are described as the types of the species.

Capt. H. M. Knowles, Point Judith, Rhode Island. Accession 13653; catalogue, 33193. A specimen of *Fistularia serrata*, a species which is very rare on our coast.

Royal Museum of Natural History, Leiden, Indian Archipelago. Accession 13058; catalogue, 32689–32751. A collection embracing upwards of 60 named species of fishes in return for American species.

Historical and Scientific Society, Winnipeg, Manitoba. Accession 11897; catalogue, 31940–9 and 31951–5. A collection of the more important species of Winnipeg, secured through the instrumentality of Mr. Strong, of the Canadian press. The entire list is worthy of record:

1. *Moxostoma carpio*, (Val.) Jord. "White-scaled sucker."
2. *Catostomus teres*, (Mitch.) Le S. "Blue sucker."
3. *Moxostoma macrolepidotum*, (Le S.) Jor. "Red sucker."
4. *Hyodon alosoides*, (Raf.) Jor. & Gilb. "Gold eye."
5. *Stizostedium canadense*, (Smith) Jor. "Pickerel."
6. *Esox lucius*, L. "Pike."
7. *Amiurus vulgaris*, (Thomp.) Nelson. "Mud pout."
8. *Perca americana*, Schranck. "Perch."
9. *Catostomus longirostrum*. Le S. "Black sucker."
10. *Carpiodes tumidus*, Baird and Girard. "Buffalo."
11. *Haploidonotus richarsdsoni*, (C. & V.).
12. *Coregonus clupeiformis*, (Mitch.) Milner. "Whitefish."
13. *Hyodon alosoides*, (Raf.) Jor. & Gilb. "Gold eye."
14. *Catostomus teres*, (Mitch.) Le S. "Black sucker."
15. *Moxostoma macrolepidotum*, (Le S.) Jor. "Red sucker."

Fred. Mather, Adirondack Lakes, New York. Accession 13811; catalogue, 33917–33999. Mr. Mather has described, for the Adirondack survey report, two new species of *Catostomus* and forwarded the types to the National Museum. One of these is *Catostomus nanomyzon*, Mather, from a tributary of Big Moose Lake. I am inclined to think that these are simply young, or dwarfed, examples of *Catostomus longirostrum*, which have early begun reproduction. I can see no specific characters to warrant their separation from *longirostrum*. *Catostomus utowana*, Mather, from Blue Mountain Lake, Hamilton County, New York, and also from Big Moose Lake, I should call *C. teres*, (Mitch.), the commonest of the northern suckers. The fact that these two species were found spawning when of small size does not warrant their separation as distinct species, this being probably a climatic phenomenon.

Lewis G. Mitchell, Barnegat, N. J. Accession 13671; catalogue, 33197. Mr. Mitchell forwarded a fine *Pomacanthus arcuatus*, which we have not before known to exist in our seas north of Florida. A color sketch and a cast were made, and Mr. Todd is now at work on a drawing of both the adult and the young.

E. W. Nelson, Saint Michael's and vicinity, Alaska. Accession ———; catalogue, 32821–987. This includes the major portion of Mr. Nelson's collection of fishes and contains many valuable species. There is a large series of *Oncorhynchi*, *Coregoni*, and other Salmonoids, besides the following: *Chirolophus polyactocephalus* (Pall.); Mr. Nelson obtained the only specimens we have of this blenny; *Lycodes turnerii; Anarrhichas lepturus; Parophrys ischyrus*, from Unalashka, the most northern record from Alaska; *Brachyopsis* sp.; *Uranidea*, from mouth of Tananah River; *Murænoides*, probably a new species.

Capt. H. E. Nichols, U. S. N., British Columbia and Alaska. Accession 13757; catalogue, 33781–33803, 33910–33913. Among numerous species of interest were the two following: *Delolepis virgatus*, Bean, the singular scaled genus of *Cryptacanthidæ* which Captain Nichols was the first to discover; *Prionistius macellus*, Bean, of which we now have two examples, both obtained from Captain Nichols.

Capt. H. E. Nichols, U. S. N., Alaska and British Columbia. Accession ———; catalogue, 31956–32019. A collection of forty-three species, in fine condition, including the following of special interest:

1. *Triglops pingelii*, not previously taken in Alaska.
2. *Prionistius macellus*, Bean, a new genus and species related to *Triglops*, described in Proc. Nat. Mus. for 1883, pp. 355–359. A second example was taken by Captain Nichols and is mentioned with the type.
3. *Gymnacanthus galeatus*, Bean, extending its range considerably eastward. The species was discovered first at Unalashka.
4. *Potamocottus gulosus*, its first occurrence in Alaska.
5. *Micrometrus aggregatus*, the first Embiotocoid known from Alaska.
6. *Somniosus microcephalus*, jaws cut from an Alaskan example 8 feet long, demonstrating the existence of the species in Southeastern Alaska.

Prof. Félipe Poey, Havana, Cuba. Accession 13463; catalogue, 33079–33141. This collection contains many species, among which are: *Elops saurus*, *Echeneis*, several species, *Gerres zebra*, *Holacanthus parræ*, *Tetrodon occipitalis*, *Opisthonema*, *Muræna*, *Ophichthys*, *Tylosurus*, *Agonostoma*, *Fistularia*, *Plectropoma*, several species, *Trachinocephalus myops*, *Xyrichthys*, *Aulostoma*.

Silas Stearns, Pensacola, Fla. Accession ———; catalogue, 33915. Mr. Stearns sent the example here recorded to Professor Jordan with some other species and, for a time, it was believed to be new; but a comparison with typical specimens shows it to be *Emblemaria nivipes*, Jor. & Gilb., a species first made known from the Pearl Islands in the Pacific, whence it was brought by Prof. F. H. Bradley. The occurrence of this fish in the Gulf of Mexico is quite interesting.

Silas Stearns, Pensacola, Fla. Accession 12247; catalogue, 31891–31939. A collection of great value, containing the following, among many other species:

1. *Stenotomus caprinus*, Bean (young), the singular "goat's-head porgy" recently discovered at Pensacola by Mr. Stearns.
2. *Opisthognathus scaphiurus*, Goode & Bean.
3. *Echeneis albescens*, Temm. & Schleg., now for the first time recorded in our waters.
4. *Phycis floridanus*, Bean & Dresel, a manuscript species, of which a brief diagnosis has been prepared for publication in Proc. Biological Society of Washington, Vol. II.

5. *Coryphæna equisetis*, L. (? or *hippurus*, L.), 13 examples of rather small size.
6. *Aprion ariommus*, Jor. & Gilb., a species recently described in Proc. Nat. Mus. for 1883, pp. 142, 143.

Silas Stearns, Pensacola, Fla. Part of accession 12991; catalogue, 33000–33001. The first of these is an example of *Conger caudicula*, Bean, the second one known in this Museum. The other is *Antennarius pleurophthalmus*, Gill, which has not been previously obtained for many years.

Silas Stearns, Pensacola, Fla. Accession 12991; catalogue, 32755–32767. Among these fishes were two which have not before been known to occur in Florida; these are *Brotula barbata*, (Bl. Schn.) Cuv., a species of the Caribbean and West Indies, and a new species of *Phycis*, *Phycis floridanus*, Bean & Dresel, a manuscript species about to be described in Proc. Biol. Soc. Wash., Vol. II.

Silas Stearns, Pensacola, Fla. Accession 12991 part; catalogue, 32632–32637, 32647. Among the species are the following rare ones: *Diplodus* sp., *Tylosurus gladius*, Bean, *Diplodus caudimacula*, Poey, *Caulolatilus microps*, Goode & Bean, *Batrachus pardus*, Goode & Bean, *Ophichthys guttifer*, Bean & Dresel, a new species just described in manuscript for Proc. Biol. Soc. Wash., Vol. II.

Dr. Leonard Stejneger, Commander Islands and Kamtschatka. Accession ———; catalogue, 33804–33908. This is a collection of great value, which was made by Dr. Stejneger during the years 1882 and 1883, while in the service of the Signal Bureau, U. S. A. The collection is valuable because of its bearing upon geographical distribution and from the fact that it contains many hitherto doubtful Pallassian species from localities visited by Steller, besides others which appear to be undescribed. The species are not yet fully identified, but the following may be mentioned as reasonably ascertained:

33806, 33837. *Cyclopterichthys* species, two specimens from Bering Island. The genus is extremely rare in collections, and very little known, save from a description by Dr. Steindachner, which is accompanied by a good figure. Pallas described the fish under the name *Cyclopterus ventricosus*, and Steindachner re-described it as *Cyclopterichthys glaber*. Our specimens are, in all probability, *C. ventricosus*.

33807. *Gymnacanthus galeatus*, Bean. I did not learn much from the type of *G. pistilliger* in Berlin, because of its very bad condition. It may be that my species is, after all, identical with that of Pallas, but of this I cannot be sure.

33809. *Hypomesus*, probably *olidus*.

33817. *Cottus diceraus* from Kamtschatka, the original locality of the species.

33821. *Pleurogrammus monopterygius* from Bering Island, extending its range very much to the westward.

33848. *Blenny* not yet made out.

33849. *Agonid* not yet identified.

33869. *Bathymaster signatus*, Cope, from Bering Island, greatly extending its range.

33870. *Gymnelis*, from Copper Island. There is a splendid lot of Cottoids and also of Salmonoids which will throw much light on the relations of the Kamtchatkan fauna to that of Alaska.

Capt. Thomas Stratton (through Jas. G. Swan), Port Angelos, Wash. Ter. Catalogue, 32547. This was an example of *Delolepis virgatus*, Bean, and is the third example known to be preserved. It was picked up on the beach. Mr. Swan writes that "specimens are occasionally but rarely seen in the Victoria market."

James G. Swan, Port Townsend, Wash. Ter. Accession 12647; catalogue, 32492–32503. Mr. Swan had in this collection the following among other species: *Brama raii*, whose occurrence in the North Pacific he was the first to detect. *Macrurus acrolepis*, Bean, a new species described in Proc. Nat. Mus. for 1883, pp. 362–363. This is the first specimen of the genus known from the Eastern Pacific.

U. S. Fish Commission, off Southern New England coast and southward to Chesapeake Bay. Accession ———; catalogue, 33266–33587. This large collection was made mainly by the parties on the steamers "Albatross" and "Fish Hawk," in depths varying from 35 to 2,949 fathoms. In this greatest depth the following fishes were taken: *Cyclothone lusca* (many), *Scopelus* sp. (three?), *Alepocephalid* juv. (one), *Mancalias uranoscopus* (one), *Plectromus* (one). The collection embraced many of the species recently described by Goode & Bean, from specimens trawled by the "Blake," but not previously in the National Museum, and there was, besides, a goodly number of new forms which have been for the most part briefly characterized by Professor Gill and Mr. J. A. Ryder.

Of the "Blake" species the summer explorations yielded the following: *Chalinura simula*, Goode & Bean; *Coryphænoides carapinus*, Goode & Bean; *Macrurus asper*, Goode & Bean; *Bathysaurus agassizii*, Goode & Bean; *Halosaurus macrochir*, Gunther; *Alepocephalus agassizii*, Goode & Bean; *Lycodonus mirabilis*, Goode & Bean; *Dicrolene introniger*, Goode & Bean. The new species were first noticed in part in Forest and Stream of August 30, 1883, and again in a subsequent issue; afterwards (November 27, 1883) a more extended paper based upon this material was published in Proc. Nat. Mus., volume VI, pages 253–273.

Professor Gill also published in Nature a note upon the affinities of the *Eurypharyngidæ*, contrasting them more especially with *Saccopharynx*. It is to be hoped that the new species will soon be fully described, for, without the typical specimens, it would be very difficult if not impossible to recognize them in the future. The following species appear to have been erroneously considered as new:

1. *Chimæra abbreviata*, Proc. Nat. Mus., 1883, 254, is the young of *C. plumbea*, Gill, which is identical with *C. affinis*, Capello, described in 1868.
2. *Sigmops stigmaticus*, Proc. Nat. Mus., 1883, 256, does not represent a new genus and species, but is simply a badly preserved example of *Gonostoma denudata*, (Raf.) Bonap., of which we already had a drawing from a "Fish Hawk" specimen taken October, 1881.
3. *Halosaurus goodei*, Proc. Nat. Mus., 1883, 257, is not sufficiently distinguished from *H. macrochir*, Gthr. to receive a new name. Mr. Goode and I observed more variation among the types of the latter species than will be found between the published descriptions of the contrasted forms.
4. *Stephanoberyx monæ*, Proc. Nat. Mus., 1883, 258, belongs to the same genus as Gill's proposed *Acanthochænus*, and the family *Acanthochænidæ* is unnecessary, as both the species are Berycoids.

The remark "closely allied to *Melamphaes*" was intended to follow and apply to *Plectromus*.

5. *Typhlopsaras shufeldtii*, Gill, Forest and Stream, 1883, is not blind and is not a new genus and species, but is identical with *Mancalias uranoscopus*, (Murray), "The Atlantic," New York, 1878, II, p. 67, Fig. 20.

Other species which are especially interesting are the following:

33296, 33495, 33560. *Argyropelecus olfersii*, (Cuv.). We had previously obtained *A. hemigymnus*, so that we now possess two species of the genus from the Western Atlantic. These are the first specimens of *olfersii* that we have secured.

33471, 33563. *Sternoptyx diaphana*, Hermann, not taken before except by the "Blake."

33510. *Bathylagus* species. A specimen, No. 31861, of the same species was taken by the "Fish Hawk," October, 1882, haul 1,155, in N. latitude 39° 52′, W. longitude 70° 30′, 554 fathoms. The genus was described by Dr. Gunther (Ann. and Mag. Nat. Hist., September, 1878, p. 248) from examples obtained in the Antarctic and South Atlantic, at depths ranging from 1,950 to 2,040 fathoms. Our species resembles his *B. Atlanticus* very closely, but has a longer anal.

U. S. Fish Commission steamer "Albatross," off mouth of Chesapeake Bay. Accession ———; catalogue, 32649–32661, 32665–32682, 32684–32688. A valuable collection, especially for geographical distribution, and because of numerous rare species. I name the following: *Nemichthys scolopaceus*, very fine examples; *Coryphænoides rupestris*; *Melanostigma gelatinosum*; *Sternoptyx diaphana*; *Chauliodus sloanii*;

Lycodonus mirabilis; Cryptacanthodes maculatus; Centroscymnus sp., the last two being the first of their kind from so far south.

U. S. Fish Commission steamer "Albatross," N. lat. 35° 37′ 30″; *W. long.* 74°. Accession 13134; catalogue, 32782–32798, 32804–32820. The collection was made during April and May. It contains many interesting species, and the following apparently new ones: *Raia*, 32793; *Lycodes*, 32813.

U. S. Fish Commission steamer "Albatross," off Chesapeake and Delaware Bays, &c. Accession 13247; catalogue, 33006–33061. This collection is particularly rich in the following species: *Haloporphyrus viola, Glyptocephalus cynoglossus, Scylliorhinus retifer, Alepocephalus agassizii, Macrurus bairdii.*

Dr. H. C. Yarrow, Washington, D. C. Accession ——; catalogue, 33076. A fine large specimen of *Tylosurus caribbæus* (52 inches in length).

Work done upon the fishes during 1883.

In arranging the collection of fishes for exhibition and study, as well as for the ordinary purposes of preservation, I have tried to transfer the contents of tanks as far as possible into glass jars. Powder tanks are so liable to become leaky and the tin lining wears off so quickly that we need to be continually overhauling them in order to save the contents from deterioration and destruction. It would be very hard to tell the number of such transfers made during the year, but some idea of the work may be gained from the fact that almost the entire stock of jars purchased for the year was used.

Most of the fishes are now identified and labeled and collected in their proper families, though not yet in zoological sequence, for want of a hall sufficiently large to hold the entire collection.

A card catalogue of the fishes in jars has been completed, filling at least 20,000 cards and representing more than three times that number of individuals. This does not include undetermined collections and tank specimens.

A collection was prepared for exhibition at the International Fisheries Exhibition in London. This included 450 species and represented pretty fully the following subjects: Alaska, Gulf of Mexico, and East Florida, Salmonoids of North America, exclusive of Greenland, and the genera of fresh-water fishes. Of the Alaskan species, 81 were exhibited; of the Salmonoids, 38 species; of the fishes of the Gulf of Mexico and East Florida, 173 species; and of the fresh-water fishes, 183 species were shown. Section F of the London Fisheries Catalogue relates to the collections of fishes exhibited. In this section there is a general survey of the regions represented, and the common names, maximum size, food qualities, and spawning habits of the species are treated upon. This collection of fishes was made the basis in London of some exchanges with the British Museum, to which institution a large part of it was presented at the close of the exhibition.

In the review of the important accessions during the year, it will be observed that the number of additions has been very large, and a considerable amount of time has been spent in the care of these accessions. The steamers of the United States Fish Commission have been especially active in adding to the collections, securing to the Museum a vast amount of material of great value.

In conjunction with the assistant director, I was engaged for some time in studying and reporting upon the deep-sea fishes collected by the Coast Survey steamer "Blake," in the year 1880. This report was finished and the fishes were returned before my departure for London. Drawings of the new species were made by Mr. H. L. Todd and examined before the return of the fishes to Mr. Alexander Agassiz.

My assistants were employed for several months in the preparation of the bibliography of works relating to the fishes of the Atlantic. A list of the bibliographies prepared is appended. Among other works consulted may be mentioned the Zöological Record, all of the volumes of which were searched for references to Atlantic fishes.

Late in the month of June I left Washington to join the United States commissioner at the International Fisheries Exhibition in London. During my stay in the latter city I was engaged for a while in the selection of duplicates for the National Museum from the collections of the British Museum. The greater portion of my time, however, was devoted to the study of fishes in South Kensington and in the exhibits of Sweden, Norway, Russia, Canada, Newfoundland, and other countries exhibited in London. A great mass of notes relating to species either similar to or identical with forms occurring in the Western Atlantic was collected and is now in process of elaboration for a final report.

Through the courtesy of Dr. Murie, Mr. Goode and I were allowed to study a large number of Linne's types of American fishes. The information thus obtained will enable us to settle numerous doubtful questions as to the nomenclature of some of our species.

Among the exhibits studied which are of especial interest was a collection of the Vega fishes taken by Professor Nordenskiold. As a result of the investigations thus carried on we will be enabled to solve many unsettled problems in the relationships between the fishes of the two sides of the Atlantic basin.

Through the means of a special mission to Vienna opportunity was found for studying numerous types of American species belonging to museums in Paris and Berlin, the especial objects of investigation in Paris being types of Cuvier and Valenciennes, and, in Berlin, Pallas's types. The material thus acquired will be utilized in future reports.

In Genoa an arrangement was made for an exchange of fishes with the Museo Civico, by which we hope to obtain numerous desiderata of Mediterranean species in return for duplicates from our own collections. Arrangements were made, also, with Dr. Steindachner, in Vienna, for a similar exchange of fishes, Dr. Steindachner having numerous fishes from the Mediterranean and elsewhere, which he will give to the National Museum in exchange for duplicates of our deep-sea species.

During the year 1883 there were fifty-three papers received and catalogued for the Proceedings of the United States National Museum.

Proofs of Sections D and E of Bulletin 27 (London Fisheries Exhibition Catalogue) were read, and Section F, relating to the fishes, was written and the proofs revised before leaving for London.

Entries in the catalogue of fishes during 1883.

The total number of entries in the catalogue was 1,576, the first number being 31,891, and the last 33,919. By subtraction we would have nearly 500 entries more than the number given, but these are partly blanks not yet filled up, or entries made in 1882. The actual number is 1,576, as stated above. This number was distributed through the different months, as shown in a table farther on.

Table showing some of the work upon the collection of fishes during 1883.

Months.	Lots of fish received.	Lots of fish catalogued.	Packages sent out.	Fish drawings examined.
January	7	139	18	12
February	9	61	19	10
March	12	43	24	5
April	14	169	12	4
May	9	242	24	10
June	4	76	12	5
July	8	5	5	13
August	2	....	....	7
September	11	79	2	....
October	10	24	1	4
November	10	361	1	2
December	12	377	1	9
Totals	108	1,576	119	81

Present state of the collection.

The exact number of specimens has not yet been accurately determined, but it cannot be less than 65,000, divided as follows: (1) In the reserve series 35,000; (2) on exhibition 20,000; (3) duplicates 10,000. Most of the collection is in good condition, the only exception being very old collections which have not been kept in sealed bottles, specimens received in bad condition, and collections kept in inferior tanks. I am convinced that powder tanks are unreliable for the preservation of fishes on account of the liability to become leaky and the rapidity with which the coating of tin wears off. We shall never be able to preserve fishes successfully until some good substitute for the copper tanks is provided, and at present nothing else seems to be available except glass vessels.

Recommendations and general remarks.

I would recommend that the duplicates be disposed of as soon as possible, in order to save time and expense in caring for them. I would also suggest that collectors in regions which have been reasonably well studied should be instructed not to send duplicates in large numbers. Should the Museum at any time need additional specimens of a particular species which is known to be common at a given point it would be comparatively easy to obtain it from one of its collectors. It is to be hoped that a suitable place will soon be provided for the reception of the skeletons of fishes which are now in storage and consequently not available for study. It is essential to the welfare of the collection of fishes in alcohol that a separate fire-proof building be constructed to contain them; until that is done the collection will never be systematically arranged and secure against accident.

In concluding this review of the work carried on in the department of fishes, I take pleasure in acknowledging my indebtedness to my assistants, without whose help it would have been impossible to have accomplished what has been done. Mr. Barton A. Bean has been engaged principally in labeling and arranging collections, recording accessions and distributions, preparing duplicates for distribution and outfits for collectors, and he has assisted in the correspondence. Ensign H. G. Dresel, United States Navy, has devoted his time mainly to preparing bibliography of Atlantic fishes, cataloguing the fishes in jars, and in the identification of recent collections from the Gulf of Mexico and the West Indies. Mr. Peter Parker, jr., has been occupied for the most part in the bibliography of Atlantic fishes, in field work at Wood's Holl, Mass., and in the preparation of the card catalogue. Mr. H. L. Todd has made a large number of excellent drawings and is now producing some of the finest illustrations of fishes extant.

DEPARTMENT OF INSECTS.

C. V. Riley, Honorary Curator.

The work of the department has consisted in mounting and properly taking care of the material received so far as time would permit, but there is a large amount of material, principally alcoholic, which has accumulated for many years, besides that turned over by the Department of Agriculture, which urgently needs working over and mounting. There is also a great deal of valuable exhibit material that needs properly arranging and labelling.

The lists given below virtually comprise two sets of accessions, those which are recent and belong properly to the year 1883, and some that were simply received during the year, but collected in previous years. Most of the single specimens reached me in poor condition, and were not worth preserving, especially as such single specimens are ordinarily common and well-known species. The most valuable collections are those received from Capt. R. W. Shufeldt, U. S. A., while stationed at New Orleans, La.; those from Mr. C. L. McKay, collected in Alaska; and those left by the late Mr. George Shoemaker.

A case of specially prepared insects, chiefly from my own cabinet, was arranged for the London Fisheries Exhibition, illustrating the transformations of the principal insects affecting the fishery industries either beneficially or injuriously.

For the rest, the work of the department has been confined to answering the letters of inquiry as indicated by the accessions and many others received without specimens.

The samples of rice which were on exhibition at the Centennial Exposition, and are now stored in the Museum, proved to be badly infested by various species of insects. A list of these has been published in the *American Naturalist*, 1883, p. 1071, the most interesting of them being a small Coleopteron (*Murmidius ovalis*) the life-history of which had previously remained unknown.

During the past summer my attention was called to the depredations done by some insect to the wooden frames of the Japanese pictures of plants in the Museum. Upon investigation the author of the mischief proved to be a very interesting and undescribed species of the genus Hedobia (family Ptinidæ, order Coleoptera), probably introduced from Japan, and which I will at some future time describe.

I transmit herewith a list of the papers published by me during the year, chiefly in my capacity as entomologist to the Department of Agriculture, but in some part also based upon material received at the Museum.

On account of the accumulated material already indicated which is in pressing need of being properly mounted and worked over, and with a view of commencing the formation of an exhibit collection for which there is also a great deal of valuable material that needs to be transferred into proper cases, disinfected, properly arranged and labeled, I would again urgently recommend and advise the appointment of a competent assistant, as I had no such assistance from the Museum during the past year.

As heretofore, some valuable collections have been offered for sale and necessarily declined. I would mention that of the late G. W. Belfrage, of Clifton, Bosque County, Texas. Sample boxes sent on for examination showed the collection to be in admirable condition, and as it contained many typical specimens in all orders its accession to the Museum would have been invaluable, and it could have been obtained at a very reasonable price. The famous collection of the late Prof. P. Zeller, of Stettin, Germany, was also offered; it was finally secured in England. It is much to be regretted that we do not have some provision for the purchase of desirable collections, and rather than see them lost to Washington, have in some instances purchased such individually.

List of Accessions, 1883.

No. 12236. *Lucilia macellaria* (screw-worm fly), sent by Mr. José C. Zeledon, San José, Costa Rica.

No. 12504. Many insects for determination from New Orleans, sent by Capt. R. W. Shufeldt, U. S. A., Jackson Barracks, Louisiana.

No. 12535. *Dynastes tityus* ♂, from Mr. Fred. Vander Tower, Paris, Tex.

No. 12598. *Dynastes tityus* ♂, from W. H. Ogdin, Parkersburg, W. Va.

No. 12654. Egg-sac of *Cyrtarachne cornigera*, from Mr. Leon Taylor, Chino, San Bernardino County, California.

No. 12680. *Tarentula carolinensis*, sent by Mr. H. Tobias, Cuthbert, Randolph County, Georgia.

No. 13080. Some Californian insects of various orders, sent by Mr. R. E. C. Stearns, Berkeley, Cal.

No. 13098. *Phileurus truncatus*, *Anisomorpha buprestoides*, *Microcentrus retinervis*, from William J. Taylor, Allapaha, Ga.

No. 13107. *Belostoma americanum*, sent by Mr. William Stine, Elmore, Ohio.

No. 13114. Larvæ of *Eristalis* sp., from Mr. James Bell, Gainesville, Fla.

No. 13048. Collection of insects for names from Louisiana, sent by Capt. R. W. Shufeldt, U. S. A., Jackson Barracks, New Orleans, La.

No. 13139. *Spectrum femoratum*, *Midas clavatus*, *Tarentula carolinensis*, from Mr. Robert Ridgway, U. S. National Museum.

No. 13164. Small collection of insects from Alaska, collected by Charles L. McKay, U. S. S. C., Hushagak, Alaska.

No. 13184. *Telea polyphemus*, sent by Miss Rosecrans, 304 Louisiana avenue, Washington, D. C.

No. 13234. Four species of Coleoptera from Oregon, sent by Mr. Aurelius Todd, Coquille, Coos County, Oregon.

No. 13236. Collection of alcoholic specimens from Louisiana, sent by Capt. R. W. Shufeldt, U. S. A., Jackson Barracks, New Orleans, La.

No. 13240. *Calosoma laqueatum*, sent by Mr. Aurelius Todd, Coquille, Coos County, Oregon.

No. 13251. Pupa of *Papilio asterias*, from H. R. Bostwick, Atchison, Kans.

No. 13257. ? Muscid from breast of a woman, sent by T. E. Peters, Abbyville, Va.

No. 13269. *Dynastes tityus*, sent by F. J. Packwood, New Smyrna, Fla.

No. 13322. *Julus marginatus*, discharged by a colored man, sent by T. S. Jones, Tolersville, Louisa County, Virginia.

No. 13330. *Cantharis nuttalli*, *Epicauta maculata*, sent by Prof. F. S. Williams, Northville, Dak.

No. 13331. *Telea polyphemus*, sent by Mr. J. B. Wiggins, Waverly, N.Y.

No. 13338. *Dynastes tityus*, *Mygale hentzii*, sent by Mr. George Stolley, Austin, Tex.

No. 13343. *Cicada septendecim* and a few other insects, from Mrs. Elizabeth Freene, Mount Gilead, Loudoun County, Virginia.

No. 13351. Lucanid larva affected with *Torrubia* sp. sent by Mr. Robert L. Stede, Rockingham, N. C.

No. 13360. Four species of Coleoptera from Japan, sent by P. L. Jouy, Yokohama, Japan.

No. 13253. Some Coleoptera from Central America, addressed to G. W. Belfrage, deceased, of Clifton, Bosque County, Texas.

No. 13364. Pupa of *Danais archippus* sent by Mr. J. Carter Walker, Woodberry Forest, Virginia.

No. 13377. *Strategus julianus* ♂, sent by Capt. Emmet Crawford, U. S. A., San Carlos, Ariz.

No. 13380. *Penthina* sp., sent by Mr. W. G. Watts, Leicester, Mass.

No. 13381. *Zopherus* sp., *Metapodius* sp., *Acridium semirubrum*, from Mr. José C. Zeledon, San José, Costa Rica.

No. 13387. Larva of *Philampelus achemon*, from Mr. H. F. Moffat, Hampstead, Rockingham County, New Hampshire.

No. 13428. *Dynastes tityus*, sent by Dr. J. R. Godwin, Fincastle, Va.

No. 13431. *Thelyphonus giganteus*, sent by John R. Adams, Grafton, Socorro County, New Mexico.

No. 13458. *Limacodes scapha*, *Cynips* sp., from Ellinwood Woodman, North Topeka, Kans.

No. 13462. Manna produced by *Lachnus strobi*?, from James O'Neill, Colville Indian Agency, Chewaha, Washington Territory.

No. 13470. Larva of *Phobetron pithecium*, sent by Mr. J. Bishop, Columbiana, Ohio.

No. 13492. *Microgaster* on *Sphinx gordius*, *Cecidomyia salicis-strobiloides*, from Mr. C. M. Ferry, Oneida, N. Y.

No. 13527. Many alcoholic specimens of various orders, collected in Alaska by the late Mr. C. L. McKay.

No. 13543. Deformation of fruit of *Akebia quinata*, from E. R. Reynold, Falls Church, Va, through Capt. J. E. Engle.

No. 13616. *Samia californica* (pupa), *Synaphœta guexi*, *Galgulus variegatus*, from J. S. Arnheim, San Francisco, Cal.

No. 13662. Various species of insects, pinned, from Mr. J. B. Adams, Grafton, N. Mex.

No. 13692. *Mygale* sp., found on bananas in Washington, D. C., and evidently imported. Sent by Mr. T. J. Offutt, United States National Museum, Washington, D. C.

No. 13727. Eggs of *Diplodes luridus*, sent by Dr. D. H. Young, Chicago Junction, Ohio.

No. 13730. *Dolomedes tenebrosus*, sent by Mr. Willard Wye, jr., New Bedford, Mass.

No. 13755. Small collection of insects from Nicaragua, sent by Lieut. Jeff. F. Moser, U. S. N., Slatington, Pa.

No. 13824. A number of pinned insects from Alaska, collected by the late Mr. C. L. McKay.

No. 13834. Web produced by larva of *Ephestia zeæ*, sent by Messrs. Hunt & Roberts, Cameron Mills, Fairfax County, Virginia.

Without accession number: A large collection (17 alcoholic bottles) of insects from Washington, D. C., made by the late Mr. George Shoemaker, U. S. National Museum, Washington, D. C.

Old accessions, but only sent to Department in 1883.

No. 8095. A box of silkworm cocoons. Source not indicated.

No. 9140. One centipede (irrecognizable), sent by M. L. Wood, ensign, U. S. N., Galveston, Tex.

No. 10217. *Strachia histrionica* from W. L. Love, Franklin, N. C.

No. 10221. Collection of alocholic and pinned insects from Surinam, sent by C. S. Herring, Paramaribo, Surinam.

No. 10661. *Sphinx cingulata*, *Attacus polyphemus*, from S. T. Walker, Milton, Fla.

No. 10273. Worms destroying meadow grass (irrecognizable), sent by S. W. Powell, Madison, N. Y.

No. 10302. Egg-mass of *Mantis carolina*, sent by Mr. W. A. Williamson, Fredericksburg, Tex.

No. 10337. A few common insects, sent by Mr. J. R. Thoensson, Toronto, Canada.

No. 10351. Large number of alcoholic specimens from California, sent by Mr. A. W. Crawford, Oakland, Cal.

No 10472. *Thelyphonus giganteus* and a few Coleoptera, from the Southern States, sent by Mr. John Yarrow, Washington, D. C.

No. 10478. A few pinned insects collected at Fort Laramie, Wyo., sent by Capt. R. W. Shufeldt, U. S. A., Washington, D. C.

No. 10488. *Telea polyphemus* sent by Henry Wagner, Washington, D. C.

No. 10538. Large collection of unmounted insects from California, sent by Mr. Gustav Eisen, Fresno, Cal.

No. 10595. *Thyridopteryx* sp., sent by Mr. J. G. Wells, Grenada, West Indies.

No. 10661. A few common Coleoptera, sent by Mr. W. A. Williamson, Toronto, Canada.

No. 10725. Large collection of alcoholic specimens from Florida, collected by William Wittfield, Georgiana, Brevard County, Florida.

No. 10769. Three larvæ of different insects, sent by Capt. Charles Bendire, U. S. A., Fort Walla Walla, Wash. Ter.

No. 10756. *Prionus imbricornis* from Virginia, sent by Col. M. McDonald, United States Fish Commission.

No. 10775. *Scolopendrus heros* from Texas, sent by Mr. L. A. Wright, Washington, D. C.

No. 11064. Specimen of locust caught at sea on board ship Lighting, sent by James T. Rowell through Lieut. C. D. Sigsbee, U. S. N.

No. 11072. Two species of bird parasites, sent by James P. Melzer, Milford, N. H.

No. 11267. Specimens of "buffalo gnats" from Arkansas, sent by Mr. M. H. Thomson, Pecan Point, Ark.

No. 11468. A few insects from Central America and cave crickets from Mammoth Cave, sent by Mr. Theodore Roosevelt, New York.

No. 11543. Several species of insects from La Paz, Cal., sent by Mr. L. Belding, Stockton, Cal.

No. 11771. *Mygale hentzii*, sent by Mr. D. W. Harris, Homer, Claiborne Parish, Louisiana.

No. 12001. A few unmounted insects, sent by Mr. W. Hudson, Tehuacana, Tex.

No. 12052. *Belostoma americanum*, *Cybister fimbriolatus*, *Dytiscus fasciventris*, sent by Hon. William McAdams, Jerseyville, Ill.

DEPARTMENT OF MOLLUSKS.

WM. H. DALL, Honorary Curator.

The removal of the collections from the lower part of the building in order to make room for clerks, &c., while the east end of the building was being remodeled, was hurriedly carried out. It was discovered in the course of the removal that parts of the collection which had not been inspected for several years had suffered much from the defects of the old and badly-made cases which admitted mice and dust. The collection of chitons offering much animal matter to these vermin, was almost entirely destroyed; many labels and paper trays were soiled or nibbled so as to require replacing.

Lieut. Francis Winslow, U. S. N., undertook the preparation of the exhibit of economic mollusks of the United States which were sent to the International Fisheries Exhibition at London in pursuance of the act of Congress requiring an exhibit on the part of the Museum and Fish Commission.

As will be seen from the list of accessions, a large amount of material was received from various sources for this purpose and part of the exhibit prepared by the writer for the Centennial Exposition at Philadelphia, and afterwards taken to the Berlin Fisheries Exhibition, did duty on this occasion. The writer, at Lieutenant Winslow's request, aided him from time to time by such suggestions or advice as circumstances seemed to call for. A catalogue of the collection as exhibited was prepared by Mr. Winslow and has been published as one of the series of official catalogues of the collective exhibit of the United States. It was, of course, based entirely upon specimens in the national collection, many of which were obtained especially for the purpose.

Mr. Safford, a graduate of the United States Naval Academy detailed for special study by the Navy Department, rendered assistance in labeling and cataloguing a few species of shells at the National Museum, and subsequently was engaged in similar but more extended work in the field with the United States Fish Commission during the summer of 1883.

On July 1, Miss Agnes Nicholson was engaged to take charge under my direction of clerical and analogous work in the department, which she has carried on in a satisfactory and efficient manner.

A number of collections sent for naming by various students throughout the country have been named and returned by the Curator, who has devoted nearly all his available leisure from other official duties to the improvement of the arrangement of the collection.

There can be no doubt, from the inquiries addressed to the Curator during the year, that when the conchological collection is once arranged for ready reference it will be resorted to very largely by students either in person or by letters addressed to the curator. With the existence of such facilities properly administered, the study of these animals will be promoted and the number of students largely increased. This however cannot be expected to occur until the curator shall be able to devote his whole time exclusively to the collection and cognate matters.

The accessions of the past year have been extremely important.

The United States Fish Commission work has been carried on with new facilities and its usual vigor; many mollusks new and known were dredged, and a rough catalogue of them made before they were sent for study to Professor Verrill at New Haven, where, with the exception of a few cephalopods, the entire Fish Commission collection of mollusca for the last twelve years remains.

The collection prepared for the London Fisheries Exhibition will be available on its return for exhibition in the Museum. The oyster industry is especially well illustrated by it. The models of gigantic cuttlefish and octopus prepared by Mr. Emerton are especially valuable for the instruction of the public.

The collection received from R. E. C. Stearns, Ph. D., of the University of California, and still unpacked, is general in its nature, but with regard to the western coast of both Americas is probably not only the most valuable collection in existence but more valuable than all other collections from the region put together. It has been made on scientific principles, and in this respect differs from most of the older collections, in which little more than the mere name of the shell was preserved. There are other collections containing more species, but few, if any, of greater beauty; none are known which so well illustrate the fauna of our Pacific coasts and territories.

Mr. W. G. Binney and Dr. Isaac Lea have furnished valuable types of land and fresh-water species belonging to the fauna of the United States, mostly *Helix*, *Limnæa*, and the like.

The classical collection of Dr. John Gwyn Jeffreys, F. R. S., &c., has been secured for the National Museum. What the Stearns and Carpenter collections are for the California fauna, that of Dr. Jeffreys is for the fauna of the North Atlantic, the British Isles, and Northwest European coasts. Indeed, it is really more, for, in addition to a profusion of types described by himself and other authors in modern days, the collection contains selections of typical specimens from the cabinets of nearly all the older British naturalists, such as Montague, Turton, Humphrey, Alder, Brown, and a host of others. It also contains the types and in most cases the unique examples of the shells dredged by most of the deep-sea explorers of the North Atlantic except the Challenger expedition, as for instance specimens from the "Lightning," "Porcupine," and "Valorous" expeditions; others from the "Josephine," "Knight Errant," "Triton," and "Vöringen" parties. Now that the United States, through the Fish Commission, are doing more toward deep-sea investigation than any other nation, the possession of these types is invaluable for our students, who must otherwise have gone to Europe for determining the objects of their study. When to these are added the Stearns and Alaskan collections and those of the Fish Commission, it will be evident that for the study of the marine fauna of our shores we have a collection which can never be rivaled, and only awaits suitable administration. An extremely interesting collection from the south and west shores of Florida has been contributed by Mr. Henry Hemphill to the National Museum. It contains about two hundred species, nearly all quite small, and many of them new to science or to our coasts; Mr. Hemphill is at present further exploring the same region. A list of this collection has appeared in the Proceedings U. S. National Museum for 1883.

The less noteworthy accessions appear in the list hereto appended.

Our registers show addition of about 3,000 entries during 1883, but this has no relation to the accessions, as it is impossible with the present force to administer upon a one-hundredth part of the accessions per annum, until the arrears of the past ten years are brought up. There are perhaps 20,000 miscellaneous mollusks awaiting entry, while the Stearns and Jeffreys collection will contain 50,000 more.

At present, owing to the condition of the lower hall, no mollusks are on exhibition, but a large number are ready for exhibition whenever cases and facilities may be afforded.

List of accessions.

Austin C. Apgar, *Trenton*, *N. J.*, *October* 19. Accession 13597. One box specimens of mollusks from New Jersey, *Sphærium* and *Pisidium*, unassorted, about 1,000 specimens.

J S. Arnheim, San Francisco, Cal., October 26. Accession 13616. Two specimens of snail shells (*Helix*) from California.

W. G. Binney, Burlington, N. J., October 31. Accession 13639. Twelve specimens of United States land shells.

E. G. Blackford, 80 *Fulton Market, New York, January* 3. Accession 12505. Four barrels oysters, assorted specimens, for use in the London Fisheries Exhibit.

E. G. Blackford, 80 *Fulton Market, New York, January* 19. Accession 12585. One oyster shell, peculiarly overgrown with *Polyzoa.*

E. G. Blackford, 80 *Fulton Market, New York, February* 22. Accession 12759. One box of clam and other shells. Useful mollusks for the London Fisheries Exhibit.

L. A. Blochman, San Diego, Cal., April 20. Accession 13031. One small box, specimens of shells.

A. Booth, Baltimore, Md., March 27. Accession 12941. Two boxes, 1 barrel, and 2 bales of oysters for London Exhibit.

W. M. Bowron, South Pittsburg, Tenn., May 4. Accession 13094. Specimens of *Helicina orbiculata* for name.

W. M. Bowron, South Pittsburg, Tenn., June 2. Accession 13198. Two specimens of land shells, for name, from Tennessee.

T. W. B. Clark, Boston, Mass., January 12. Accession 12542. One package small oysters, shells split and not split. Specimens of oysters bored by *Diplothyra Smithii* for London Exhibit.

*T. W.B. Clark, Boston, Mass., March*19. Accession 12895. One box, and bottle alcohol with oysters, from Devil's Island, Chesapeake Bay, for London Exhibit.

F. C. Dayton, Patchogue, Suffolk County, New York, February 2. Accession 12651. One box oysters from Long Island for use in London Fisheries Exhibit.

M. Deming, Providence, R. I., March 1. Accession 12798. One box oysters for use in London Fisheries Exhibit.

Horace D. Dunn, San Francisco, Cal., November 1. Accession 13645. One package specimens of oyster shells from California. Transplanted east coast oysters (*O. virginica*) showing growth in Californian waters.

R. D. Evans, Baltimore, Md., June 23. Accession 13265. Ten bottles specimens of coral, &c., taken from buoys in James, York, and Potomac Rivers, also specimens of shells, oysters, &c., for use in London Fisheries Exhibit.

C. M. Ferry, Oneida, N. Y., September 15. Accession 13492. Specimens of shells from Oneida Lake, New York. Two specimens of *Unio.*

Alexander Fish, Smith's Landing, N. J., January 5. Accession 12520. One box oysters. Assorted economic mollusks for use in Fisheries Exhibit at London.

A. Foote & Co., New Haven, Conn., January 4. Accession 12516. One box of fresh clams from Connecticut for use in Fisheries Exhibit, London.

A. Foote & Co., New Haven, Conn., January 29. Accession 12626. One box of clam shells; same use as the preceding.

A. Foote & Co., New Haven, Conn., February 12. Accession 12692. One box clams; same as preceding.

A. Foote & Co., New Haven, Conn., February 14. Accession 12704. One box *Mytilus edulis* and *Solen americanus* for London Exhibit.

George T. Garrison, Accomack C. H., Va., May 11. Accession 13119. One box specimens of borer, shells of oysters destroyed by borer, and three live oysters, one of which borer has just penetrated. For London Exhibit.

J. W. Grey (through Barnet Phillips), Hartford, Conn., November 23. Accession 13711. Two specimens of shells, said to have fallen at Hartford, Conn., November 11, 1883, in a rain storm. These are *Cionella lubrica* Mull., and doubtless were under leaves, &c., before the rain fell.

E. H. Hawley, U. S. National Museum, September 11. Accession 13486. One bottle alcoholic specimens of shells, Niagara River, above American Falls.

Henry Hemphill, Cedar Keys, Fla., April 24. Accession 13044. One box marine shells, from coast of Florida.

Henry Hemphill, Albert Lea, Minn., June 25. Accession 13268. One package specimens of shells, from Texas, Mississippi, and Louisiana. Supplementary to the preceding.

Henry Hemphill, Cedar Keys, Fla., November 30. Accession 13733. One package specimens of shells from Florida. Supplementary to the preceding.

Alfred W. Hinde, Anaheim, Cal., August 18. Accession 13429. One package, 18 specimens of shells for name, from California. They were named and returned to sender.

G. S. Hobbs, U. S. National Museum, February 24. Accession 12765. One box oysters from Savannah, Ga.

G. S. Hobbs, U. S. National Museum, February 24. Accession 12768. One box of oysters from Florida.

J. Gwyn Jeffreys, England, April 30. Accession 13083, 13424, 13508, &c. Four boxes shells, being miscellaneous European and British acephala, land and fresh-water shells and brachiopods.

John F. Kelly, Washington, D. C., April 7. Accession 12986. One bottle alcoholic specimens of snail (*Limax flavus*) which infests cellars.

Isaac Lea, Philadelphia, Pa., April 2. Accession 12965. One package miscellaneous land and fresh-water shells.

C. C. Leslie, Charleston, S. C., February 26. Accession 12780. One box oysters for use in London Fisheries Exhibit.

W. R. Lighton, Ottumwa, Iowa, October 2. Accession 13537. One box specimens of unios from Ottumwa, Iowa.

Thos. J. Love, Cedarville, N. J., January 25. Accession 12618. One box oysters assorted sizes and ages for use in London Exhibit.

C. L. McKay (deceased), September 27. Accession 13527. Specimens of marine shells from Alaska, 10 specimens, 4 species collected at Nushagak.

John J. McLean, Cape Mendocino, Cal., December 21. Accession 13805. Specimens of shell from California (*Cryptochiton Stelleri* Midd.).

J. A. McNiel, New York City, September 6. Accession 13473. One box alcoholic specimens shells from mountain streams of Chiriqui. *Neritina*, *Ampullaria*, and *Glandina*, 1 species of each, and about 12 specimens.

Allen Neil, Barnegat, N. J., January 9. Accessions 12530. One box oysters, &c., for use in London Exhibit.

Henry E. Nichols, Lieutenant-Commander U. S. Navy, commanding U. S. S. "Hassler," December 5. Accession 13757. Miscellaneous collection marine shells, from Southeastern Alaska.

Willard Nye, jr., New Bedford, Mass., February 27. Accession 12791. One package clam shells, for use in London Exhibit.

Willard Nye, jr., New Bedford, Mass., November 30. Accession 13730. Alcoholic specimens of shells (*Mactra* sp. jun.) taken from a "white wing" bird, Trimble Island, Long Island Sound.

Charles R. Orcutt, San Diego, Cal., September 21. Accession 13512. Specimens of shells from Lower California. *Hinnites giganteus* Gray.

Dr. Edward Palmer, U. S. National Museum, January 23. Accession 12601. Small box of land shells from Red Foot Lake, Tennessee.

Jason S. Pearce & Co., Providence, R. I., January 5. Accession 12519. One basket oysters for use in London Exhibit.

Robert Ridgway, Wheatland, Ind., May 16. Accession 13139. One bottle alcoholic specimen of land shells from Indiana.

F. A. Sampson, Sedalia, Mo., March 3. Accession 12815. One box land and fresh-water shells.

Ernest E. T. Seton, De Winton Farm (through Jas. W. Taylor, U. S. consul, Winnipeg), Carberry, Manitoba, August 2. Accession 13383. Two land shells, &c.

R. W. Shufeldt, Jackson Barracks, New Orleans, La., April 24. Accession 13048. Specimens of land and fresh-water mollusks in alcohol from Louisiana.

Steamer "Lookout," U. S. Fish Commission, Washington, D. C. Accession 12546. Two baskets oysters, Potomac River.

R. E. C. Stearns, Berkeley, Cal., April 30. Accession 13080. Specimen of shell, from 8 feet below surface in Tanaja Cañon, Texas. Nineteen cases of mollusca and shells contained in the Stearns collection.

John Southerland, 64 Liberty street, New York, May 18. Accession 13148. One specimen of shell of *Arca pexata* Say.

Samuel W. Very, Santa Cruz, Patagonia, June 6. Accession 13209. Specimen of shells of oysters, &c.

Peter Watkins, Ocean View, N. J., January 4. Accession 12518. One box of oysters for use in London Exhibit.

Dr. C. A. White, U. S. National Museum, January 16. Accession 12558. Two large oyster shells from Sheepscot River, Maine, subfossil, the bed being extinct.

George White, U. S. National Museum, September 3. Accession 13459. Four alcoholic specimens of snails (*Limax flavus*).

A. A. Wilson, East Greenwich, R. I., January 3. Accession 12503. Specimen of quahogs or clams for use in London Exhibit.

Lieut. F. Winslow, U. S. N., February 27. Accession 12789. One box oysters, cluster of natural growth from the sea-coast.

DEPARTMENT OF MARINE INVERTEBRATES.

RICHARD RATHBUN, Curator.

Accessions.

The principal accessions to this department during 1883 were made by the U. S. Fish Commission, and consist of both determined and undetermined collections, the majority of which were obtained in the recent deep-sea explorations of the new Fish Commission steamer "Albatross," off the eastern coast of the United States. During the spring, two lots of determined marine invertebrates, belonging to collections made in former years, were received from Prof. A. E. Verrill, of Yale College. Again, in October, at the close of the summer explorations of the Fish Commission, about forty cases of specimens were shipped directly from the Wood's Holl station to Washington. The latter shipment contained about 200 identified species, belonging mainly to the groups of crustacea, echinoderms, anthozoa, tunicates, and annelids, and a large quantity of material which had not yet been carefully examined. Many of the species, both determined and undetermined, were represented by several varieties, or by specimens from numerous localities and different depths, to illustrate geographical and bathymetrical distribution. The entire collection filled upwards of 1,500 tanks, jars, bottles, homœopathic vials, and small boxes, and was mostly preserved in alcohol. In this enumeration no account has been taken of the collections sent to Professors Verrill and Smith, at Yale College, for examination and report, and which will soon be turned over to the Museum.

Mr. Vinal N. Edwards, the permanent agent of the Fish Commission at Wood's Holl, has sent in during the year several interesting collections, made at seasons when that station is not visited by any of the scientific party.

From the Museum of Comparative Zoology at Harvard College there have been received three collections, representing a portion of the scientific results of the explorations of the United States Coast Survey steamer "Blake," from 1877 to 1880, off the southern and eastern coasts of the United States and among the West Indies. Prof. Alexander

Agassiz was in charge of the natural history work, and accompanied the steamer during nearly the entire time while dredging operations were being carried on. The valuable collections made were, under the supervision of Mr. Agassiz, placed in the hands of competent specialists in the several groups for study, and as rapidly as the reports upon each group were published, the National Museum has received a complete series of all the species obtained. The sponges and a portion of the crustaceans were received during 1882, and are referred to in the annual report for that year. The collections received this year are as follows: Thirty-one species of deep-sea corals, consisting of dry preparations entirely, and mainly obtained from the region of the West Indies, between 1877 and 1879; determined by the late Count L. F. de Pourtales. One hundred species of Ophiurans (brittle-stars or serpent stars) and Astrophytons (basket-fish), entirely preserved in alcohol and determined by the Hon. Theodore Lyman. Thirty-six species of *Echini* or sea urchins, mainly alcoholic preparations, determined by Prof. Alexander Agassiz.

The Museum of Comparative Zoology has also contributed to the National Museum during the year a collection of 18 species of North American fresh-water cray-fishes (*Astacidæ*), which nearly completes our list of desiderata in that interesting group, for the United States.

From Prof. H. E. Webster, of Union College, a very valuable collection of marine annelids in alcohol, containing about 180 species, obtained from the eastern coast of the United States, between Eastport, Me., and Virginia. These specimens were mainly obtained from the shores and from the shallow waters just off shore, and represent the recent researches and publications of Professor Webster, one of the best known American authorities on this group of marine invertebrates. Mr. James E. Benedict, now naturalist of the U. S. Fish Commission steamer "Albatross," was associated with Professor Webster in much of his annelid work.

From Dr. William B. Carpenter, London, England, through Mr. Romyn Hitchcock, 47 microscopic slides, representing four species of the genus *Orbitolites* of rhizopods, collected by H. M. SS. "Challenger," "Porcupine," and "Valorous." This collection consists of both dry and moist preparations in fine condition, and is illustrative of a recent monograph by Dr. Carpenter, contained in the "Reports of the scientific results of the exploring voyage of H. M. S. 'Challenger,' 1873–'76."

From Mr. Edward Potts, Philadelphia, Pa., 23 species of American fresh-water sponges, contained on 89 microscopic slides and in 16 bottles. Twenty species are from the States of Pennsylvania, New Jersey, New York, and Massachusetts, and three species from South America. Nearly all the known North American species are represented.

From Dr. Edward Palmer (by purchase), a fine collection of dried preparations of the non-commercial horny sponges of Florida and the Bahama Islands, identified by Prof. Alpheus Hyatt, of Boston. Twenty-two species, represented by 42 specimens, and covering several varieties, have been selected from this collection for the reserve series, and have been mounted by Mr. Hawley for exhibition. A sufficient number of duplicates remain to form two good sets for exchange. These specimens formed a part of the collection on which Professor Hyatt based his monograph of the Poriferæ, published in the Memoirs of the Boston Society of Natural History, for 1871-'78.

From Messrs. McKesson & Robbins, New York, over 200 specimens of Florida commercial sponges, representing nearly all the known commercial varieties. This collection is supplemental to collections received from the same firm in 1882, and derives a special value from the fact that the supposed age of each specimen is indicated, based upon recent experiments in sponge cultivation at Key West, Fla., by the agent of McKesson & Robbins. The latest information received regarding these experiments indicates that the practical success of sponge culture has been quite fully assured.

From Dr. Leonhard Stejneger, a large collection of marine and fresh-water invertebrates from Bering Island, off the Pacific coast of Siberia, made during 1882 and 1883. From Dr. R. W. Shufeldt, U. S. A., a collection of cray-fishes, containing several species and very many specimens from the Mississippi River, near New Orleans, and of fresh-water and marine shrimps from Southern Louisiana.

From the United States Signal Service Bureau, a valuable collection of marine and fresh-water invertebrates, made in the vicinity of Point Barrow, Alaska, by the observing party under Lieutenant Ray, U. S. A., stationed there from 1881 to 1883, and of which Mr. John Murdoch and Mr. Middleton Smith acted as naturalists. This collection is now being examined by Mr. Murdoch. Also a small but interesting lot of marine invertebrates from Bristol Bay, Alaska, collected by Signal Observer C. S. McKay, deceased.

From naval sources: A large and fine collection of marine invertebrates, mainly echinoderms and crustaceans, from the coasts of British Columbia and Southern Alaska, made by Lieut. Commander Henry C. Nichols, U. S. N., in command of the United States Coast Survey steamer "Hassler." A collection of crustacea from the west coast of Greenland, made by Ensigns H. G. Dresel and A. A. Ackerman, attached to the United States steamer "Yantic," tender to the Greely relief steamer "Proteus." Miscellaneous collections containing immense numbers of small animals, obtained by dredging and by scraping buoys, &c., from Commander R. D. Evans, U. S. N., in charge of the fifth light-house district. These materials were mostly collected at the mouth of Chesapeake Bay, and of the Potomac, James, and York Rivers, and contain a large number of small, undescribed species. Two species of corals from an iron buoy and chain in the harbor of the Dry Tortugas, Florida, sent by Lieut. Commander J. K. Winn, U. S. N., in charge of the Key West, Fla., naval station. A very large and finely preserved specimen of star coral, *Oculina varicosa* Lesueur, growing about one end of a long iron crow-bar, obtained at Key West, Fla., and contributed by Mr. R. E. Peary, civil engineer, U. S. N. The history of this specimen, as given by Mr. Peary, is as follows: "It was found in some 6 feet of water, on the site of a former coal wharf, belonging to the naval station. This wharf, as I am informed, was built in 1865 and destroyed by a hurricane in 1873. The inference is that the crow-bar, to which the coral is attached, fell overboard from the wharf some time between those two dates." The coral mass, which consists of rather large and closely-growing branches, measures about 20 inches in height by 15 inches in diameter.

The following accessions, although not of great extent, are worthy of special mention: Fine collection of the edible crustacea of the vicinity of San Francisco, Cal., from Prof. R. E. C. Stearns. Collection of fresh-water shrimps and crabs, from mountain streams of Chiriqui, United States of Colombia, at an elevation of about 4,000 feet above the level of the sea, presented by Mr. J. A. McNiel. Alcoholic marine invertebrates from the Mauritius Islands, presented by Col. N. Pike. Fresh-water invertebrates from Utah and Wyoming Territories, and marine invertebrates from Buzzard's Bay and Long Island Sound, collected by Willard Nye, jr.

Outline of work accomplished during the year.

During the first three months of this year, the curator was mainly occupied in preparing for the London Fisheries Exhibition the collections illustrating the marine invertebrate industries of the United States, exclusive of the mollusca, and the scientific investigation of the sea and fresh waters by American explorers. In making up the former collection, the collections of the National Museum were largely drawn upon for specimens of the economic crustaceans, worms, echinoderms, and sponges, of which every American species known to be of direct importance to mankind, either as food, as bait, or otherwise, was fully represented by carefully made preparations. In several instances, where the Museum collections were deficient in materials required, the deficiencies were supplied by donations to the Museum, resulting in permanent gain to that institution. In this manner were obtained for the Museum large numbers of Florida commercial sponges, many annelids from the eastern coast of the United States, and crustaceans from the coast of California, as noted above in the list of important donations. The catalogue descriptive of this industrial collection, prepared by the curator, contains eighteen pages of introductory matter, briefly describing the present state of, and the methods of conducting, the marine invertebrate fisheries, and a list of seventy-four species of crustaceans, worms, echinoderms, and sponges, useful or injurious to man. At the Fisheries Exhibition three awards were made in this section, as follows: A gold medal to the U. S. Fish Commission, for a model of a lobster-canning establishment; and a bronze medal and a diploma to Messrs. McKesson & Robbins of New York, for a collection of Florida sponges.

The second collection regarding scientific investigations had a direct bearing upon this department only so far as concerns the results of investigations, the methods coming more within the scope of the U. S. Fish Commission. The methods of research were represented by models and plans of American exploring steamers, and by all the modern appliances used by American explorers in investigating the sea and fresh waters, more especially with reference to biological problems. This portion of the collection was mainly supplied by the U. S. Fish Commission, the U. S. Coast Survey, and Commander Charles D. Sigsbee, U. S. N., and will probably be turned over, in large part, to the National Museum as a permanent exhibit. The results of reseach were represented by oceanic charts and relief maps furnished by the U. S. Coast Survey, the Naval Hydrographic Bureau, and the U. S. Fish Commission, and by collections of deep-sea invertebrates, fresh water cray-fishes and sponges, marine algæ, &c., supplied by the National Museum. To accompany this collection a catalogue of 109 pages was also prepared by the curator, giving a historical sketch of American explorations, and describing in detail the various appliances of research exhibited, with lists of the specimens, and charts illustrating results of investigations.

Nine awards were made in this section by the jurors of the Fisheries Exhibition, as follows:—Gold medals: To the U. S. Fish Commission, for collective exhibit of apparatus for deep-sea explorations; to Prof. J. E. Hilgard, for optical densimeter; to Commander Charles D. Sigsbee, U. S. N., for deep-sea sounding apparatus; to Passed-Assistant Engineer W. L. Bailie, U. S. N., for deep-sea thermometer case. Silver medals: To the U. S. Fish Commission, for exhibit of dredges; to Lieutenant-Commander Z. L. Tanner, U. S. N., for deep-sea sounding apparatus; to Prof. W. G. Farlow, for collection of marine algæ. Bronze medal to Mr. Edward Potts, for collection of fresh-water sponges. Diploma to Mr. James E. Benedict, for rake-dredge.

From April to June, special attention was paid to identifying and classifying the higher Decapod crustaceans, and several other groups of crustaceans, of which the Museum possesses valuable collections from many parts of the world. During the two or three months devoted to this work, only comparatively slight progress could be made, owing to the lack of literature and of type collections for comparison, but it is proposed to continue again upon these and other groups at an early date, with the intention of preparing materials for publication. The following families and genera were examined and placed in complete order, nearly all the species having been identified and transferred to exhibition jars, which are now properly labeled and available for reference: the families, *Portunidæ*, *Ocypodidæ*, *Grapsidæ*, *Porcellanidæ*, *Raninidæ*, *Hippidæ*, *Panuliridæ*, *Squillidæ;* and the genera, *Cancer*, *Hyas*, *Epialtus*, *Calappa*, *Hepatus*, and *Randallia*. The crustacea remaining to the Museum from the Wilkes United States Exploring Expedition and the North Pacific Exploring Expedition were also gone over in the same manner. The former collection now contains only 51 species, and the latter 34 species, out of many hundreds destroyed by the Chicago fire of 1872.

During June, the entire collection of alcoholics was overhauled and placed in safety for at least another year, and the collecting outfit, stored in the armory, was put in order and packed for shipment to Wood's Holl. Much time was also spent in correcting the proof sheets of a report on the natural history of economic marine invertebrates for the Fishery quarto report.

From July 1 until about the middle of October, the Curator was at Wood's Holl, Mass., assisting in the explorations of the U. S. Fish Commission. This time was mainly occupied in collecting and studying the parasitic Copepoda of that region, a common group of crustacean parasites, occurring principally upon the exterior surface and the gills of fishes. A number of new species were obtained and several figured. The collection of parasitic Copepoda in the Museum is now quite large and in a good state of preservation. An account of the summer's work of the Fish Commission would be out of place in this connection, and reference need only be made to some of the results by which the Museum has already been enriched, and the disposition made of the remainder of the materials collected. Deep-sea dredging was carried on mainly by the new steamer "Albatross," although a few short trips were also made by the steamer "Fish Hawk." The cruises of the "Albatross" covered a wide area, extending from the eastern slope of George's Bank westward to near New York, and southward at least one-third the distance to Bermuda. The deepest haul was made in nearly 3,000 fathoms of water with the common form of beam trawl, this being the greatest depth in which the trawl has been used by any explorers. The total number of casts made with the dredge and beam-trawl was 116. Mr. James E. Benedict was in charge of the collecting of marine invertebrates on the "Albatross," and was assisted mainly by Mr. Sanderson Smith, although other members of the party made frequent trips. Prof. A. E. Verrill, of Yale College, had immediate charge of the explorations and laboratory work, and was aided by nearly the same party as in former years. Such specimens as it was possible to identify on the spot, and which needed no further examination, including many duplicates of deep-water species, were sent to the National Museum at the close of the season. The collections of sponges and of parasitic copepods were also sent to the same institution. The material belonging to the following groups, and requiring further elaboration, were shipped to New Haven: the Mollusca, Mulluscoida, Echinodermata, Anthozoa, and Hydroida, for report from Professor Verrill, and the Crustacea for report from Prof. S. I. Smith. The Foraminifera were referred to Prof.

L. A. Lee, of Bowdoin College, Brunswick, Me., and the Annelida were retained on the steamer "Albatross" for examination by Mr. Benedict. About forty boxes of invertebrate materials were brought directly to the National Museum. Their character has already been discussed under accessions.

Since the return from Wood's Holl, the Fish Commission collections have been unpacked, and a large collection brought to Washington by the steamer "Albatross," on her last trip from Wood's Holl, has been sorted, catalogued, and, in large part, sent to New Haven. In December, the work of entirely revising the invertebrate collections of the department, and of arranging the catalogue cards in systematic order, was begun. This will occupy several months, and when completed will enable one to obtain any species or specimens in the department without loss of time.

Assistants.

In the routine work of the Museum I have been assisted during the year by Mr. R. S. Tarr and Mr. George Weld; Ensign W. E. Safford, U. S. N., also acted as an assistant in the department from January until July. All of these assistants were stationed at Wood's Holl, Mass., during the summer explorations of the U. S. Fish Commission, and since their close Mr. Safford has remained at New Haven, Conn., aiding Professor Verrill in the examination of the Fish Commission collections. Mr. Tarr has been mainly occupied in preparing the duplicate materials for distribution, in arranging the collection of star-fishes, and in general sorting and cataloguing. Mr. Weld has assisted him in this work. Mr. Safford's time, during the winter and spring, was devoted to sorting, cataloguing, and identifying collections of mollusca, and during the summer, to figuring small species of mollusca obtained by the Fish Commission, and in sorting. Mr. James E. Benedict, in the intervals in which the steamer "Albatross" has remained in port at Washington, has devoted much time to classifying and studying the annelid collections of the National Museum. After the return of the "Albatross" to Washington, in November, Mr. Sanderson Smith remained at the Museum about a month, completing his work upon the collection of mollusks, made on the last trip of that steamer. Ensign C. S. McClain, U. S. N., reported to this department in December for duty, and is now aiding me in the revision of the collections. Mr. E. H. Hawley has, during the year, mounted for exhibition a number of specimens of marine invertebrates, principally crustaceans, corals, and sponges. But want of time has prevented the curator from selecting much material for that purpose.

Work upon collections by specialists outside of the Museum.

The Hon. Theodore Lyman, member of Congress from Massachusetts, the well-known authority on the group of Ophiuroidea, has kindly offered to spend as much of his leisure time as possible in identifying the species of that group contained in the Museum collections, and he has already examined considerable material. Last winter the Museum collection of fresh-water cray-fishes was sent to Prof. Walter Faxon, of Harvard College, who is preparing a monograph upon that group. During the past year much material on the same subject has been received from many American sources and forwarded to Cambridge for his use. He proposes first to monograph the specimens belonging to the Museum for one of the Museum reports. The Labrador collections of Mr. W. A. Stearns, made during the summer of 1882, were referred to Professors Verrill and Smith, of Yale College, for examination. Reports upon the crustaceans by Prof. S. I. Smith, and upon the echinoderms and mollusks by Miss Katherine J. Bush, have been published during the year in the Proceedings of the Museum. It is proposed to offer the Museum collections of foraminifera to Prof. L. A. Lee, of Bowdoin College, for study.

Distribution of duplicates and exchanges.

The distribution of duplicate specimens selected from the large collections received from the U. S. Fish Commission has been continued through the year. Series III, or the educational series of duplicates, prepared in 1882, has been entirely expended. Of Series II, the preparation of which was completed in the spring of 1883, 31 sets have already been sent out. Of the London series, prepared for the purpose of making exchanges in connection with the London Fisheries Exhibition, 5 sets have been disposed of, with suitable returns promised to the Museum, and negotiations are now pending regarding the remaining five sets of the series.

The institutions supplied with duplicate sets during 1883 were the following:

Series II, containing about 190 species each: Johns Hopkins University, Baltimore, Md.; Williams College, Williamstown, Mass.; College of New Jersey, Princeton, N. J.; Dartmouth College, Hanover, N. H.; Kentucky University, Lexington, Ky.; College of New York, New York City; Vassar College, Poughkeepsie, N. Y.; Smith College, Northampton, Mass.; Wellesley College, Wellesley, Mass.; Hanover College, Hanover, Ind.; Tabor College, Tabor, Iowa; Middlebury College, Middlebury, Vt.; University of North Carolina, Chapel Hill, N. C.; Cornell University, Ithaca, N. Y.; Martha's Vineyard Summer Institute, Cottage City, Mass.; Knox College, Galesbury, Ill.; Ohio Wesleyan University, Delaware, Ohio; Wabash College, Crawfordsville, Ind.; University of the State of Missouri, Columbia, Mo.; Massachusetts Agricultural College, Amherst, Mass.; Normal School, Cincinnati, Ohio; Owen College, Manchester, England; McGill University, Montreal, Canada; Queen's University, Kingston, Canada; University

Laval, Quebec, Canada; University College, Toronto, Canada; Portland Society of Natural History, Portland, Me.; Buffalo Society of Natural Sciences, Buffalo, N. Y.; Polytechnic Society of Kentucky, Louisville, Ky.; Professor Duges, Guanajuato, Mexico; Mr. William Macleay, Elizabeth Bay, Sydney, Australia.

Series III, or Educational Series, containing 102 species each: Griswold College, Davenport, Iowa; Hampton Normal and Agricultural Institute, Hampton, Va.; Rockford Seminary, Rockford, Ill.; Avery Normal Institute, Charleston, S. C.; Cedar Valley Seminary, Osage, Iowa; Gates College, Neligh, Nebr.; Woodstock College, Md.; Theil College, Greenville, Pa.; State College, Pa.; Agricultural College, Fort Collins, Colo.; High School, Washington, D. C.; Mehurry Medical College, Nashville, Tenn.; King's College, Windsor, Nova Scotia; Historical and Scientific Society, Winnipeg, Manitoba; Davenport Academy of Natural Science, Davenport, Iowa; Kansas City Academy of Science, Kansas City, Mo.; Long Island Historical Society, Brooklyn, N. Y.; Agassiz Association, Saint Clair, Pa.; Public Museum of the city of Milwaukee, Milwaukee, Wis.; Professor C. T. Lindley, Davenport, Iowa.

London series of duplicates, containing about 225 species each: Prof. George S. Brady, Sunderland, England; Rev. A. M. Norman, Durham, England; Oxford University, Oxford, England; Cambridge University, Cambridge, England; Royal Academy, Stockholm, Sweden.

In return for the London sets sent out, the following collections have been promised, and, in one or two instances, have already been shipped to us: From Professor Brady, a complete series, so far as practicable, of the British free-swimming Copepods, a low order of Crustaceans, forming the chief food supply of many of our common surface-feeding fishes, such as the mackerel, menhaden, &c.; from the Rev. Mr. Norman, a nearly complete collection of all the known British crabs, shrimps, and parasitic Copepods, with other species of marine invertebrates; from the Royal Academy of Sweden, portions of the Vega collections, made by the Baron Nordenskiold, in the Arctic regions; and from the Universities of Oxford and Cambridge, carefully-made preparations of marine invertebrates for Museum display and the use of students.

Negotiations for four of the remaining sets are now in progress with the British Museum, the Imperial Museum of Austria, the Royal Institute of Natural History of Florence, Italy, and Prof. A. H. Malm, of Gothenborg, Sweden. The exchanges to be received for the London series of duplicates will form valuable accessions to the Museum, and amply repay the time and labor spent in preparing them.

A fourth series of duplicates of Fish Commission specimens, called Series IV, or Educational Series No. 2, is now in course of preparation, and will consist of 200 sets, each containing about 120 species. This series will be ready for distribution about March or April, 1884.

Collecting outfits supplied.

Collecting outfits for obtaining marine invertebrates were furnished during the year to the following parties: Ensigns H. G. Dresel and A. A. Ackerman, U. S. N., acting as naturalists on the U. S. S. "Yantic," of the Greely Relief Expedition; Lieut. Commander R. D. Evans, U. S. N., in charge of the sixth light-house district, covering the coasts of Virginia and Maryland; Dr. N. M. Ferebee, U. S. N., of the U. S. S. "Trenton," now en route for Corea via Europe and the Suez Canal; Dr. W. G. G. Willson, U. S. N., of the U. S. S. "Pinta," now en route for Alaska, from Norfolk, Va., via the Straits of Magellan; Mr. W. A. Stearns, of Amherst, Mass., for the purpose of collecting on the coast of Southern Labrador; Capt. Alexander Gray, of the S. S. "Labrador," who, in July last, carried supplies to Mr. L. M. Turner, signal observer at Ungava Bay, Northern Labrador. The smallest of these outfits consisted of a small dredge and a liberal supply of bottles and alcohol. The most of them also included one or more towing-nets, and that of the "Yantic" was quite complete, having a 6-foot beam trawl and a Baird seine in addition to several dredges, towing nets, &c. Collections have already been received from the "Yantic" party and from Lieutenant-Commander Evans.

Records.

The number of parcels catalogued during the year is shown in the following table, from which, however, no idea can be formed of the number of species or specimens included, as, while each parcel (bottle, vial, or box) is devoted to only a single species, it may contain a greater or less number of specimens, and the same species may be represented by several lots from as many different localities.

Table of entries made in the record books.

Groups.	Number of entries made to December 31, 1882.	Number of entries made to December 31, 1883.	Number of entries made during the year.
Crustacea	4,859 5,999	5,719 6,213	1,074
Porifera and protozoa	916	1,114	198
Bryozoa and tunicata	161	209	48
Annelida	160	729	569
Radiata	5,685	6,840	1,155
Totals	11,781	14,825	3,044

General Remarks.

The Curator is unable at present to make any positive statement regarding the number of specimens or determined species belonging to this department. The number of both is very great and will be calculated during the coming year, in connection with the work of revision now in progress. Materials have been received so rapidly and in such large quantities that the work of sorting, properly preserving and cataloguing specimens has occupied nearly the entire time of the small force assigned to this department. This large amount of routine work has greatly interfered with scientific research and the preparation of such reports upon biological subjects as are naturally expected from a department of this character. It is expected, however, that in the course of a few months the arrangement of the collections will be so perfected that the sorting and cataloguing of new materials will occupy much less time comparatively than in the past.

The lack of sufficient and suitably arranged space for handling and storing the alcoholic collections has been the main cause of much of our trouble and delay. At present, our only work room for alcoholics is a small laboratory in the west basement of the Smithsonian Institution, and nearly all the collections have to be stored in a dark passageway, where they are difficult of access and much crowded. For convenience in revising the collections, the west exhibition hall of the Smithsonian Institution has been temporarily closed to the public, and is being used for that purpose. As soon as that work has been completed, and the pottery removed from the cases on the west side of the hall, those cases will be refitted and devoted to dried collections of marine invertebrates, which have been already prepared for exhibition.

DEPARTMENT OF FOSSIL INVERTEBRATES (MESOZOIC AND CENOZOIC SECTIONS).

C. A. WHITE, Honorary Curator.

The fact that myself and my assistants are regularly employed upon the United States Geological Survey has largely prevented the accomplishment of much Museum work proper, but the necessary routine work of my division has been attended to.

Important accessions.

Early last summer Dr. Orville A. Derby presented to the Museum an important collection of invertebrate fossils from Brazil. Some of them are Carboniferous, a few are Devonian, but the most of them are duplicates of a considerable part of the Cretaceous species which I have prepared for publication under the auspices of the Brazilian National Museum.

Mr. George Stolly, of Austin, Tex., has, during the year, sent fifty-nine boxes of fossils from Texas to the Museum, only a part of which have been opened.

Of the collections that have been received through the United States Geological Survey, much the most important are those which have been sent from the Cretaceous and Tertiary rocks of the Gulf States by Mr.

Lawrence C. Johnson. He has sent sixty-two boxes of fossils during the year 1883.

Some interesting collections were made by my own party during last season, but they are not so important as they were last year.

Routine work.

Mr. John B. Marcou having been appointed my assistant upon the Geological Survey, I have placed him in charge of the Museum work of my division.

The present demands of the Survey has almost entirely prevented work upon the installment of the collections; but the ordinary routine work of receiving and recording accessions has been attended to. The accessions from miscellaneous sources during the year have been mainly unimportant.

The register-numbers of entries for the year are from 11,886 to 12,230.

Present state of the collections.

The arrangement of the collections has not progressed far enough to allow of any detailed report. They are still in the unit trays of the table-cases, in the west-south range, where they are in a safe condition.

Recommendations.

The work of the Survey and Museum is so rapidly increasing in my division that certain wants are becoming urgent. Near a hundred boxes of fossils are yet unopened, and we are now in want of suitable facilities for arranging those which are now opened. We need more unit and pasteboard trays, as well as racks for the former. I respectfully request also that I be furnished with a competent person whose duty it shall be to record and mark specimens with their numbers as the same are turned over to the Museum from the survey and elsewhere.

DEPARTMENT OF FOSSIL INVERTEBRATES (PALEOZOIC SECTION).

CHAS. D. WALCOTT, Honorary Curator.

Accessions.

The most important addition to the collection of Paleozoic invertebrate fossils during the year was that of the first series of duplicates from the James Hall collection of the American Museum of Natural History, New York. This collection was received before my appointment as curator, but had not been unpacked or recorded. It is now arranged in drawer cases, and will serve as the nucleus for the systematic arrangement of the collections from the regions east of the Rocky Mountains, or the Mississippi Valley and Atlantic area. It embraces over 1,200 species, as follows:

	Species.		Species.
Potsdam sandstone	25	Upper Helderberg	89
Chazy limestone	13	Marcellus shale	16
Quebec	8	Hamilton group	196
Trenton limestone	86	Tully limestone	3
Utica slate	24	Genesee slate	6
Hudson River group	76	Portage group	5
Medina sandstone	8	Chemung group	73
Clinton group	46	Catskill group	2
Niagara group	186	Waverly group	25
Onondaga salt group	5	Lower Carboniferous	128
Lower Helderberg group	84	Coal-measures	46
Oriskany sandstone	37		
Caudagalli grit	1	Total	1,221
Schoharie grit	33		

Another important addition is that of the collection of the Fortieth Parallel Exploring Expedition. This includes representations of upwards of one hundred species, many of which are types. This collection has not been recorded.

Mr. U. P. James presented the Museum with a series of typical specimens representing seventy-eight species, described by him, from the Hudson River group of Ohio.

Owing to the pressure of work in connection with the preparation of a report on the Paleontology of the Eureka Mining District, Nevada, I have not been able to give much time to arranging and classifying the collections except as incidental to that work.

The study of the collections of the U. S. Geological Survey is preparing a large amount of valuable material that will only need to be recorded in the records of the Museum, to form the nucleus of a large collection from the regions of the Rocky Mountains. In my next annual report I hope to give a list of the genera and species in this collection.

During the year no publications were made upon material recorded. A short paper in *Science* (vol. XI, p. 808) notices the discovery of fresh-water shells from the Lower Carboniferous of Central Nevada, the types of which are now in my hands.

The present state of the collections may be briefly stated: Ten standard cases of drawers containing about 20,000 specimens, representing nearly 1,800 species. These are arranged in stratigraphic order, and within that a zöologic arrangement is more or less clearly defined. This collection includes the Smithsonian collections and those of the various Government surveys, up to the time of the organization of the present Geological Survey. I found it without systematic arrangement, on taking charge in May, 1883, and have given most of the time I could spare from paleontologic work in connection with the Geological Survey, to arranging it, and also in getting the laboratory rooms fitted up. The latter are now in good order, and the facilities for work are such that little expenditure will be required the present year.

In the laboratory rooms there are upwards of 15,000 specimens, representing over 1,000 species, that will be ultimately added to the collection.

DEPARTMENT OF FOSSIL PLANTS.

LESTER F. WARD, Honorary Curator.

Accessions.

The most important addition which was made to the department during the year was a large collection of fossil plants from the Green River group of Elko Station, Nev., Bell's Fish Cliff, Alkali Stage Station, Wyoming, and Florissant, Colorado, but chiefly from the last named locality, consisting of more than 700 specimens belonging to nearly 100 species. These have been numbered and catalogued and form part of the reserve series.

The only other addition of numerical importance consists of 236 specimens from various localities in Europe and America, which were found in the north tower of the Smithsonian building, and which have also been duly installed.

The present state of the collection is as follows:

Number of specimens	4,924
Number of species	871
Of which there are—	
Paleozoic	236
Cretaceous	142
Tertiary	493

At the close of the year, in order to make room for a large collection of fresh material for study, it was found necessary to remove some of the duplicates. These were taken entirely from the Paleozoic and Mesozoic series, 896 specimen from the former and 195 from the latter, making 1,091 specimens. They were all carefully selected from the least perfect of the most abundantly represented species and have been placed in drawers, properly labeled, and are ready to be sent to the Armory building for storage.

DEPARTMENT OF LITHOLOGY AND PHYSICAL GEOLOGY.

GEORGE P. MERRILL, Acting Curator.

Accessions.

The total number of entries upon the department catalogue during the year has been 2,311, comprising 2,738 specimens. Strictly speaking however these cannot all be considered as accessions of the year, since many of the specimens have been the property of the Museum for a much longer period, but never before catalogued.

Below is given a list of the more important accessions:

(1) Ten specimens Vermont marble, showing methods of cutting and polishing. Gift of the Vermont Marble Company.

(2) Eighty specimens Kansas building stones. Gift of A. A. Robinson, agent for Atchison, Topeka and Santa Fé Railroad.

(3) Eighty-two specimens North Carolina building stones. Collected by Prof. W. C. Kerr.

(4) One hundred and four specimens building stones from the United States and foreign countries. Gift of John S. F. Batchen.

(5) A collection of thirteen varieties of grindstone. Gift of J. E. Mitchell, Philadelphia.

(6) Forty-five specimens of Italian marble. Gift of W. W. Story, Florence, Italy.

(7) One hundred and seventy-five specimens drift and eruptive rocks from Montana. Collected by Dr. C. A. White and J. B. Marcou, U. S. Geological Survey.

(8) One hundred and ninety-four specimens rocks from Yellowstone National Park. Gift of W. H. Holmes.

(9) Three hundred and eighty-five specimens typical rocks of New Hampshire, being the private collection of the late Dr. George W. Hawes.

(10) Twenty specimens obsidian and tufa from Mono Lake, California. Collected by I. C. Russell and G. K. Gilbert, U. S. Geological Survey.

(11) Four large concretions from near the mouth of Cannon Ball River, Dakota. Gift of Brig. Gen. M. C. Meigs.

(12) Thirty specimens Japanese marble. Received from Centennial Exhibition, Philadelphia.

(13) Three hundred and fifty-five specimen rocks of Victoria, Australia. Received from Centennial Exhibition, Philadelphia.

(14) One hundred and fifty-four specimens building stones of Portugal. Received from Centennial Exhibition, Philadelphia.

(15) A slab of Potomac breccia marble 2 × 3 feet, from Frederick County, Maryland. Gift of Col. Edward Clarke.

In arranging and classifying collections, the accurate determination of the specimens is the first essential. For this purpose the microscope is usually employed and some two hundred and fifty thin sections of rocks have been prepared. For exhibition purposes the building stones are dressed into 4-inch cubes, this being the unit size, while specimens of purely lithologic or geologic importance are broken with a hammer into sizes of about 3 inches × 4 inches × 1 inch.

Specimens illustrative of physical phenomena are prepared to suit individual cases. In the exhibition series the building stones are classified by States, this method being deemed best calculated to meet the wants of the general public. Collections of lithologic and geologic interest, representing the formations of any definite area, or investigations tending towards the solution of any particular problem, are preserved intact. Miscellaneous collections are broken up and classified by kinds.

No work upon the collections has been done by parties not officially connected with the Museum since the close of the census investigation of the building-stone industry of the United States early in the year.

The number of specimens in the entire collection is not far from 12,500, of which 3,862 are building stones, while the remainder are mostly smaller specimens of more strictly scientific interest. Of the entire collection not less than 2,000 are duplicates. Of the 3,862 specimens of building stone 1,684 are dressed, and 1,332 already on exhibition, though not yet fully labeled; but 54 specimens were dressed during the past year.

The following table gives the collection of building stone proper in detail, the majority of the specimens being of sufficient size to dress into 4-inch cubes, or to give at least 16 square inches of finished surface:

UNITED STATES.	
Alabama	10
Arkansas	8
Arizona	4
California	44
Colorado	31
Connecticut	65
Dakota	5
Delaware	5
District of Columbia	3
Florida	7
Georgia	7
Idaho	2
Illinois	110
Indiana	78
Iowa	195
Kansas	182
Kentucky	6
Maine	125
Massachusetts	226
Maryland	108
Michigan	29
Minnesota	108
Missouri	152
Montana	9
Nebraska	8
New Hampshire	106
New Jersey	133
New Mexico	16
New York	272
Nevada	8
North Carolina	120
Ohio	314
Oregon	6
Pennsylvania	331
Rhode Island	42
Tennessee	126
Texas	41
Utah	13
Vermont	220
Virginia	71
West Virginia	16
Washington Territory	4
Wisconsin	89
Wyoming	7
FOREIGN COUNTRIES.	
Africa	2
Bermuda	75
Canada	16
China	1
Egypt	6
France	3
Germany	1
Greece	2
Ireland	1
Italy	89
Japan	50
New Brunswick	5
New South Wales	8
Portugal	154
Russia	21
Scotland	24
Turkey	2
Total No. of specimens	3, 862

Much work yet remains to be done in the way of cataloguing and labeling. During the greater part of the year no one but myself has been engaged in this work, and the progress has necessarily been slow. Some of the older collections are in a most deplorable condition, owing to the fact that many of the labels are lost, or, if present, were written with a common pencil and have become almost illegible. Moreover, the data given are frequently so scanty that they are of no possible value. The collections of the various U. S. Geological Surveys are especially bad in this respect, and doubtless much of their material must ultimately be thrown away on this account alone.

A swing saw, made on the same general plan as the saw ordinarily used by stone-workers for sawing marble, &c., but much smaller, has been added to the department, and promises to be very efficient in cutting all varieties of material not sufficiently hard to require diamond dust. Steam-power has been introduced into the work-room, and the preparation of microscopic sections is thereby greatly facilitated.

The department of physical geology has been so recently assigned to my care that no report of progress can as yet be made.

DEPARTMENT OF MINERALS.

F. W. CLARKE, Honorary Curator.

The report of Mr. W. S. Yeates, who for the past year has had practically sole charge of the department of minerals, is here presented. Inasmuch as I only entered upon the duties as curator during the month of December, I have had as yet few opportunities of familiarizing myself with the collections, and can add nothing of importance to what Mr. Yeates has said. I have already taken steps towards the organization of a system of exchanges, and have entered into correspondence with some collectors; but there has not yet been time enough to realize anything from my efforts.

The department, in addition to the services of Mr. Yeates, now has the assistance of Naval Ensigns E. Wilkinson, H. S. Knapp, and O. G. Dodge. These gentlemen have been detailed for Museum services by the Secretary of the Navy, and are to be regarded as students rather than regular aids. Although they are called upon for work in the arrangement for cataloguing of specimens, it is clear that their chief efforts should be in the line of study; and that with them mechanical labor should be reduced to a minimum.

W. S. YEATES, Acting Curator. (*Jan.–Nov.*)

Accessions.

A large number of additions have been made to the collection during the year; and a large number of specimens, which had been temporarily under the care of this department, have been turned over to the departments to which they properly belonged. Special mention may be made of the following contributions: From Mr. John W. Lee, of Baltimore, Md., a choice collection of twenty-six specimens, principally from Maryland and Pennsylvania, for exchange; from Mr. F. L. Moore, of Georgetown, D. C., a contribution of six hundred pounds of gypsum from Windsor, Nova Scotia, which furnished us several handsome specimens for the reserve series, and two hundred and fifty-one specimens for the duplicate series; from Prof. F. W. Clarke, as an officer of the U. S. Geological Survey, we received a collection of beryl crystals, hyalite, &c., from Ashe County, North Carolina, consisting of thirty-seven specimens; a collection of muscovite, tourmaline, &c., from New Hampshire, consisting of twenty-four specimens; and a collection of allanite, triphylite, lepidolite, &c., from Maine, consisting of one hundred and forty-three specimens. Besides these, from his private collection we received a contribution of thirty-one specimens from various localities. In the collection from North Carolina there were three handsome specimens of hyalite and an exceptionally interesting crystal of quartz. All these specimens were received from Professor Clarke, prior to his official connection with this department. From Mr. N. H. Perry, of South Paris, Me., we received a collection from Oxford County, Maine, consisting of eighty-six specimens. These specimens were obtained for the Museum by Mr. George P. Merrill, of the department of rocks and building stones. From Dr. Wm. H. Jones, U. S. N., a box of garnets, both detached and in mica schist, from Alaska, consisting of one hundred and ninety specimens. This contribution was one of the most desirable received during the year. From Mr. George P. Merrill, a collection of minerals from Maine, consisting of one hundred and two specimens. Besides other good specimens in this lot, there was an interesting group of calcite crystals from Rockland, Me. From Mr. Joseph Willcox, of Delaware County, Pennsylvania, a collection of minerals from various localities, consisting of one hundred and nineteen specimens. Besides the gift of these, Mr. Willcox has been kind enough to lend to the department one thousand three hundred and thirty-four of the choicest specimens from his handsome collection of American minerals, to assist in filling a deficiency in our exhibition series. This collection being a loan, its withdrawal would leave quite a gap in our exhibition series. From Dr. Theo. Schuchardt, of Görlitz, Germany, was purchased a very good set of sixty specimens of minerals representing the Vesuvius locality. The private collection of Dr. George W. Hawes (late curator of this department), consisting of over five hundred specimens, has recently been turned over to me. The specimens are small, but some of them are very desirable. From the dump heap of the excavation for the foundation of a large building on Connecticut avenue, in this city, I obtained one hundred and twenty specimens of vivianite in clay, a mineral new to this locality.

Administration.

It may not be amiss to indicate the routine of this department. Specimens upon being received are carefully examined and named; they are then entered on the register, cleaned, trimmed, labelled, numbered, and assigned to that series of the collection, which is deemed best. Classifying and arranging specimens for exhibition constitute a large part of the work. The preliminary classification has been based upon Dana's System of Mineralogy. Attending to correspondence and preparing card catalogues are other work of the department.

In the reserve series of the department there are 7,150 specimens, of which 1,152 are on exhibition. In the duplicate series there are about 7,400 specimens, which, with the reserve series, make a total of about 14,550.

DEPARTMENT OF METALLURGY AND ECONOMIC GEOLOGY.

FRED. P. DEWEY, Curator.

During the past year, as it will be for several years to come, by far the larger portion of the material administered upon in this department was from the Centennial collections. Aside from this material, among the most interesting additions the department has received may be mentioned an extensive series of cokes, for the most part kindly sent by the various manufacturers, upon solicitation, for the purposes of an extended examination into its physical properties as affecting its employment as a metallurgical fuel (the series already represents most of the chief coking regions and is being increased from time to time); an extensive series of the iron ores and their associates and of apatite and its associates from Canada, collected by myself during my summer vacation; a small suite of Virginia gold ores from various parties, and especially Mr. W. G. Love, of Richardsville; a full suite of the recently discovered tin ore and its associates from Irish Creek, Virginia, collected by Mr. F. W. Taylor, U. S. N. M; a suite of specimens collected by Ensign E. Wilkinson, U. S. N., in Colorado, which is especially interesting from its richness in coal specimens, both bituminous and anthracite; and, finally, two very important suites of specimens representing the production of cast iron of extraordinary strength; the first is from Mr. Edward Gridley, of the Wassaic Furnace, Dutchess County, New York, where on a short run, on a carbonate ore, No. 4 charcoal pig iron of 47,500 pounds tensile strength per square inch was produced; and embraces the ore, both raw and roasted, the flux, the slag, and several pieces of the metal, including some of the test pieces; the second suite is from the Hon. C. E. Coffin, of the Muirkirk Furnace, in Prince George's County, Maryland; at this furnace charcoal pig iron of unusual strength has been regularly made from a carbonate ore for a number of years, some recent tests of the No. 4 pig iron running up to the very extraordinary figures of 52,475 pounds tensile strength per square inch. This suite includes a very full series of the different varieties of the ore and its associates from a pure siderite through its various stages of decomposition to a limonite, the flux (oyster shells), the charcoal, both kiln and meiler, the slag, and a very extensive and valuable collection of test pieces, with full records of the tests extending over a series of years.

In cataloguing the collections, 1,257 entries have been made upon the Museum register, embracing 1,918 specimens; of these, 535 entries were of the 83 accessions received during the year, embracing 882 specimens, and including 190 specimens received from Surveyor-General J. W. Robbins, of Arizona, through the General Land Office; the remaining 722 entries of 1,036 specimens were of material previously received, but of which no entry had been made, derived from four sources; 81 entries of 109 specimens from the U. S. Geological Surveys; 172 entries of 206 specimens from the U. S. General Land Office; 86 entries of 100 specimens from the old Smithsonian collection, and 383 entries of 621 specimens from the Centennial collections. In the preparation of the card catalogue 3,321 entries, embracing 5,265 specimens, have been made; these specimens have all been carefully examined by the curator in person and 7,314 determinations of mineral species made in the ore specimens. For the Smithsonian Institution 36 specimens have been examined and the necesssary reports prepared to accompany them, and two letters of information upon special topics have been written. Ensign A. A. Ackerman, U. S. N., rendered valuable aid in the work of the department until the 1st of June, when he was detailed to accompany the Greely relief expedition. Ensign H. M. Witzel, U. S. N., was detailed to the department December 1, and has scarcely had time to become familiar with the operations of the department. The clerical work has been ably performed by Mr. F. J. Offutt.

There have been two researches commenced during the year, neither of which, however, has been completed. The first is an extended examination into the physical properties of coke with especial reference to its employment as a metallurgical fuel and the prerequisites of a good coking coal. There have already been examined 153 specimens from 12 localities, and a synopsis of the results already obtained has been published by the American Institute of Mining Engineers, covering 15 pages of their Transactions, under the title of "Porosity and Specific Gravity of Coke."

The second investigation is upon the occurrence of free gold in galena, and will soon be ready for publication.

Any statement of the total number of specimens in the collections must be largely of the nature of an estimate, as there are still a great many boxes and packages of Centennial remaining unpacked. With the additions received from the permanent exhibition at Philadelphia during the year, I would place the total number at 30,000 or more.

As will be seen from what has gone before, the principal attention of the department has been devoted to the preparation of the card catalogue of the ores; and although many specimens are visible, yet it was only towards the close of the year that any attempt was made at placing the specimens on exhibition, so that only 763 specimens can be said to belong to the exhibition series; the large bulk of the material is therefore considered as being for the present in the reserve series, although there have been 321 specimens definitely assigned to the reserve series proper and 465 specimens to the duplicate series.

The general condition of the ore collection has been greatly improved by the care and attention devoted to it during the past year; the most part of it is now thoroughly identified, catalogued and provided for, at least temporarily, in cases; it is no longer subject to the unfavorable influences which in the past have tended so much to impair its utility, so that its further deterioration is guarded against as securely as possible.

A beginning has been made upon the metal specimens, and while many of them are badly injured from the exposure and want of care to which they, in common with the ore specimens, have been subjected, others are not so far gone but that they can be made useful, while a few are in a tolerably good state of preservation.

The ore collection, while large and in general quite complete, yet contains a few prominent deficiencies, for the filling of which some steps should be soon taken, and this is especially so in regard to the ore of a few regions, as Arizona, New Mexico, and the Menominee region, which have come into prominence since the close of the Centennial.

Illustrations of the various steps in the extraction of the metals, together with the incidental and by-products, are not as full and complete as could be desired. This being a subject of instruction in the science of metallurgy rather than a matter of the exhibition of showy and attractive specimens, it is not at all to be wondered at that the Centennial collection from which we derived so much should be deficient in this respect. A few complete series in this direction would very greatly enhance the instructive value of the extensive collections of ores and finished products by providing the necessary connection between the two. An excellent illustration of what is desired in this direction is furnished by the collection already mentioned from the Muirkirk Furnace. This collection embraces 75 specimens, and shows everything connected with the production of No. 4 iron at that furnace. Besides this, Mr. Coffin has very kindly furnished the department with full analyses and with the record of the running of the furnace, the whole forming a complete and very instructive exhibit. In this connection it might be well to say that manufacturers are not always willing to give such full illustrations of their operations, and, when they are willing, they do not always take the necessary care in selecting illustrations, so that it will not be so easy to procure just what we need as it might at first appear.

As indicated in my last annual report, the least satisfactory portion of the collections is that of the methods and means of metallurgical operations, the illustration by means of drawings, views, models, and, where practicable, the actual tools used, of the art of metallurgy. This is one of the most interesting and valuable portions of the subject, and at present is so poorly represented as to be scarcely illustrated at all. This deficiency of the collection could very readily be supplied, and it is so important, that a beginning should be made upon it as soon as possible in the coming year.

The construction of a special chemical laboratory for the use of this department, which has been approved and ordered, will facilitate greatly the work of the department in making chemical examinations and analyses. The present chemical laboratory, besides being crowded with other work, is inconvenient for this department. There are many subjects for chemical examination coming up almost daily in the work of cataloguing the collection, while the opportunities and demands for research upon the collections are almost unnumbered, so that the laboratory will be well occupied just as soon as it can be completed.

This being the first complete year since the establishment of the department, a great deal of care and attention has been absorbed in its proper inauguration, and, on account of the difficulties of handling so much bulky material as must necessarily constitute the exhibition series, the department has not made as much progress in the exhibition of specimens as could be desired; but most of the difficulties of inauguration are now passed, and, with a sufficient force of laborers to prepare and handle the specimens, there is no reason why the exhibition of this department should not begin to assume the prominent position in the Museum which it is entitled to hold from its interest and great value.

THE MUSEUM LIBRARY.

F. W. TRUE, Librarian.

The following report upon the operations of the library in 1883 is respectfully submitted. In the present condition of affairs it is perhaps impossible to furnish a report of a general character suitable for publication. I have therefore confined myself entirely to the simple details of administrative work.

The recommendations which I have already made relative to additional assistance, the establishment of more definite relations between this library and that of the Smithsonian Institution, an increase of regularity in the receipt of periodicals, it is unnecessary to repeat in this connection.

Accessions.

The accessions for 1883 surpassed in number those of the preceding year. The following table shows the proportion of quarto and larger books, to the octavos and those of smaller size, and the total for the year:

Table showing the number of accessions in 1883.

Sizes.	Volumes.	Parts.	Pamphlets.*	Total.
Quartos and larger	17	7	73	97
Octavos and smaller	147	44	389	580
Total	164	51	462	677

*Any work of less than 100 pages is regarded as a pamphlet.

The accessions of public documents, except those relating to the natural sciences, are not included in this table. The majority are not properly within the scope of the library, and if entered and put upon the shelves, would occupy space which should be devoted to works more directly of use. The works included in the table were received from 73 societies, museums, and other organizations, and from 74 individuals. Only 14 were obtained by purchase. The following persons and institutions have contributed four or more works during the year:

Contributors.	Octavo volumes.	Quarto volumes.	Octavo pamphlets.	Quarto pamphlets.
Prof. S. F. Baird	52	6	367	5
Geological Survey of Great Britain and Ireland	49	....	61	14
Dr. Francis Day, London	....	....	16	....
Prof. William H. Flower, London	....	....	7	5
Dr. Charles A. White, U. S. Geolog. Survey.	1	....	10	....
Portland Society of Natural History	....	....	9	....
Mr. Walter Faxon, Cambridge, Mass	....	....	7	....
Royal Society of New South Wales	....	....	4	....

Late in the year, the United States Fish Commissioner deposited in the library 140 volumes upon ichthyology and kindred subjects. A complete set of the reports upon the scientific results of the Challenger Expedition and other equally important works are included in this series.

Loan and return of books.—For the record of these most important transactions of the library, two large record-books are in use. In one of these the books borrowed are entered by the names of the authors, with cross-reference to the name of the person borrowing and the date of the loan. In the second record all the books borrowed by each person are recorded under his name. This system, which might be impracticable in a large library, is very useful and desirable in a smaller one in which the books are much handled. In addition, each person is required to sign a call-card for the books received and to demand the same when they are returned.

The number of names now included in the list of those entitled to draw books is sixty-seven.

The number of books issued and returned during the several months is as follows:

Months.	Drawn.	Returned.
January	119	92
February	199	57
March	174	138
April	95	65
May	767	412
June	144	238
July	149	185
August		
September	334	176
October	206	68
November	143	276
December	295	477
Total	2,535	2,184

During the period of active work in winter and until May, the number of books drawn exceeds that of those returned, while the reverse is usually the case upon the approach of summer. The abnormal condition in November and December is due to the fact that certain rearrangements in the Museum made it necessary that the whole of one sectional library should be returned.

For the benefit of the clerks, messengers, and other employés who are debarred by the regulations from withdrawing books regularly from the library, it has been deemed advisable to set apart a certain number of works of general interest. A list was prepared, including the principal books of travel, manuals of the natural sciences, and the like, contained in the library, and distributed to the employés, with a notice that the works could be withdrawn. This arrangement has met with much favor, the only regret being that there are not more books on the list.

Administrative work.

Registers.—The regular registers have been constantly in use during the year. The record-book shows an addition of 677 entries. These are divided among the months as follows:

January	128	July	46
February	102	August	0
March	71	September	47
April	54	October	40
May	62	November	58
June	57	December	12

In the periodical register, in which all journals are entered number by number, with the date of receipt, 2,639 entries have been made.

Catalogues.—The card-catalogue by authors has been very considerably added to during the year.

The number of books catalogued each month is as follows:

January	148	August	0
February	132	September	133
March	147	October	97
April	62	November	119
May	262	December	43
June	126		
July	66	Total	1,335

The catalogue includes, in addition to titles of the books in the Museum library, and those of the books in the library of the U. S. Fish Commission.

The number of cards in each case is as follows:

Museum	9,557
U. S. Fish Commission library	634
Total	10,191

Sectional libraries.—Two new sectional libraries have been established, those in charge of the honorary assistant curator of invertebrate fossils and the acting curator of foods and textiles. There are, in all, 13 similar libraries. The number of volumes of monographic books and pamphlets in each is as follows:

Section of building stones	110
Department of mammals	122
Department of invertebrate fossils:	
Mesozoic	96
Paleozoic	17
Department of birds	92
Section of materia medica	71
Department of fishes	54
Department of chemistry	64
Department of archæology	25
Department of metallurgy	26
Department of reptiles	22
Department of marine invertebrates	29
Section of foods and textiles	6
Total	734

Number of books.—On page 3 of the report of the assistant director for 1882, the number of books in the library is estimated at 5,800, and of pamphlets, 5,500. By the additions of the past year the number of books now reached is about 6,015, and of pamphlets, 5,962.

APPENDIX A.—OFFICERS OF THE NATIONAL MUSEUM.

SPENCER F. BAIRD, LL. D., *Secretary of the Smithsonian Institution, Director of the Museum.*

G. BROWN GOODE, A. M., *Assistant Director; Curator, Dep't of Arts and Industries.*

TARLETON H. BEAN, M. S., M. D., *Curator, Department of Fishes: Editor.*
CAPT. CHARLES BENDIRE, U. S. A., **Curator, Section of Oology.*
A. HOWARD CLARK, *Assistant, Department of Arts and Industries.*
FRANK W. CLARKE, A. M. (U. S. Geol. Sur.), **Curator, Department of Minerals.*
JOSEPH W. COLLINS, *Acting Curator, Section of Naval Architecture.*
WILLIAM H. DALL (U. S. Coast Survey), **Curator, Department of Mollusks.*
FRED. P. DEWEY, S. B., *Curator, Department of Metallurgy.*
R. EDWARD EARLL, S. B., *Acting Curator of the Fisheries Collection.*
JAMES M. FLINT, M. D., U. S. N., **Curator, Section of Materia Medica.*
ROMYN HITCHCOCK, *Acting Curator, of the Textile Collection.*
FREDERIC A. LUCAS, *Assistant, Department of Comparative Anatomy.*
GEORGE P. MERRILL, M. S., *Acting Curator, Depart. Lithology and Physical Geology.*
RICHARD RATHBUN, M. S., *Curator, Department of Marine Invertebrates.*
CHARLES RAU, Ph. D., *Curator, Department of Archæology.*
ROBERT RIDGWAY, *Curator, Department of Birds.*
CHARLES V. RILEY, Ph. D. (Depart. Agr), **Curator, Depart. of Insects.*
ROBERT E. C. STEARNS, *Adjunct Curator, Department of Mollusks.*
FREDERICK W. TRUE, M. S., *Curator, Depart. of Mammals and Compar. Anatomy.*
CHARLES D. WALCOTT (U. S. Geological Survey), **Curator, Department of Fossil Invertebrates (Paleozoic).*
LESTER F. WARD, LL. B. (U. S. Geological Survey), **Curator of Department of Fossil Plants.*
CHARLES A. WHITE, M. D. (U. S. Geological Survey), **Curator, Department of Fossi Invertebrates (Mesozoic and Cenozoic).*
HENRY C. YARROW, M.D., **Curator, Department of Reptiles and Batrachians.*
WILLIAM S. YEATES, *Aid, Department of Minerals.*

STEPHEN C. BROWN, *Registrar.*
HENRY HORAN, *Superintendent of Buildings.*

* Honorary.

APPENDIX B.—BIBLIOGRAPHY FOR 1883.

NOTE.—The annotations, unless otherwise signed, will be understood to have been made by the curator of the department to which the paper relates.

ANALYSIS.

PART I.—PUBLICATIONS OF THE MUSEUM.
PART II.—PAPERS BY OFFICERS OF THE MUSEUM.
PART III.—PAPERS BY INVESTIGATORS NOT OFFICERS OF THE MUSEUM, BASED ON MUSEUM MATERIAL.

PART I.—PUBLICATIONS OF THE MUSEUM.

Department of the Interior. U. S. National Museum. 34. Proceedings of the U. S. National Museum. Vol. v, 1882. Published under the direction of the Smithsonian Institution. Washington: Government Printing Office. 1883. 8vo, pp. i–xii, 1–703.

The first twenty-eight signatures, viz, pp. 1–448, were published in 1882. Sigs. 29, 30, Feb. 13, 1883; 31, 32, Feb. 28; 33–35, March 21; 36, March 23; 37, Apr. 19; 38, Apr. 25; 39, May 12; 40, May 22; 41, May 23; 42, June 26.

This volume contains 91 papers relating to the work of the Museum, prepared by 35 authors. All published in 1883 are enumerated under the author's name in this appendix.

Proceedings of the U. S. National Museum. (Vol. VI.) Signatures 1–22 inclusive were printed and distributed in 1883.

Department of the Interior. U. S. National Museum. Bulletin of the U. S. National Museum. No. 16. Synopsis of the Fishes of North America. By David S. Jordan and Charles S. Gilbert. Washington: Government Printing Office. 1883. 8vo. pp. i–lvi, 1–1018.

Department of the Interior: U. S. National Museum. Bulletin of the U. S. National Museum. No. 20. Bibliographies of American Naturalists. I. The publishers writings of Spencer Fullerton Baird, 1843–1882, by George Brown Goode, Assistant Director of the National Museum. Washington: Government Printing Office. 1883. 8vo. pp. i–xvi, 1–377.

Department of the Interior: U. S. National Museum. Bulletin of the U. S. National Museum. No. 24. Check List of North American Reptilias and Batrachia, with Catalogue of Specimens in U. S. National Museum. By H. C. Yarrow, M. D., Honorary Curator Department of Reptiles. Washington: Government Printing Office. 1883. 8vo. pp. (6) 1–249.

Department of the Interior: U. S. National Museum. Bulletin of the U. S. National Museum. No. 26. *Avifauna Columbiana:* Being a list of Birds ascertained to inhabit the District of Columbia, with the times of arrival and departure of such as are nonresidents, and brief notices of habits, &c. The second edition, revised to date, and entirely re-written. By Elliott Coues, M. D., Ph. D., Professor of Anatomy in the National Medical College, &c., and D. Webster Prentiss, A. M., M. D., Professor of Materia Medica and Therapeutics in the National Medical College, etc. Washington: Government Printing Office. 1883. 8vo. pp. 1–133. 4 maps.

The following Museum circulars which were printed as "separates" during the year, were also published in the Appendix to volume VI, Proceedings of the U. S. National Museum, for 1883.

No. 19. Classification of the Materia Medica collection of the U. S. National Museum, and Catalogue of Specimens. By James M. Flint, Surgeon U. S. Navy, Curator of Materia Medica. 8vo. 1–14 pp.

No. 20. Request for Specimens of Drugs, and Information concerning them. 8 vo. 1 p.

No. 21. Circular relative to contributions of Aboriginal Antiquities, to the U. S. National Museum. By Charles Rau. 8vo. 4 pp.

No. 22. Brief directions for removing and preserving the skins of Mammals. By William T. Hornaday, Chief Taxidermist. 8vo. 1–6 pp.

No. 23. Instructions for taking paper moulds of inscriptions in stone, wood, bronze, &c. By Ensign A. P. Niblack, U. S. N. 8vo. pp. 1–17.

Parts A, B, C, D, E, F, G, Bulletin 27, U. S. N. M., were printed as "separates" in 1883, and are mentioned in this bibliography under the names of the authors. See GOODE, RATHBUN, RIDGWAY, WINSLOW, BROWN, BEAN.

PART II.—PAPERS BY OFFICERS OF THE MUSEUM.

BAIRD, SPENCER F.—The instruction of naval midshipmen in taxidermy, ichthyology, etc., at the United States National Museum, and on board the steamers of the United States Fish Commission.

(Bull. U. S. Fish Commission, III, pp. 239–243. 1883.)

BEAN, TARLETON H.—Description of a species of whitefish, *Coregonus hoyi*, (Gill) Jordan, called "smelt" in some parts of New York.

(Proc. U. S. Nat. Mus., V, pp. 658–660. 1883.)

———. List of the FISHES. (In Stearns' "Notes on the Natural History of Labrador.")

(Proc. U. S. Nat. Mus., Aug 1, 1883,) vol. VI, pp. 123–125..

The names of seventeen species collected for the U. S. National Museum by Mr. W. A. Stearns in 1882. The common names and the remarks are by Mr. Stearns. One of the most interesting of the species is *Scomber scombrus*, from Labrador.

BEAN, TARLETON H.—Directions for collecting and preserving fish.

(Bull. U. S. Fish Com. Sept. 3, 1883, vol. III, pp. 197–200. Reprinted from Proc. U. S. Nat. Mus., vol. iv, pp. 235–238.)

——— The first occurrence of *Pseudotriacis microdon*, Capello, on the coast of the United States.

(Proc. U. S. Nat. Mus., Oct. 5, 1883, vol. VI, pp. 147–150.)

This shark stranded, February 8, 1883, at the Amagansett life-saving station, on Long Island, and was forwarded to the Museum by Mr. J. B. Edwards. It is the first result of a request by Prof. S. F. Baird to the superintendent of life-saving stations, Mr. S. I. Kimball, for information from points along the entire coast concerning the movements and the stranding of marine animals and for the sending of desirable specimens to the National Museum.

Pseudotriacis microdon is a rare shark which was first observed on the coast of Portugal.

The genus *Pseudotriacis* is redefined and the species fully described.

——— Description of a new species of *Alepidosaurus* (*A. æsculapius*) from Alaska.

(Proc. U. S. Nat. Mus. March 23, 1883, v, pp. 661–663.)

Alepidosaurus æsculapius, n. s. (Iliuliuk, Unalaschka, p. 661.)

——— Great International Fisheries Exhibition; London, 1883. United States of America. F. Catalogue of the Collections of Fishes exhibited by the United States National Museum, by Tarleton H. Bean, Curator of the Department of Fishes in the United States National Museum. Washington: Government Printing Office. 1883. 8vo, pp. 1–124.

(Forms part of Bull. 27, U. S. Nat. Mus.)

This catalogue relates to about 450 species of North American fishes, or nearly one-third of the known fauna. The principal common names are given, and the geographical distribution is stated as fully as possible. The maximum size of the species, their importance as food or bait, and their reproductive habits are briefly noticed. In the remarks upon the several groups of fishes exhibited will be found a sketch of the most recent information concerning the fish-fauna of the regions from which they were obtained. The survey of Alaskan fishes is the most detailed, and brings the list of known species up to the date of printing of this section of the catalogue.

——— Notes on some fishes collected by James G. Swan in Washington Territory, including a new species of *Macrurus*.

(*Proc. U. S. Nat. Mus.*, 1883, VI, pp. 362–364.)

Macrurus acrolepis, n. s., besides information concerning *Delolepis virgatus*, *Bramaraii*, and 8 other species.

——— Notes on fishes observed at the head of Chesapeake Bay in the spring of 1882, and upon other species of the same region.

(*Proc. U. S. Nat. Mus.*, 1883, VI, pp. 362–364.)

Concerning 31 species for the most part taken in the seine by the U. S. Fish Commission, June 9 and 10, 1882. The common names in use at Havre de Grace are recorded, and brief notes are given about spawning habits and times of arrival and departure.

BEAN, TARLETON H.—Condition and methods of administration of the department of fishes in the U. S. National Museum in 1882.

(Report Asst. Director U. S. Nat. Mus., II, 1882, pp. 19–21; 49–50; 87–96.)

BROWN, JAMES TEMPLE.—Great International Fisheries Exhibition; London; 1883. United States of America. (E.) The Whale Fishery and its Appliances. Washington: Government Printing Office. 1883. 8vo. pp. 1–116.

Contains (*a*) classification of apparatus used in American whale fishery; (*b*) catalogue of whaling apparatus sent by United States to London, including: 1. Apparatus used by the white man; 2. Apparatus used by the Cape Flattery Indians, with a brief account of these Indians, their manners, habits, and customs; 3. Whaling and sealing apparatus used by Eskimo.

——— Some notes on whales.

(Bull. U. S. Fish Com., vol. III, p. 411.)

CLARK, A. HOWARD.—Statistics of the whale fishery.

(In United States Catalogue of London Fisheries Exhibition (section E). "The whale fishery and its appliances," pp. 26–29, inclusive.)

Reviews the past and present extent of the American whale fishery, gives the distribution of the fleet, the relative importance of the various whaling grounds during the years 1870 to 1880, and exhibits statistical tables showing (1) the number and tonnage of vessels engaged in the fishery for the years 1870–1880, (2) the value of sperm-oil, whale-oil, and whalebone landed by the American fleet, the value of the consumption in the United States, and the value of the exportation annually from 1870 to 1880, and (3) the number of barrels of sperm and whale oil and pounds of whalebone landed by the American fleet, the quantities consumed in the United States, and the quantities exported annually from 1870 to 1880.

——— International angling tournament.

(Forest and Stream, New York, June 28, 1883.)

Letter from London, giving an account of an angling tournament at Welsh Harp, near London, June 11, 1883.

——— London Fisheries Exhibition.

(Chelsea Record, Chelsea, Mass., July 8, 1883.)

Letter from London, descriptive of incidents connected with the International Fisheries Exhibition.

——— The United States display at the London Exhibition.

(Boston Herald, September 9, 1883.)

Communication concerning the exhibit of the United States at the International Fisheries Exhibition.

——— Methods of packing [mackerel] and inspection laws.

(Materials for a history of the mackerel fishery, 1883, pp. 137–161; Rep. U. S. Fish Com., Part ix, for 1881, pp. 227–252.)

——— Statistics of inspection of mackerel from 1804 to 1880.

(Materials for a history of the mackerel fishery, 1883, pp. 162–213; Rep. U. S. Fish Com., Part ix, for 1881, pp. 252–307.)

CLARK, A. HOWARD.—[The mackerel] inspection laws of the United States.

(Materials for a history of the mackerel fishery, 1883, pp. 354–394; Rep. U. S. Fish Com., Part ix, for 1881, pp. 444–484.)

——— [Statistical description] of the American whale fishery.

(Goode's fishery industries of the United States, London, 1883, pp. 37–39).

——— Table.—Statistics of the menhaden industry in 1880.

(Goode's fishery industries of the United States, London, 1883, opp., p. 41.)

COLLINS, JOSEPH WILLIAM.*—Notes on the movements, habits, and capture of mackerel for the season of 1882.

(Bull. U. S. Fish Com., II, pp. 273–285.)

——— Notes on the herring fishery of Massachusetts Bay in the autumn of 1882.

(Bull. U. S. Fish Com., II, pp. 287–290.)

——— Notes on the halibut fisheries of 1881–'82.

(Bull. U. S. Fish Com., II, pp. 311–316.)

——— Success of the gill-net cod-fishery on the New England coast, winter of 1882–'83.

(Bull. U. S. Fish Com., III, pp. 441–443.)

——— Chronological notes [on the mackerel fishery, 1621–1881].

(Materials for a history of the mackerel fishery, 1883, pp. 217–353; Rep. U. S. Fish Com., Part ix, for 1881, pp. 307–443.)

DALL, WILLIAM HEALEY.—Circe *versus* Gouldia.

(Journal of Conchology, Leeds, April, 1883, pp. 60–63).

——— Year book of the German Malakozoölogical Society.

(Review in American Naturalist, May, 1883, XVII, pp. 521–523.)

——— Pearls and pearl fisheries.

(American Naturalist, vol. XVII, No. 6, June, 1883, pp. 579–587, and No. 7, July, 1883, pp. 731–745.)

——— Norwegian North Atlantic expedition, 1876–'78.

(American Naturalist, XVII, No. 6, pp. 628, 629, June, 1883.)

——— Notes on the Pacific coast trade in shells, shrimps, cod, and salmon (during the year 1882).

(Bull. U. S. Fish Com., 1883, III, p. 425.)

——— Note on cluster flies.

(Proc. U. S. Nat. Museum, 1883, V, pp. 635-636.)

——— More about the "stickfish" (*Verrillia blakei* Stearns).

(Forest and Stream, June 14, 1883, vol. XX, p. 384.)

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* See also under GOODE and COLLINS.

DALL, WILLIAM HEALEY.—The snail nuisance.

(Evening Star, Washington, June 30, 1883.)

NOTE.—This is in regard to a plague of slugs which appeared to annoy housekeepers in an unusual way.

——— The Department of Mollusks in the U. S. National Museum.

(Rep. Asst. Director U. S. Nat. Museum for 1882, pp. 21–24, 50–57, 96; Smithsonian Report for 1882 (1884), pp. 139–142, 168, 169, 214.)

——— On a collection of shells sent from Florida by Mr. Henry Hemphill.

(Proc. U. S. Nat. Museum, Dec. 27, 1883, VI, pp. 318–342.)

——— History and distribution of the fresh-water mussels.

(Science, vol. I, No. 1, p. 22, Feb. 9, 1883.)

——— Studies of the Italian cretaceous fossils.

(Science, vol. I, No. 1, p. 22.)

——— Tryon's conchology.

(*Ibid.*, No. 2, p. 40.)

——— A remarkable molluscan type.

(*Ibid.*, p. 51.)

——— First use of wire in deep-sea sounding.

(*Ibid.*, p. 65.)

——— Trade in California invertebrates.

(*Ibid.*, p. 78.)

——— Mollusks of the family Cocculinidæ.

(*Ibid.*, p. 130.)

——— American paleozoic fossils.

(*Ibid.*, p. 173.)

——— Use of wire in sounding.

(*Ibid.*, p. 191.)

——— European land shells.

(*Ibid.*, p. 202.)

——— Shells from the Colorado region.

(*Ibid.*, p. 202.)

——— Variations of Pompholyx.

(*Ibid.*, p. 202.)

——— Report of the Connecticut Shell-fish Commission, 1883.

(*Ibid.*, p. 223, 224.)

——— Soft parts of Ammonites.

(*Ibid.*, p. 230.)

——— Report on mollusks of the North Atlantic.

(*Ibid.*, p. 259.)

DALL, WILLIAM HEALEY.—Disease in oysters.
(Science, vol. I, p. 316.)

——— Venus mercenaria in Britain.
(*Ibid.*, p. 316.)

——— Large American pearls.
(*Ibid.*, p. 371.)

——— Ottawa Unionidæ.
(*Ibid.*, p. 371.)

——— Fossils of the Rizzolo clays.
(*Ibid.*, p. 371.)

——— White's Fossil [non-marine] mollusks of North America.
(*Ibid.*, p. 425.)

——— The position of Rhodope.
(*Ibid.*, p. 443.)

——— Fischer's Manuel de Conchyliologie.
(*Ibid.*, p. 443.)

——— Anatomy of Parmacella.
(*Ibid.*, p. 443.)

——— Curious slug from Madagascar.
(*Ibid.*, p. 443.)

——— Italian limaces.
(*Ibid.*, p. 466.)

——— Molluscan fauna of Sardinia.
(*Ibid.*, p. 466.)

——— East Indian Pulmonata.
(*Ibid.*, p. 466.)

——— Snails used for food in Spain.
(*Ibid.*, p. 492.)

——— Extraordinary Eulima.
(*Ibid.*, p. 492.)

——— Arctic mollusks.
(*Ibid.*, p. 492.)

——— North German miocene.
(*Ibid.*, p. 492.)

——— Variations in Unionidæ.
(*Ibid.*, p. 523.)

——— Action of the heart [in *Helix*] during hibernation.
(*Ibid.*, p. 523.)

DALL, WILLIAM HEALEY.—Malacological notes.
(Science, vol. I, p. 524.)

——— Land-snails from Bering Strait and Alaska.
(*Ibid.*, pp. 583, 584.)

——— A man-eating mollusk.
(*Ibid.*, p. 584.)

——— Monograph of Onchidium.
(*Ibid.*, p. 584.)

——— The coloring matter of the bile of invertebrates.
(*Ibid.*, p. 612.)

——— First use of wire in sounding.
(Science vol. II, pp. 12, 13.)

——— Abyssal mollusks.
(*Ibid.*, pp. 22, 23.)

——— Mediterranean mollusca.
(*Ibid.*, p. 113.)

——— Structure of the shell in brachiopods and chitons.
(*Ibid.*, p. 113.)

——— Economic mollusks at the Fisheries Exhibition.
(*Ibid.*, p. 117.)

——— Existence of a shell in Notarchus.
(*Ibid.*, p. 206.)

——— New abyssal mollusks.
(*Ibid.*, p. 206.)

——— Pleurotomidæ of Senegambia.
(*Ibid.*, p. 381.)

——— Mollusca of the Caucasus.
(*Ibid.*, p. 382.)

——— Monograph of Ringicula.
(*Ibid.*, p. 382).

——— The Chesapeake oyster beds.
(*Ibid.*, pp. 440–443.)

——— Astarte triquetra Conrad.
(*Ibid.*, p. 447.)

——— Anatomy of Urocyclus.
(*Ibid.*, p. 447.)

——— Tryon's conchology.
(*Ibid.*, pp. 658, 659.)

DALL, WILLIAM HEALEY.—Land shells of Gibraltar.

(Science, vol. II, p. 663.)

——— Absorption of the shell in Auriculidæ.

(*Ibid.*, p. 663.)

——— Organization of chitons.

(*Ibid.*, p. 691.)

——— Pulmonata of Central Asia.

(*Ibid.*, p. 721.)

——— Mediterranean oysters.

(*Ibid.*, p. 721.)

——— Mollusks at the Fisheries Exhibition.

(*Ibid.*, p. 721.)

——— Abyssal mollusks.

(*Ibid.*, p. 748.)

——— Further researches on Nudibranchs.

(*Ibid.*, p. 748.)

——— Extra marine mollusks of New Guinea.

(*Ibid.*, p. 773.)

——— Structure of the oyster shell.

(*Ibid.*, p. 773.)

——— Spinning by Arion hortensis.

(*Ibid.*, p. 773.)

——— Fossils of Pachino.

(*Ibid.*, p. 803.)

——— Spicula amoris of British Helices.

(*Ibid.*, p. 803.)

——— Shell structure of Chonetes.

(*Ibid.*, p. 803.)

DEWEY, FRED. P.—The condition and prospects of the department of metallurgy and economic geology in the U. S. National Museum.

(Rep. Asst. Director U. S. Nat. Mus. for 1882, 1883, pp. 34, 37, 105; Smithsonian Report for 1882, 1884, pp. 152–155, 223.)

——— Biographical sketch of the late Dr. George Wesson Hawes.

(Smithsonian Report for 1882, pp. 35–38.)

——— Some practical applications of combustion.

(Journ. U. S. Assoc. of Charcoal Iron Workers, April, 1883, vol. IV, pp. 105–115.)

Gives a review of the applications of heat.

DEWEY, FRED. P.—Connellsville *v.* New River Coke.

("The Virginias," April, 1883, p. 51.)

A criticism of some published results of determinations of physical properties of coke.

——— The porosity and specific gravity of coke.

(Trans. Am. Inst. Mining Engineers, vol. XII, pp. 111–125.)

Gives the results of a series of experiments made in the Museum upon the porosity and specific gravity of various American cokes.

——— Some Canadian iron ores.

(Trans. Am. Inst. Mining Engineers, vol. XII, pp. 192–204.)

Gives the results of an examination of some of the Canadian iron-ore fields.

EARLL, R. EDWARD.—The present condition of fish culture.

(Nature, vol. XXVIII, No. 23, October, 4, 1883, pp. 542–544.)

Contains a comparison of the more important forms of apparatus employed for heavy semi-buoyant floating and adhesive eggs. The methods of collecting and transporting eggs, and of retarding their development by reduction of temperature. The possibility of retarding the spawning season by judicious feeding is also referred to, together with a brief summary of the results of fish culture in different countries.

——— Statistics of the mackerel fishery in 1880.

(Materials for a history of the mackerel fishery, 1883, pp. 124–131; Report U. S. Fish Commission, part ix, for 1881, pp. 214–221.)

——— The mackerel canning industry.

(Materials for a history of the mackerel fishery, 1883, pp. 131–137; Report U. S. Fish Commission, part ix, for 1881, pp. 221–227.)

——— A brief history of fish culture in the United States.

(Goode's Fishery Industry of the United States, London, 1883, pp. 14–18.)

——— Statistics of the work of the U. S. Fish Commission.

(Goode's Fishery Industry of the United States, London, 1883, pp. 68–73.)

——— Remarks on fish culture in America.

(Goode's Fishery Industry of the United States, London, 1883, pp. 75–79.)

——— On possibilities for the development of Irish fishery.

(Conference papers. International Fisheries Exhibition, London, 1883, July 30, pp. 26–30.)

——— On the soft clam of the United States.

(Conference papers. International Fisheries Exhibition, London, 1883, June 21, pp. 16–18.)

——— Remarks on the Alaska seal fisheries.

(Conference papers. International Fisheries Exhibition, London, 1883, July 6, pp. 20–21.)

FLINT, JAMES M.—Report upon the section of materia medica in the U. S. National Museum.

(Report, Asst. Director U. S. Nat. Mus., for 1882 (1883), pp. 107–112; Report Smithsonian Institution for 1882 (1884), pp. 225–230.)

GOODE, G. BROWN.—Notes on the Lampreys—Petromyzontidæ.

(Bull. U. S. Fish Comm., Apr. 25–May 4, 1883, vol. II, pp. 349–354.)

——— The generic names Amitra and Thyris replaced.

(Proc. U. S. Nat. Mus., July 27, 1883, vol. VI, p. 109.)

Amitra replaced by *Monomitra* and *Thyris* by *Delothyris*.

——— Great International Fisheries Exhibition. London, 1883. United States of America. A preliminary catalogue and synopsis of the collections exhibited by the U. S. Fish Commission and by special exhibitors, with a concordance to the official classification of the exhibition. Washington: Government Printing Office, 1883. 8vo., pp. 1–107.

(A. Howard Clark and J. W. Collins assisted in the preparation of this part of the London catalogues.)

——— Plan of inquiry into the history and present condition of the fisheries of the United Sates.

(Report U. S. Commissioner of Fish and Fisheries, for 1880, part viii, pp. 1–52.)

A reprint of a circular printed by the Census Office in 1879, 8vo., pp. 54. Circular 29 in Appendix B was prepared by C. G. Atkins.

——— The first decade of the U. S. Fish Commission; its plan of work and accomplished results, scientific and economical. Read at the Boston meeting of the American Association for the Advancement of Science, August, 1880.

(Report U. S. Commissioner of Fish and Fisheries for 1880, Part viii, pp. 52–62. Bull. U. S. Fish Commission, II, pp. 169–178.)

Reprint with slight modifications, from the Proceedings of the American Association for the Advancement of Science, 1881.

——— Materials for a history of the sword-fishes.

(Report U. S. Commissioner of Fish and Fisheries for 1880. Part viii, pp. 287–394 (with plates i–xxiv and index.)

Materials for a history of the sword-fishes by George Brown Goode. Washington: Government Printing Office. 1883. 8vo., pp. [1]–[106] plates i—xxiv. Extracted from the annual report of the Commissioner of Fish and Fisheries for 1880.

——— Natural history of the mackerel.

Materials for a history of the mackerel fishery. (Title in full below.) 1883, pp. [3]–[48].

——— Statistics of the fisheries of the United States in 1880.

(Compendium of the Tenth Census, Part ii, Table cvi, pp. 1402–1403.) (Bull. U. S. Fish Com., III, pp. 270–271; also in Fishery Industries of the United States, and in Part A of the Official Catalogue of the Fisheries Exhibition.)

——— Outline of a scheme of museum classification.

(Trans. Anthropological Society of Washington, II, 1883, pp. 5–7.)

Notice of reading with abstract and remarks of Prof. O. T. Mason, Dr. Miles Rock, Dr. Robert Fletcher, Mr. Hutcheson, and Mr. F. W. True, with replies of author.

GOODE, G. BROWN.—Report of the assistant director of the U. S. National Museum for the year 1881.

(Report of the Smithsonian Institution for 1881, pp. 81–159; also as separate with title, pp. (2) 1–79.

The first of the series. Review in *Science*. Boston, II, pp. 63–66; 119–123.

——— The fisheries of the United States.

(Official Catalogue, Great International Fisheries Exhibition, London, 1883, 1st ed., pp. 283–5; 2d ed., pp. 189–91.)

——— A review of the fishery industries of the United States and the work of the U. S. Fish Commission by G. Brown Goode, M. A., assistant director of the U. S. National Museum, and commissioner to the International Fisheries Exhibition, London, 1883. Read at a conference of the International Fisheries Exhibition June 25, 1883, his excellency James Russell Lowell in the chair. London, William Clowes & Sons, Limited, International Fisheries Exhibition, and 13 Charing Cross, S. W. 1883, 8vo, pp. 1–84.

Full text with remarks of Professor Huxley, Mr. Earll, the Marquis of Exeter, the Marquis of Hamilton, and Mr. James Russell Lowell.

——— Salmon culture in the United States.

Papers of the conferences, International Fisheries Exhibition, June 21, 1883, pp. 28–29.

——— On the land-locked salmon.

Papers of the conferences, International Fisheries Exhibition, London, June 21, 1883, pp. 29–31.

——— The uses of the round clam of the United States.

Papers of the conferences, International Fisheries Exhibition, London, June 21, 1883 (No. 2), pp. 19–20.

——— The suitability of the black-bass for introduction into England. Letter to R. B. Marston, esq.

Papers of the conferences, International Fisheries Exhibition, June 29, pp. 1883, 18–19.

——— Recent progress of the Canadian fisheries.

(Conference papers, International Fisheries Exhibition, London, 1883, July 2. pp. 46–47.)

——— American investigations upon the food of fishes.

(Conference papers, International Fisheries Exhibition, London, 1883, July 12. pp. 29–33.)

——— The development of the American mackerel fisheries.

Conference papers, International Fisheries Exhibition, London, 1883, July 13. pp. 30–32.)

——— The successes of fish culture in the United States and Canada.

Conference papers, International Fisheries Exhibition, London, 1883, July 17. pp. 27–29).

GOODE, G. BROWN.—Motion of thanks to Sir Henry Thompson for papers on "Fish as food."

(Conference papers, International Fisheries Exhibition, London, 1883, July 17, 1883. No. 2, pp. 31–32.)

——— The scientific results of the Fisheries Exhibition.

(Conference papers, International Fisheries Exhibition, London, 1883, July 20. pp. 23–26.)

——— Importance of forest protection to fish culture in the United States.

(Conference papers, International Fisheries Exhibition, London, 1883, July 20. No. 2, pp. 13–14.)

——— On methods of protection of fisheries. Motion of thanks to C. E. Fryer for paper on "A National Fishery Society."

(Conference papers, International Fisheries Exhibition, London, 1883, July 27. pp. 36–38.)

——— The International Fisheries Exhibition.

(Science, 1883, vol. I, pp. 447–450; pp. 564–565, II, pp. 129–131; 612–615, with illustrations.)

——— Report of the assistant director of the U. S. National Museum for the year 1882. From the Smithsonian report for 1882. Washington: Government Printing Office. 1883. 8vo., pp. 1–145.

——— Obituary notice of Dr. G. W. Hawes.

(In report assistant director U. S. N. M., 1882, pp. 40–48, with bibliography prepared by George P. Merrill.)

——— Bibliography of the published writings of Spencer Fullerton Baird.

GOODE, G. BROWN, and BEAN, TARLETON H.—Bulletin of the Museum of Comparative Zoology, at Harvard College. Vol. X, No. 5. Reports on the results of dredging, under the supervision of Alexander Agassiz, on the east coast of the United States, during the summer of 1880, by the U. S. Coast Survey steamer Blake, Commander J. R. Bartlett, U. S. N., commanding. Published by permission of Carlile P. Patterson and J. E. Hilgard, Superintendents of the U. S. Coast and Geodetic Survey. XIX.—Report on the fishes.

(Bull. Mus. Comp. Zool., Cambridge, vol. X, No. 5, pp. 183–226, April, 1883.)

A list of 52 species collected at stations 302–346 of the Blake dredgings. Only the new genera and species are fully discussed; they are the following: *Aphoristia nebulosa*, n. s.; *Notosema dilecta*, n. g. and n. s.; *Macrurus asper*, n. s.; *Coryphænoides carapinus*, n. s.; *Chalinura simula*, n. g. and n. s.; *Barathrodemus manatinus*, n. g. and n. s.; *Dicrolene introniger*, n. g. and n. s.; *Læmonema barbatula*, n. s.; *Lycodes paxilloides*, n. s.; *Lycodonus mirabilis*, n. g. and n. s.; *Prionotus alatus*, n. s.; *Cottunculus torvus*, Goode, n. s.; *Poromitra capito*, n. g. and n. s.; *Bathysaurus Agassizii*, n. s.; *Alepocephalus Agassizii*, n. s.; *Cyclothone lusca*, n. g. and n. s.; *Nettastoma procerum*, n. s.

GOODE, G. BROWN, and JOSEPH W. COLLINS.—The mackerel fishery of the United States.

(Materials for a history of the mackerel fishery (full title below). 1883. pp. (48)-(118).)

GOODE, G. BROWN, JOSEPH W. COLLINS, R. E. EARLL, and A. HOWARD CLARK.—Materials for a history of the Mackerel Fishery. By George Brown Goode, Joseph W. Collins, R. E, Earll, and A. Howard Clark. Washington: Government Printing Office. 1883. 7617. 8vo, pp. [1]-[441.]

Extracted from the Annual Report of the Commissioner of Fish and Fisheries for 1881.

GOODE, G. BROWN, and NEWTON P. SCUDDER.—Bibliography of the writings of the alumni and faculty of Wesleyan University.

(Alumni Record of Wesleyan University. Middletown, 1883. pp. 529-668.)

GOODRICH, J. KING.—The Pacific coast fisheries viewed from a non-professional standpoint.

(American Field, 1883, vol. XIX, No. 11, pp. 185-186.)

——— Fish and Fishing. The Beluga or White Whale.

(American Field, 1883, vol. XIX, No. 9, pp. 152-154.)

Describes the methods employed in the capture of the white whale by natives in the Arctic regions, together with a complete and illustrated description of the implements of a beluga hunter's outfit.

HITCHCOCK, ROMYN.—Water-bottles and thermometers for deep-sea research at the International Fisheries Exhibition [London].

(Science, August 10, 1883 vol. II, p. 155.)

In this article is described the apparatus exhibited by the United States, Swedish apparatus devised by Professor F. L. Ekman, Arfwidson's water-bottle, Captain Rung's apparatus for temperature, the Negretti and Zambra thermometers, and Commander Magnaghi's device for inverting the same.

HORNADAY, WILLIAM T.—Mental capacity of the elephant.

(Popular Science Monthly, August, 1883, vol. XXIII, No. 136, pp. 497-509.)

An array of facts drawn from the observations of the author on the Indian elephant to show the elephant's powers of observation, memory, and reason, and an argument to show the possibilities of education in elephants.

——— Every boy his own taxidermist.

(Mastery, vol. I, eight chapters, p. 131, July 5, 1883; p. 147, July 12; p. 167, July 19; p. 185, July 26; p. 337, October 4; p. 353, October 11; p. 369, October 18; p. 385, October 25. Illustrated by sixteen figures.)

One series of four chapters, describing the methods employed in skinning, preserving, mounting, and finishing a small mammal, and another treating of the same processes with small birds.

——— A review of Maynard's Manual of Taxidermy.

(Science, September 7, 1883, vol. II, No. 31, p. 312.)

LUCAS, FREDERIC A.—Nature's Surgery.

(Ward's Natural Science Bulletin, January, 1883, p. 9.)

Noting instances in which the bones of wild animals had been broken and healed.

LUCAS, FREDERIC A.—Our walruses.

(Ward's Natural Science Bulletin, January, 1883, p. 9.)

NOTE.—With cut of three Pacific walruses sent to Am. Mus. Nat. Hist., New York. Contains a criticism on Mr. H. W. Elliott's remarks on walruses.

——— Our osteological department.

(Ward's Natural Science Bulletin, January, 1883, pp. 11 and 12.)

Description of the skeletal work at Ward's Natural Science Establishment, Rochester, N. Y.

——— The London Fisheries Exhibition.

(Ward's Natural Science Bulletin, April, 1883, p. 7.)

A brief description of the exhibit prepared by the U. S. Fish Commission.

——— How to skin turtles; with diagrams.

(Ward's Natural Science Bulletin, April, 1883, p. 8.)

——— Dental abnormalities; with cuts.

(Ward's Natural Science Bulletin, April, 1883, p. 8.)

Notes on malformed or aberrant teeth of woodchuck, hog, orang, narwhal, and gorilla.

——— The American Museum of Natural History.

(Ward's Natural Science Bulletin, April, 1883, pp. 10 and 11.)

A description of the origin, growth, contents, work, and plans of the Am. Mus. Nat. Hist., New York City.

——— The shark's attendants; with cut.

(Mastery, July 19, 1883, p. 169.)

Popular account of pilot-fish and remora.

——— How to mount a bird.

(Sport with Gun and Rod, pp. 833–853.)

Pub. by Century Co., New York, 1883. With many irrelative illustrations from the Century Magazine.

MERRILL, GEORGE PERKINS.—On the black nodules in the Maine granites.

(Proc. Nat. Mus., 1883, vol. VI, p. 137.)

——— On the collection of Maine building stones in the U. S. National Museum.

(Proc. Nat. Mus., 1883, vol. VI, p. 165.)

——— Preliminary note on the crystalline schists of the District of Columbia.

(Proc. Nat. Mus., 1883, vol. VI, p. 159.)

——— Bibliography of writings of Dr. George W. Hawes.

(Report of assistant director U. S. National Museum for 1882, pp. 42–48.)

——— Note on a Potsdam sandstone, or conglomerate, from Berks County, Pennsylvania.

(Proc. U. S. Nat. Mus., 1883, vol. V, p. 660.)

MERRILL, GEORGE PERKINS.—The department of rocks and building stones, U. S. National Museum, 1882.

(Report assistant director U. S. Nat. Mus. for 1882 (1883), pp. 105–106, 112, 113; Report Smithsonian Institution for 1882 (1884), pp. 223–227, 230–231.

RATHBUN, RICHARD.—Great International Fisheries Exhibition. London, 1883. United States of America. B. Collection of Economic Crustaceans, Worms, Echinoderms, and Sponges. By Richard Rathbun, Curator of the Department of Marine Invertebrates in the United States National Museum. Washington: Government Printing Office. 1883. 8vo., pp. 31.

Section of the catalogue of the American exhibit at the London Fisheries Exhibition, published in advance of the full catalogue. Contains a *résume* of the industries afforded by the marine and fresh-water invertebrates (exclusive of the mollusca) of the United States, based upon the fishery census investigations of 1880 (pp. 3–20); a list of the species of economic crustaceans, worms, echinoderms, and sponges, and a list of the photographic views illustrative of the lobster fishery, exhibited at London (pp. 21–31).

——— Great International Fisheries Exhibition. London, 1883. United States of America. G. Descriptive catalogue of the collection, illustrating the scientific investigation of the sea and fresh waters. By Richard Rathbun, Curator of the Department of Marine Invertebrates in the United States National Museum. Washington: Government Printing Office. 1883. 8vo., pp. 1–109.

Section of the catalogue of the American exhibit at the London Fisheries Exhibition, published in advance of the full catalogue. Contains an introduction (pp. 3–29) discussing the extent and character of American explorations, with reference to the biology of the sea and fresh waters of the globe, and a descriptive catalogue (pp. 31–109) of the articles exhibited. Very full descriptions are given of the vessels and of all the apparatus now employed by Americans in deep-sea explorations. The descriptive catalogue is divided according to subjects, into the following sections: Vessels employed in deep-sea research; apparatus for collecting zoological materials; accessory apparatus used in connection with deep-sea dredging and trawling; appliances for the examination and storage of zoological materials; appliances for deep-sea sounding; apparatus for physical observations, &c.; marine zoological stations; maps, models, and collections of natural history, illustrating results of explorations.

——— The United States Fish Commission steamer Albatross.

(Science, 1883, vol. II, pp. 6–10, 66–72, with 7 cuts.)
A popular description of the steamer Albatross, and of her equipment for deep-sea research.

——— Sponge culture in Florida.

(Science, 1883, vol. II, p. 213.)
An account of recent experiments in growing the sheep's wool sponge from cuttings for commercial purposes, as exemplified by specimens received at the National Museum from Key West, Florida.

RATHBUN, RICHARD, and TARR, R. S.—List of duplicate marine invertebrates distributed by the United States National Museum, Series IV, Educational Series No. 2. Prepared by R. S. Tarr, under the direction of Richard Rathbun.

(Proc. U. S. Nat. Mus., 1883, vol. VI, pp. 212-216.)

A list of 124 species of duplicate Crustacea, Annelida, Mollusca, Tunicata, Molluscoida, Echinodermata, Cœlenterata, and Porifera, selected from the collections made by the U. S. Fish Commission on the New England Coast, for distribution to institutions of learning. About 200 sets, in all, will be prepared.

——— The Department of Marine Invertebrates in the U. S. National Museum.

(Rep. Asst. Director U. S. Nat. Mus. for 1882, 1883, pp. 27-31; 52; 98-103; Report Smithsonian Institution for 1882 (1884), pp. 145-149; 170; 216-221.)

RAU, CHARLES.—Indian stone graves,

(American Naturalist, vol. XVII, 1883 (Feb.), pp. 130-134.)

A short sketch of the so-called "Indian stone graves", frequently found in some of the States of the Mississippi Valley, with interesting description of their construction. It is explained that, although the practice of burial in stone graves may belong to a remote period, there is good reason to believe that some of these graves are of more recent date, and that the practice of constructing them had not ceased in the present century.

——— Accessions to the Department of Antiquities of the U. S. National Museum in 1882.

(Rep. Asst. Director U. S. Nat. Mus. for 1882 (1883), pp. 77-80; Report Smithsonian Institution, for 1882 (1884), pp. 195-198.)

RIDGWAY, ROBERT.—Catalogue of a collection of birds made in the interior of Costa Rica, by Mr. C. C. Nutting.

(Proc. U. S. Nat. Mus., vol. V, pp. 493-502.)

An annotated list of 32 species from the Volcan de Irazù and 33 species from San José. The notes on habits, color of eyes, etc., by Nutting.

——— Description of a new Warbler from the Island of Santa Lucia, West Indies.

(Proc. U. S. Nat. Mus., vol. V, pp. 525, 526.)

Dendrœca adelaidæ delicata; type, No. 80,909, U. S. Nat. Mus. coll.

——— Description of a supposed new Plover, from Chili.

(Proc. U. S. Nat. Mus., vol. V, pp. 526, 527.)

Ægialites albidipectus; type No. 26,997, S. U. Nat. Mus.

——— On the genus *Tantalus*, Linn., and its allies.

(Proc. U. S. Nat. Mus., vol. V, pp. 550, 551.)

The genus Tantalus restricted to the American Wood Ibis, the name *Pseudotantalus* being proposed for the several Old World species.

——— Description of a new Petrel from Alaska.

(Proc. U. S. Nat. Mus,, vol. V, pp. 656-658.)

Œstrelata fisheri, type No. 89431, U. S. Nat. Mus., from Kodiak, June 11, 1882, William J. Fisher, collector.

RIDGWAY, ROBERT.—Descriptions of some Birds, supposed to be undescribed, from the Commander Islands and Petropaulovski, collected by Dr. Leonhard Stejneger, U. S. Signal Service.

(Proc. U. S. Nat. Mus., vol. VI, pp. 90–96.)

(1) *Haliaëtus hypoleucus* Stejneger, MS.; (2) *Acrocephalus dybowskii*, Stejneger, MS.; (3) *Anorthura pallescens*, Stejneger, MS.; (4) *Hirundo saturata*, Stejneger, MS. The type specimens of all in the National Museum collection.

——— On the probable identity of Motacilla ocularis, Swinhoe, and M. amurensis, Seebohm, with remarks on a supposed species, M. blakistoni, Seebohm.

(Proc. U. S. Nat. Mus., vol VI, pp. 144–147.)

Based principally upon specimens collected on Bering Island, Kamtschatka, by Dr. L. Stejneger.

——— Descriptions of some New Birds from Lower California, collected by Mr. L. Belding.

(Proc. U. S. Nat. Mus., vol. VI, pp. 154–156.)

(1) *Lophophanes inornatus cineraseens*; (2) *Psaltriparus grindæ*, Belding, MS.; (3) *Junco bairdi*, Belding, MS.

——— Anthus cervinus (Pallas) in Lower California.

(Proc. U. S. Nat. Mus., vol. VI, pp. 156, 157.)

A specimen (No. 89,799, U. S. Nat. Mus.) shot by Mr. L. Belding at San José del Cabo, January 6, 1883.

——— Note on Merula confinis (Baird).

(Proc. U. S. Nat. Mus., vol. VI, pp. 158, 159.)

Two additional specimens collected by Mr. Belding at Laguna, Lower California, early in February, 1883, fully confirm the validity of the species, the type specimen of which, collected at Todos Santos, in 1860, had remained unique for twenty-three years.

——— On Leconte's Bunting (*Coturniculus lecontei*) and other Birds observed in Southeastern Illinois.

(Bull. Nutt. Orn. Club, Jan., 1883, vol. VIII, p. 58.)

——— The Scissor-tail (*Milvulus forficatus*) at Norfolk, Va.

(Bull. Nutt. Orn. Club, Jan., 1883, vol. VIII, p. 59.)

Based upon specimen No. 85,934, U. S. Nat. Mus.

——— On some Remarkable Points of Relationship between the American Kingfishers.

(Bull. Nutt. Orn. Club, Jan., 1883, vol. VIII, p. 59.)

Based entirely upon specimens in the National Museum collection.

——— Geographical variation in size among certain Anatidæ and Gruidæ.

(Bull. Nutt. Orn. Club, Jan., 1883, vol. VIII, p. 62.)

Refers to the larger size of American specimens, as compared with European examples of the same species, and to several exceptions to the supposed law of increase of size to the northward.

——— Notes upon some Rare Species of Neotropical Birds.

(The Ibis, fifth series, Oct., 1883, vol. IV, pp. 399–401.)

These species noticed are (1) *Harporhynchus ocellatus*, Scl., (2) *Pyranga erythrocephala* (Sw.), (3) *Zonotrichia quinquestriata*, Scl. & Salv., (4) *Peucæa notosticta*, Scl. & Salv., (5) *Contopus ochraceus*, Scl. & Salv., and (6) *Panyptila cayennensis* (Gm). None of these are in the National Museum collection, the specimens being borrowed for study.

RIDGWAY, ROBERT.—(Letter to the editors of "The Ibis," concerning the National Museum exhibit of North American Fish-eating and Aquatic Birds at the Great International Fisheries Exhibition, London.)

(The Ibis, fifth series, October, 1883, vol. IV, pp. 578–580.)

——— Great International Fisheries Exhibition; London, 1883. United States of America. (C.) Catalogue of the Aquatic and Fish-eating Birds exhibited by the United States National Museum. Washington: Government Printing Office, 1883. 8vo, pp. 1-46.

——— (The condition of the department of birds in the U. S. National Museum in 1882.)

(Report Asst. Director U. S. Nat. Mus. for 1882 (1883), pp. 13–17; 53–56, 83–86: Report Smithsonian Institution for 1882 (1884), pp. 132–135; 171–174; 201–204.)

(See also papers by L. BELDING and C. C. NUTTING.)

RILEY, CHARLES V.* Emulsions of petroleum as insecticides.

(Scientific American, Jan. 6, 1883.)

Notice of experiments made, in 1882, in the use of emulsions of kerosene oil to kill insects injurious to orange trees; report of H. G. Hubbard upon experiments made by him; critical review of S. F. Chapin's "scale-insects on deciduous and ornamental trees" (Pacific Rural Press, ———, 1882); effect of pure kerosene, of emulsions, and of lye upon trees.

——— An internal Mite in Fowls.

(Rural New-Yorker, Jan. 13, 1883.) (Amer. Naturalist, Apr., 1883, XVII, pp. 422, 423.)

Discovery, by T. Taylor, of mites determined as *Cytoleichus sarcoptoides*, by Riley, lining the interior membranes of fowls; habits and ravages of this mite in Europe.

——— A new Enemy to Wax Beans.

(Rural New-Yorker, Jan. 13, 1883.)

Reprint, entitled "*Epilachna corrupta* as an injurious insect." (Amer. Naturalist, Feb., 1883, XVII, pp. 198–199.)

Extract from letter of Prof. G. H. Stone, on the food-plants, habits, and ravages of *Epilachna corrupta;* geographical distribution of this beetle.

——— The Lignified snake of Brazil. An explanation of the phenomenon.

(Evening Star [Washington, D. C.], Jan. 20, 1883.)

Reprint, entitled The Lignified Snake of Brazil. (Scientific American Supplement, Feb. 17, 1883.)

Discussion of a specimen of problematical character supposed to be a lignified snake, but believed by author to be the burrow of a larva under bark; notice of writings on the subject; frequency with which the true nature of natural objects is mistaken; letter from J. H. Hutchins, accompanying a gall of *Cecidomyia vitis-pomum* mistaken for a hybrid fruit.

——— Pyrethrum, an important insecticide.

(Prairie Farmer, Jan. 27, 1883.)

History of the general introduction of pyrethrum plants into cultivation; method of growing the plants and of preparing the pyrethrum for use as an insecticide; experience in the cultivation of the plants.

* This bibliography was chiefly prepared by Mr. B. Peckman Mann.

RILEY, CHARLES V.—Utilization of ants in horticulture.

(Scientific Amer., Jan. 27, 1883.)

Abstract of C. J. Macgowan's "Utilization of Ants as Insect Destroyers in China" (North China Herald, April 4, 1882), and of H. C. McCook's "Ants as beneficial Insecticides" (Proc. Acad. Nat. Sci., Philad., 1882, pp. 263–271), with additional matter; notices of published accounts of ants which construct nests on plants, especially of *Azteca mirabilis* on *Cecropia* trees in South America; possibility that the introduction of ants into this country might involve objectionable consequences; probability that ants would not be of service in protecting orange trees from the scale insects which mainly injure those trees in this country.

——— New lists of North American Lepidoptera.

(Amer. Naturalist, January, 1883, XVII, pp. 80–82.)

Reviews of the Brooklyn Entomological Society's "Check List of the Macro-lepidoptera of America, North of Mexico. Brooklyn, N. Y., January, 1882;" C. H. Fernald's "A Synonymical Catalogue of the described *Tortricidæ* of North America, North of Mexico" (Trans. Amer. Entom. Soc., May–July, 1882, x, pp. 1–64); and A. R. Grote's "New Check List of North American Moths. [N. Y.], May [Aug.], 1882:" remarks upon the rules of nomenclature adopted in these works; faults found in Grote's work; notice of B. Gerhard's "Systematisches Verzeichniss der Macro-lepidopteren von Nord-Amerika. Lpz., 1878."

——— The "Cluster Fly."

(Amer. Naturalist, January, 1883, XVII, pp. 82–83.)

Abstract of communications by W. H. Dall and F. Baker to the Biological Society of Washington, D. C., on the habit of a fly, resembling the house-fly, of collecting in swarms or clusters in houses in winter; determination of the species as *Pollenia rudis*, Fabr.; synonymy of this fly; little known of the larval habits and development of the species of *Pollenia;* accounts and attempted explanations of the swarming of other Diptera.

Reprint (Prairie Farmer, December 23, 1882).

——— Naphthaline cones.

(Amer. Naturalist, January, 1883, XVII, pp. 83–84.)

Remarks supplementary to author's "Naphthaline Cones for the protection of Insect Collections" (Amer. Naturalist, May, 1882, XVI, pp. 409–410), in reply to C. A. Blake's objections; author's former criticism in the main maintained; Blake's naphthaline cones stain the paper lining of boxes, and seem to destroy mites and Psoci very soon, but to have little effect on *Dermestidæ*.

——— Spread of the 12-punctured Asparagus Beetle.

(Rural New-Yorker, Jan. 13, 1883, XVII.) (Amer. Naturalist, Feb., 1883, XVII, p. 199.)

Increasing destructiveness of *Crioceris duodecimpunctata*, recorded by O. Lugger to have been introduced near Baltimore, Md., from Europe; description of the imago of this species as compared with that of *C. asparagi*.

——— Hibernation of the Cotton Worm.

(Scientific Amer., Feb. 3, 1883.)

Abstract of paper read before American Association for the Advancement of Science, at Montreal, Aug., 1882; proof of the hibernation of *Aletia xylina* as a moth, and of the perpetual existence of the species in Florida.

(Also, under title of "The hibernation of Aletia xylina (Say) in the United States a settled fact." Proc. Amer. Assoc. Advanc. Sci. for 1882, XXXI, pp. 468–469.)

RILEY, CHARLES V.—Entomological Notes. Phylloxera laws.

(Rural New-Yorker, Feb. 27, 1883.)

Adoption by Belgium of the rules of the International Convention of Berne, relative to the prevention of phylloxera ravages; abstract of those rules.

——— *Trogoderma tarsale* as a museum pest.

(Amer. Naturalist, February, 1883, XVII, p. 199.)

Notice of F. H. Snow's "A new Museum Pest, *Trogoderma tarsale*, Mels." (Psyche, June, 1882, iii, pp. 351–352), with remarks on the abundance and ravages of *Trogoderma tarsale*, and the habits of its larva "in the field."

——— Natural sugaring.

(Amer. Naturalist, February, 1883, XVII, pp. 197–198.)

Excessive and wide-spread abundance, in 1882, on sycamore trees [*Platanus*] of *Lachnus platanicola* n. sp.; description of this species; attraction of great numbers of insects to its saccharine exudations, and growth of *Fumago salicina* upon these exudations; the conditions which permit the sudden and excessive increase of a given species of insect are often widely prevalent.

——— *Epilachna corrupta* as an injurious insect.

(Amer. Naturalist, Feb., 1883, XVII, pp. 198–199.)

Extract from letter of G. H. Stone on the food-plants, habits and ravages of *Epilachna corrupta;* geographical distribution of this beetle.

——— Notice of an "Illustrated essay on the *Noctuidæ* of North America."

Bull. Brooklyn Entom. Soc., Feb., 1883, V, pp. 77–79.)

——— Also separate. 4 p., O.

Critical review of A. R. Grote's "Illustrated Essay on the *Noctuidæ* of North America, ... 1883"; the matter of Grote's work chiefly second-hand and much of it false; citation and criticism of false and erroneous passages.

——— Dipterous enemies of the *Phylloxera vastatrix*.

(Canadian Entomologist, Feb., 1883, XV, p. 39.)

Crit. rev. of T. W. Fyles' "Description of a Dipterous Parasite of *Phylloxera vastatrix*" (Canadian Entomologist, Dec., 1882, xiv, pp. 237–239;) the characters given of *Diplosis grassator* are not sufficient to distinguish the species; the galls of *Phylloxera vastatrix* are inhabited by another enemy, named *Leucopis phylloxeræ* in author's MS.; comparison of larvæ and pupæ of these two Diptera.

——— Food habits of *Megilla maculata*.

(American Naturalist, March, 1883, XVII, pp. 322–323.)

Summary of S. A. Forbes's observations upon the food of *Megilla maculata*, with statement of the results of the author's and other observations on this subject, showing that the species is vegetarian.

——— Jumping seeds and galls.

(Sci. Amer., Apr. 14, 1883.)

A paper read before the Biological Society of Washington, D. C., Nov. 24, 1882 (Reprint, Proc. U. S. Nat. Mus., May 12, 1883, pp. 632–635).

Figures of larva, pupæ, and imago of *Carpocapsa saltitans*, with figure and description of seeds inhabited by the larva of this moth, and description of the plant bearing these seeds; vernacular names of the plant and insect; transformations of the insect; movements imparted by this insect to the seeds containing it, and by *Cynips saltatorius* to the galls of the *Cynips*.

RILEY, CHARLES V.—Mosquitoes *vs.* malaria.

(Sci. Amer., Apr. 14, 1883.)

Reprint (Am. Naturalist, May, 1883, XVII, p. 549).

Statement and criticism of the views of Dr. A. F. A. King, in support of the thesis that malarial disease is the result of inoculation of the body with malarial poison by the bites of insects; citation of twenty correspondences in the conditions affecting the prevalence of mosquitoes [*Culex*] and malarial disease.

——— Larval stages and habits of the Bee-fly *Hirmoneura.*

(Science, April 27, 1883, I, pp. 332–334, 3 fig.)

Summary of the life-history of *Hirmoneura obscura*, condensed from A. Handlirsch's "Die Metamorphose und Lebensweise von *Hirmoneura obscura* Meig." . . . (Wiener Entom. Zeit., Sep., 1882, i, pp. 224–228 [Jan., 1883, ii, pp. 11–15, pl. 1]), and Dr. F. Brauer's "Ergänzende Bemerkungen" . . . (*op. cit.*, Feb., 1883, ii, pp. 25–26), with figures of the several stages of this fly; correspondence of the structure and early history of the larva with the author's predictions in reference to the larvæ of *Bombyliidæ.*

——— The food relations of the *Carabidæ* and *Coccinellidæ.*

(Amer. Naturalist, April, 1883, XVII, pp. 417–419.)

Summary of the general conclusions arrived at in S. A. Forbes' ["The food relations of the *Carabidæ* and *Coccinellidæ*" (Bull. No. 6 of Ill. State Laboratory of Nat. Hist., Jan., 1883)], in regard to the proportionate amount of various animal and vegetal ingredients in the food of *Carabidæ* and *Coccinellidæ;* correspondence of the structure of the mandibles of *Carabidæ* with the nature of their food.

——— Possible Food-plants of the Cotton-worm.

(Amer. Naturalist, April, 1883, XVII, pp. 421–422.)

Notice of Dr. J. S. Bailey's "*Aletia argillacea* Hübn." (Papilio, Nov.–Dec., 1882, ii, p. 189); occurrence of newly issued imagos of *Aletia xylina* at Karner, N. Y., 7th and 8th Oct., 1882, seeming to prove that the larva of this insect may feed upon some genus of plants other than *Gossypium* in the Northern States.

——— *Agrotis messoria* Harr. vs. *Agrotis scandens* Riley.

(Amer. Naturalist, April, 1883, XVII, p. 422, 2 fig.)

Crit. rev. of A. R. Grote's "Note on *Agrotis repentis*" (Papilio, September, 1881, v. 1, pp. 126–128), and of his "New Check List of North American Moths, . . . 1882," in regard to the synonymy of *Agrotis lycarum*, *A. repentis*, and *A. cochranii*, all of which are the same as *A. messoria; A. scandens* is a distinct species; figures of larvæ and imagos of the two species, and comparison of the imagos.

——— Prevalence of the Screw-worm in Central America.

(Amer. Naturalist, April, 1883, XVII, p. 423.)

Extract from a letter of J. E. Zeledon on the abundance and ravages of *Lucilia macellaria* and related flies in Costa Rica.

——— Dried Leaves as Food for Lepidopterous Larvæ.

(Amer. Naturalist, April, 1883, XVII, pp. 423–424.)

Review of A. H. Mundt's "New Method of Feeding Larvæ"(Papilio, January, 1883, iii, pp. 25–26); larvæ of *Papilio cresphontes* and *Apatura clyton* successfully fed on leaves dried when gathered and moistened when to be used; directions for this process and suggestion of improvement upon it; larvæ successfully fed upon fresh leaves transported from a distance under pressure.

RILEY, CHARLES V.—Observations on the Fertilization of *Yucca* and on structural and anatomical Peculiarities in *Pronuba* and *Prodoxus*.

(Proc. Amer. Asso. Advanc. Sci. for 1882, 1883, XXXI, pp. 467–468. (Gardeners' Monthly, April, 1883, pp. 118–119.)

Abstract of a paper read at the Montreal meeting of the American Association for the Advancement of Science, —— August, 1882; description of the manner in which *Pronuba yuccasella* gathers the pollen in flowers of *Yucca;* the work of this insect is necessary to the fertilization of the capsular species of *Yucca*, the irregularity of whose fruit is due to its punctures; description of the egg and of the manner of oviposition of this insect.

——— Cluster-Flies.

(Proc. U. S. National Museum, May 12, 1883, pp. 636–637.)

Paper read before the Biological Society of Washington, D. C. Covering the same ground in detail as the abstract given in Amer. Naturalist, January, 1883. Appears, by error, as a part of a "note on cluster-flies" by W. H. Dall, the quotation marks being omitted.

——— Elephantiasis, or Filaria disease.

(Science, May 18, 1883, I, pp. 419–421, with fig.)

Criticism of the views of Dr. A. F. A. King, set forth in [author's] "Mosquitos vs. Malaria" (Amer. Naturalist, May, 1883, XVII, p. 549), and notice of the writings of Dr. P. Manson and others on the connection of *Culex mosquito* with the life-history of *Filaria sanguinis-hominis,* and on the production of elephantiasis and related diseases by the *Filaria.*

——— Number of Molts and Length of Larval Life as influenced by Food.

(Amer. Naturalist, May, 1883, XVII, pp. 547–548.)

Remarks on the variability in habits as in characters of insects; periods and number of molts observed in larvæ of *Tenebrio molitor*, *T. obscurus*, and *Trogoderma tarsale;* conclusion that insufficient nutrition retards development and occasions frequent molting.

——— The new Classification of the Coleoptera of North America.

(Amer. Naturalist, June, 1883, XVII, pp. 660–661.)

Notice of J. L. Le Conte and G. H. Horn's "Classification of the Coleoptera of North America. . . 1883."

——— A pretty and unique gall-making Tortricid.

(Amer. Naturalist, June, 1883, XVII, p. 661, fig. 1.)

Description and figure of imago of *Grapholitha ninana* n. sp., reared from galls found on stems of *Acacia filicina* in Arizona.

——— Synopsis of the N. A. *Heliothinæ*.

(Amer. Naturalist, June, 1883. XVII, pp. 662–663.)

Review of J. B. Smith's "Synopsis of the N. A. Heliothinæ" (Trans. Amer. Entom. Soc. for 1882, x, pp. 205–255, pl. vii, viii); nature of the generic characters of *Noctuidæ;* neglect of these characters by A. R. Grote.

——— Protection of Insect Collections.

(Amer. Naturalist, June, 1883, XVII, pp. 663–664.)

Statement of the power of Dermestid larvæ to endure the effects of certain insecticides, and of the requisites more important than the use of insecticides for the protection of collections from pests; seasons in which collections are most endangered.

RILEY, CHARLES V.—The "Pine Moth of Nantucket."

(Amer. Naturalist, June, 1883, XVII, pp. 665–666.)

Notice and crit. rev. of S. H. Scudder's. "[The Pine Moth of Nantucket. . . . A. Williams & Co., Boston, 1883]"; *Retinia frustrana* considered to be widely distributed, wherefore the suggested means against it lose much of their efficacy; number of broods of this species; principles on which popular names for injurious larvæ should be chosen.

——— Insect Plagues. Locusts, Saw-Worms, and Caterpillars in New England. Professor Riley's proposals to exterminate them. Practical Advice to Farmers and Woodmen.

(Boston Herald, July 22, 1883.)

Newspaper interview, in which the author treats of the ravages of and means against *Caloptenus atlantis, Nematus erichsonii, and Orgyia leucostigma.*

——— A unique and beautiful Noctuid.

(Amer. Naturalist, July, 1883, XVII, pp. 788–790, with fig.)

Figure of imago of *Cirrhophanus triangulifer;* description of its generic characters and discussion of its affinities: criticisms of A. R. Grote's writing on the species; its probable habits; synonyms of this species, and statement of circumstances attending the original description of it; inference from structure as to larval habit.

——— Insects affecting stored rice.

(Amer. Naturalist, July, 1883, XVII, p. 790.)

List of insects, mostly Coleoptera (*Tenebrio molitor, T. obscurus, Murmidius oralis, Trogosita mauritanica, Calandra oryzæ, Silvanus surinamensis, Attagenus megatoma, Lepisma saccharina*), found in a lot of damaged rice from the Chinese centennial exhibit in the National Museum; two species of these are carnivorous.

——— Hyper-metamorphoses of the *Meloidæ.*

(Amer. Naturalist, July, 1883, XVII, pp. 790–791.)

Proposal of simpler and more natural terms than heretofore used to designate the successive stages of development of larvæ in *Meloidæ.* (*Triungulin* = 1st larval stage; *Caraboid* = 2d larval stage; *Scarabæoid* = 3d and 4th larval stages; *Coarctate* = 5th larval stage; *Scolytoid* = 6th larval stage.)

——— Hackberry Psyllid galls.

(Canadian Entomologist, August, 1883, XV, pp. 157–159, figs. 6–7.)

Critical review of T. W. Fyles' "The Parasite of *Phylloxera vastatrix,* and the Gall Insect of the Nettle Tree" (*op. cit.,* May, 1883, XV, pp. 83–84); *Phylloxera vastatrix* has many parasites and *Celtis* is attacked by many species of gall-insects; description of characters of *Pachypsylla* n. gen.; figures of galls of *Pachypsylla venusta* and *P. celtidis-mamma,* to the latter of which species belongs the insect described in Fyles' "Notes on a Gall Mite of the Nettle Tree, *Celtis occidentalis*" (*op. cit.,* Oct. (872, XIV, pp. 198–199); *Psylla celtidis-grandis* = *Pachypsylla venusta;* derivation and orthography of the generic term *Celtis.*

——— Some recent discoveries in reference to Phylloxera.

(Science, September 7, 1883, II, p. 336.)

Abstract of paper read before American Association for the Advancement of Science, at Minneapolis, August, 1883; summary statement of the cycle of development in the genus *Phylloxera;* variation of development in the same genus; character of the gall of *P. spinosa* and place of deposit of the impregnated egg of this species. But two generations annually, the second giving the sexes and the impregnated egg passing the summer, fall, and winter.

RILEY, CHARLES V.—The *Psyllidæ* of the United States.

(Science, September 7, 1883, II, p. 337.)

Abstract of paper read before American Association for the Advancement of Science, at Minneapolis, August, 1883; list of new genera species of *Psyllidæ* described in the paper, and of their respective food-plants, with general statement of the character of the egg and larva in this family.

——— Improved method of spraying trees for protection against insects.

(Science, September 14, 1883, II, p. 378.)

Abstract of paper read before American Association for the Advancement of Science, at Minneapolis, August, 1883; description of principles embodied in apparatus devised at the U. S. Department of Agriculture for spraying trees with insecticides from the ground.

——— The old, old question of species.

(Amer. Naturalist, September, 1883, XVII, p. 975.)

Comments upon a discussion between H. A. Hagen and W. H. Edwards as to the number of North American species of *Papilio* of the *P. machaon* group; the views of both parties extreme; views of the author in regard to the true nature of species.

——— *Myrmecophila*.

(Amer. Naturalist, September, 1883, XVII, pp. 985–976.)

Record of recent captures of *Myrmecophila* in Oregon and in District of Columbia, and reference to records of former captures in United States; the habits of the genus the same in this country as in Europe.

——— Salt-water Insects used as food.

(Amer. Naturalist, September, 1883, XVII, pp. 976–977.)

Occurrence of a species of *Ephydra*, supposed to be *E. hians*, in Lake Tetscoco, in Mexico; *E. gracilis* found in Great Salt Lake, Utah, and *E. californica* in lakes in California; account given by W. H. Brewer of the manner in which the last-mentioned species is gathered and used for food by the Indians living near Mono Lake.

——— Food-plants of *Samia cynthia*.

(Amer. Naturalist, September, 1883, XVII, p. 977.)

Review of H. H. Birney's "*Samia cynthia* feeding on the Sassafras and Tulip tree" (Amer. Naturalist, August, 1883, xvii, p. 879); list of plants on which *Samia cynthia* has hitherto been found feeding; some of these are the favorite food-plants of *Callosamia promethea*.

——— *Steganoptycha claypoleana*.

(Amer. Naturalist, September, 1883, XVII, p. 978.)

Description of the imago of *Steganoptycha claypoleana* Riley, in comparison with that of *Proteoteras aesculana* Riley; notes on the habits of both species with larval differences they exhibit.

——— A parasite of the Cabbage-worm.

(Rural New Yorker, October 6, 1883.

Letter from J. H. B———, with answer; parasitism of *Pteromalus puparum* in larvæ and pupæ of *Pieris* [*rapæ*].

——— The Handmaid moth.

(Rural New Yorker, October 13; 1883.)

Answer to inquiry of H. B. S———; description of larva, pupa and imago of *Datana ministra*, from hickory and walnut trees, and of a phytophagic variety of the larva from apple and other trees; habits of the larvæ; the larvæ unusually numerous in 1883.

RILEY, CHARLES V.—The Potato-stalk Borer.

(Rural New Yorker, October 20, 1883.)

Letter from S. C. R———, with answer; habits of and means against *Gortyna nitela;* description of imago of this species; means against *Paria aterrima, Heteraspis pubescens,* and other Chrysomelid larvæ injurious to the roots of strawberry plants.

——— Recent advances in horticultural entomology. . . .

(Rural New Yorker, October 20, 1883.)

Stenographic report, by H. H———, of an address delivered by C. V. Riley before the American Pomological Society, at Philadelphia, September (13), 1883; discussion of measures recommended for adoption to prevent the ravages of insects injurious to horticulture, especially of *Carpocapsa pomonella* and *Conotrachelus nenuphar;* correction of popular statements in regard to the oviposition of *Saperda bivittata* and *Bembecia marginata;* advance in knowledge of the life-history of *Aphididæ* and in the development of machinery for the application of poison sprays to plants; relative value of the principal insecticides now in use.

——— On a gall-making genus of *Apioninæ.*

(Bull. Brooklyn Entom. Soc., October 1883, vi, pp. 61–62.)

List of gall-making Coleoptera hitherto found in North America; description of the new genus *Podapion,* and of the gall and imago of *P. gallicola* n. sp., found on twigs of *Pinus inops;* probable life habits, inquilines, and parasite of this insect.

——— [*United States*] *Department of Agriculture—Entomologist,* 1883 (C. Valentine Riley). Report of the entomologist. (Rept. [U. S.] Commiss. Agriculture for 1883.)

Separate, author's ed., entitled "Report of the Entomologist, Charles V. Riley, M. A., Ph. D., for the year 1883." From the Annual Report of the Department of Agriculture for the year 1883. Issued October 31, 1883. Wash., [Oct. 31], 1883. t. p. cover + t. p., 5 p. + p. 99 - 180 + 2 + 6 + pp., 13 pl., O.

Consists of an "Introduction" (p. 99–101), giving a sketch of the report and of the work of the entomological division and its assistants and agents during the past year; and of chapters to be cited, unless otherwise indicated, under the name of C. V. RILEY as author, bearing the following titles: —— Silk-worm notes (pp. 101–107). — Cabbage worms (pp. 107–138; pl. 1, 10, 11; pl. 12, fig. 1–2). — PACKARD, A. S., jr. Report on the causes of destruction of evergreen forests in Northern New England and New York (pp. 138–151; pl. 3, 13). — HUBBARD, H. G. Report of progress in experiments on scale insects, with other practical suggestions (pp. 152–159). — The imported elm-leaf beetle. *Galeruca xanthomelaena,* Schrank (pp. 159–170; [pl. 4–6]; pl. 12, fig. 3). — The lesser migratory locust, *Caloptenus atlanis,* Riley (pp. 170–180; pl. 2, 7–9).

The chapter on "Cabbage worms" treats of the geographical distribution, ravages, characters, habits, food-plants, seasons, enemies, and parasites of and means against *Pieris rapæ, P. protodice, P. oleracea, P. monuste, Plusia brassicae, Mamestra chenopodii, Ceramica picta, Pionca rimosalis, Botis repetitalis,* and *Plutella cruciferarum.* Packard's chapter treats of the characters, habits, and ravages of and means against, *Nematus erichsonii* and *Tortrix fumiferana,* and the characters of *Nematus integer* and *Gelechia abietisella* n. sp. The subjects of the other chapters are indicated in their titles.

RILEY, CHARLES V.—Entomology at Minneapolis.

(Amer. Naturalist, Oct., 1883, XVII, pp. 1068–1070; Nov., 1883, xvii, pp. 1169–1174.)

Minutes of the meetings of the entomologists in attendance at the meeting of the American Association for the Advancement of Science, at Minneapolis, Minn., 15–17 August, 1883; list of persons present; reorganization of the Entomological Club of the A. A. A. S,; election of officers and modification of constitution thereof; abstracts of papers read at these meetings.

Contents further analyzed under the following captions: EDWARDS, W. H.: Life histories of butterflies, pp. 1068–1069. — RILEY, C. V.: Notes on *Pædisca scudderiana*, pp. 1069–1070. — RILEY, C. V.: A Myrmicophilous Lepidopteron, p. 1070. — RILEY, C. V.: Remarks on *Arzama obliquata*, p. 1169. FORBES, S. A.: The use of contagious germs as insecticides, pp. 1169–1170. — OSBORN, H: *Bombus pennsylvanicus* in a deserted wren's nest, p. 1171. — HOY, P. R.: *Plusiodonta compressipalpis*, p. 1171. — HERRICK, C. L., *et al.* [Frost flies], pp. 1171–1172. — OSBORN, H.: Food habits of *Gortyna nitela*, p. 1172. — FORBES, S. A.: Gall-mites, p. 1172. — SAUNDERS, W.: Black-knot, p. 1172. — KELLICOTT, D. S.: Notes on certain boring Lepidopterous larvæ, p. 1172–1174. — RILEY, C. V.: *Cantharis nuttalli* injuring wheat, p. 1174.

——— Notes on *Pædisca scudderiana.*

(Amer. Naturalist, Oct., 1883, XVII, pp. 1069–1070.)

Remarks on the habits of *Pædisca scudderiana*, showing their variation, and that the published statements of Dr. D. S. Kellicott about them are correct so far as they go; difference between the gall of this insect and that of *Gelechia gallæsolidaginis.*

——— A Myrmicophilous Lepidopteron.

(Amer. Naturalist, Oct., 1883, XVII, p. 1070.)

Larva of *Helia americalis* found in nests of *Formica rufa;* this is the first Lepidopterous insect known to the author to develop in ants' nests in America.

——— Enemies of the egg-plant.

(Amer. Naturalist, Oct., 1883, XVII, p. 1070.)

Extract from a letter from Dr. A. Oemler, proving that the occurrence of *Cassida texana* and *Doryphora juncta* on *Solanum melongena,* as recorded in author's "Change of Habit; two new enemies of the Egg-plant" (*op. cit.*, Aug., 1882, xvi., pp. 678–679), was not accidental or temporary.

——— Habits of *Murmidius.*

(Amer. Naturalist, Oct., 1883, XVII, p. 1071.)

List of insects found in a lot of damaged rice from South America; occurrence of *Murmidius* [*ovalis*] in vast numbers in this rice; its probable food habits; description of its cocoon; list of families of coleoptera some of whose larvæ spin cocoons; habitat and abode of *Mychocerus.*

——— Emulsions of petroleum and their value as insecticides.

(Proc. Amer. Assoc. Advanc. Sci., for 1882, 1883, XXXI, pp. 469–470.) (Kansas City Review of Science and Industry, Nov. 1883, v. 7, pp. 447–448.)

Abstract of paper read before American Association for the Advancement of Science at Montreal, Aug. 1882; description of modes of making emulsions of petroleum to use against insects.

RILEY, CHARLES V.—A satisfactory remedy for melon-bugs, flea-beetles, &c.

(Rural New-Yorker, Nov., 1883.)

Probably the most satisfactory general preventive of the ravages of *Diabrotica vittata* and of *Halticidæ* on cucurbitaceous plants is Mr. P. T. Quinn's method of sprinkling the vines with a mixture of tobacco water and soft soap, and then dusting them with lime; description of J. M. Nicholson's siphon arrangement by which to keep the vines constantly moist with liquid.

——— Remarks on *Arzama obliquata.*

(Amer. Naturalist, Nov., 1883, XVII, p. 1169.)

Description of the egg-mass of *Arzama obliquata;* colors and abode of the larva; variations of the imago; number of annual broods of this species stated by author to be two, and by D. S. Kellicott to be one.

——— *Hymenorus rufipes* as a Myrmicophilous species.

(Amer. Naturalist, Nov., 1883, XVII, p. 1176.)

Corroboration of the statements in author's "Myrmecophilous Coleoptera," (*op. cit.*, Sept., 1882, XVI), p. 748, regarding the habits of the larva of *Hymenorus rufipes;* imagos reared from these larvæ found in the nests of *Formica fusca;* character of the nests of the *Formica;* the food-habits of the *Hymenorus* still unknown.

——— Some recent discoveries in reference to Phylloxera.

(Amer. Naturalist, Dec., 1883, XVII, p. 1288.)

Importance of a knowledge of the life-history of the species of *Phylloxera;* outline of the life-history; the several successive stages of some species have now been traced; character of the gall and place of deposit of the egg of *Ph. spinosa* on *Carya alba.*

——— The growth of insect eggs.

(Amer. Naturalist, Dec., 1883, XVII, p. 1289.)

Notice of J. A. Osborne's "On Growth in the Eggs of Insects" (Hardwick's Science-Gossip, Oct. 1, 1883, XIX, pp. 225–227), with an account of the swelling of the eggs of *Phaneroptera curvicauda;* this swelling seems to be connected with embryological development.

——— Protective device employed by a Glaucopid Caterpillar.

(Amer. Naturalist, Dec., 1883, XVII, p. 1289.)

Notice of a paper by Dr. Fritz Müller (Kosmos, ———, VI, p. 449); general use of shed hairs by larvæ of *Arctiidæ* in the construction of their cocoons; description of method in which the larva of *Eunomia eagrus* arranges its shed hairs to form a protection for the pupa.

——— The genus *Colias.*

(Amer. Naturalist, Jan., 1884, XVIII, pp. 74–76.)

Review of H. A. Hagen's "Contributions from the Northern Transcontinental Survey" (Proc. Boston Soc. Nat. Hist., ———, XXII, pp. 150–178); discussion of the number of species of *Colias* in North America; plastic nature and classificational characters of the genus; the logic of Hagen's reasoning combines all the commoner and well known forms under three well-marked species.

RILEY, CHARLES V.—Osage Orange *vs.* Mulberry for the Silkworm.

(Amer. Naturalist, Jan., 1884, XVIII, pp. 78–79.)

Comparative value of leaves of *Maclura aurantiaca* and of *Morus* as food for *Sericaria mori;* critical review of the conclusions set forth by V. des Lauriers.

——— The Chinch-bug in New York State.

(Amer. Naturalist, Jan., 1884, XVIII, pp. 79–80.)

Critical review of a circular issued from the office of the State Entomologist, of New York, Oct. 18, 1883, and J. A. Lintner's "The Chinch-bug in New York" (Science, Oct. 19, 1883, ii, p. 540): the occurrence of *Blissus leucopterus* in New York State, in unusual abundance, in 1882 and 1883, is not warrant for great alarm.

——— Bacterial Disease of the imported Cabbage-worm.

(Amer. Naturalist, Jan., 1884, XVIII, p. 80.)

Notice of observations by S. A Forbes on the death of larvæ of *Pieris rapæ* from infection by *Bacterium;* quotation of former mention of this disease by the author.

——— The Department of Insects in the U. S. National Museum.

Rep. Asst. Director U. S. Nat. Mus. for 1882: Report Smithsonian Institution for 1882 (1884), pp. 174–183; 215–216).

SHUFELDT, ROBERT W.—On the Ossicle of the Antibrachium as found in some of the North American *Falconidæ.*

(Bull. Nutt. Ornithological Club, Cambridge, Mass., Oct., 1881, p. 197.)

A description of the carpal sesamoid in *Circus hudsonicus.* The author gave this sesamoid the name of the "os prominens."

——— The Claw on the Index digit of the *Cathartidæ.*

(Amer. Naturalist, Nov., 1881, p. 906.)

This is an account of the discovery of a claw upon the pollex phalanx of all our American Vultures.

——— Remarks upon the Osteology of *Opheosaurus ventralis.*

(Proc. U. S. Nat. Mus. 1881, p. 392.)

A quite complete account of the Osteology of this apodal lizard. The dissections go to show that it possesses rudimentary femora, but the fore-limbs are entirely absent. Its skeleton is here compared with *Gerrhonotus, Eumeces,* and others.

——— Note on *Mimus polyglottus.*

(Bull. Nutt. Ornith. Club, Cambridge, Mass., July, 1882, No. 3, vol. VIII, p. 180.)

Notice of the capture of a specimen of this bird at Fort Fetterman, Wyo., latitude 42° 23′ 35″ N., and longitude 105° 21′ 4″ W., where it was breeding. This extended its geographical range.

——— Notes upon the Osteology of *Cinclus mexicanus.*

(Bull. Nutt. Ornithological Club, Cambridge, Mass., vol. VII, Oct., 1882, No. 4, pp. 213–221.)

An account of the skeleton is given, and notice taken of the structure of the tarsal joint in the young of *Cinclus,* which presents many points of interest. The results of the examination show the close relation of the Dipper to the genus *Siurus.*

SHUFELDT, ROBERT W.—The number of bones at present known in the pectoral and pelvic limbs of birds.

(Amer. Naturalist, November, 1882, No. 2, vol. XVI, pp. 892–895.)

A review of the present knowledge of the various bones to be found in the appendicular skeleton of birds, both adult and young. A table is presented showing the number for the upper extremity, where they amount to twenty, and also one for the lower extremity, where twenty-nine bones have been described and attributed to this limb. In neither case, however, do all these segments ever occur in the same subject.

——— The bite of the Gila Monster (*Heloderma suspectum*).

(Amer. Naturalist, Nov. 1882, pp. 907, 908.)

An account of the personal experi nce of the author, who was bitten by a Helodern, at the Smithsonian Institution. No bad results followed after the recovery from the original wound, which was severe and caused serious symptoms at the time of its infliction. The saliva of the same specimen was subsequently examined by Dr. S. Weir Mitchell, of Philadelphia, then engaged in experimenting upon poisonous reptiles. This eminent investigator pronounced the mixed buccal secretions of the Gila Monster to be poisonous in their effects when taken into the course of the human circulation.

——— Contributions to the Anatomy of Birds.

(Department of the Interior, United States Geological and Geographical Survey, F. V. Hayden, U. S. Geologist, in charge. Author's edition, extracted from the Twelfth Annual Report of the Survey, pp. 593 to 806, inclusive. Twenty-four lith. plates and many cuts; Washington, October 14, 1882.)

A collection of the author's early papers, revised and rewritten. An account is given, for the first time, of the skeleton of *Speotyto cunicularia hypogœa*. The osseus system of *Cremophila alpestris*, and *Lanius ludovicianus excubitorides* is also described. In the "North American Tetraonidæ" full descriptions are presented, in systematic tables, of the geographical ranges and variations of all the American partridges and grouse. These are followed by complete investigations of the osseous systems of the various species, and comparisons with a long list of kindred forms. A new bone, the "pentosteon," is described for the carpus of the young of *Centrocircus*, and the striking similarity between the skeletons of *Cupidonia* and *Pediacetes* is for the first time brought before the attention of anatomists. The most complete of these papers is that on the osteology of the Cathartidæ. The *Cathartidæ* are shown to be entirely distinct from the Old World vultures and the *Falconidæ*, and many points in the skeletons go to support this conclusion. The genus *Pseudogryphus*, made by Ridgway, is confirmed by these studies, and an account is given of many of the bones of this rare vulture.

——— The habits of *Muraenopsis tridactylus* in captivity; with observations on its anatomy.

(Science, Cambridge, Mass., August 10, 1883, No. 27, vol. II, pp. 159–163, 4 figs.)

A quite full account of several individuals of the Three-fingered Siren, which the author kept in confinement while making collections in Louisiana. Attention is called to the prevailing superstition on the part of the people of all classes in that State in regard to the bite of this reptile, but from personal experience the author proves its harmlessness. A very full description of the skeleton is given, with illustrations of the most important parts of its anatomy.

SHUFELDT, ROBERT W:—Observations on the habits of the American Chameleon (*Anolis principalis*).

(American Naturalist, September, 1883, vol. XVII, No. 9 pp. 919–926. One full-page cut.)

Anolis is an exceedingly common lizard in all the gardens and parks in the suburbs of New Orleans, and the author availed himself of the opportunity during his collecting tours in that vicinity to make observations upon its habits, etc., which are fully set forth in this article. Attention is called to its breeding, method of capturing its food, and it chameleonic powers.

This paper was reproduced by the American Field (January 14, 1884), but not properly accredited to the naturalist. A large series of specimens, collected at this time, is now in the Smithsonian Institution.

——— Observations upon the osteology of *Podasocys montanus*.

(Journal of Anatomy and Physiology; London, Oct., 1883, No. v, vol. XVIII, pt. i, pp. 86–102, 1 plate.)

In this paper the skeleton of a typical American plover has been thoroughly described, and its skull, with other parts compared with pluvialine forms.

A lithographic plate accompanies the article, engraved by F. Huth, of Edinburgh, in which all the principal bones are shown from various points of view.

——— Remarks upon the osteology of *Phalacrocorax bicristatus*.

(Science, vol. II, No. 41, Nov. 16, 1883, pp. 640–642, 3 cuts.)

At different times ornithotomists have been attracted by the many interesting points in the skeleton of a cormorant. This bird has a peculiar bone articulating on a mid-point of the occipital ridge. This feature has been described and figured by Selenka and Eyton. Marsh called it the "nuchal bone" in one of his papers on the osteology of cormorants. In this article it is again figured, being tipped up on its side, so that it may be fully seen. It does not belong to the skull, but is an ossification in mid-plane of the fascia between the heads of the biventer cervicis muscle, or what may be compared to the ligamentum nuchæ of birds. Other interesting features of the skeleton of this cormorant are reviewed.

——— *Romalea microptera*.

(Science, vol. II, No. 47, Friday, December 28, 1883, pp. 811–814, 1 life-size lith. plate.)

This paper is devoted to a study of the great black "lubber grasshopper" of the South. The observations are upon Louisiana specimens, and treat particularly upon its breeding habits and behavior during captivity. The eggs and method of laying them are fully described. The paper is illustrated by a full-page lithographic plate, giving the eggs and life-size figures of a male and female. The author collected large series of this insect, in all stages of development, and these now form a part of the entomological collections of the U. S. National Museum.

STEARNS, ROBERT E. C.—The edible clams of the Pacific coast and a proposed method of transplanting them to the Pacific coast.

(Bull. U. S Fish Com., III, pp. 353–362.)

STEJNEGER, LEONHARD.—Remarks on the systematic arrangement of the American Turdidæ.

(Proc. U. S. Nat. Mus., vol. V, 1882, pp. 449–483.)

This is by far the most important paper on the subject ever published. It is illustrated by numerous outline figures of the generic characters. (*R. Ridgway.*)

STEJNEGER, LEONHARD.—Contributions to the history of the Commander Islands. No. 1.—Notes on the natural history, including descriptions of new Cetaceans.

(Proc. U. S. Nat. Mus., VI, 1883, pp. 58–89.)

Contains descriptions of *Ziphius Grebnitzkii* and *Berardius Bairdii* and notes upon other species of mammals, also valuable contributions to ornithology.

TRUE, FREDERICK W.—On the bite of the North American coral snakes (genus *Elaps*).

(Amer. Nat., XVII, 1883, pp. 26–31.)

That the bite of the Floridan coral snakes, *Elaps fulvius*, is poisonous is proven by the symptoms which appeared in consequence of a wound inflicted by one of these serpents. Febrile symptoms lasted for about three days and were followed by ulceration in the bitten finger. The pain also returned from time to time after the normal condition of health had been recovered. From other apparently authentic cases cited it appears that the bite of the coral snake may prove fatal to children and possibly even to adults.

——— Check list of the reserve and general series of North American tortoises.

(Bull. U. S. Nat. Mus., No. 24, 1883. By H. C. Yarrow, M. D. Chelonian taxonomy and critical preface by F. W. True. pp. 26–38.)

——— The folk-lore of flowers.

(Notes and Queries, 6th ser., VII, 1883, p. 146.)

The date of the advent of certain species of fishes on the New England coast is associated by some of the fishermen with the time of blooming of different flowers. The scuppaug, for example, comes when the dandelions begin to bloom, and the striped bass when the high blackberries are in blossom.

——— The antedating of books.

(Nation, XXXVI, 1883, p. 12.)

Calls attention to the growing practice of giving books published near the close of the year the date of the succeeding year.

——— On a cinnamon bear from Pennsylvania.

(Proc. U. S. Nat. Mus., V, 1883, pp. 653–656.)

Allusions to the existence of a distinct species of American bear of a cinnamon color are to be found in the literature of the past hundred years. The opinion, however, that specimens of that color are simply the result of albinoism in the common black bear, *Ursus americanus*, seems now to be well established, except, perhaps, so far as concerns the so-called cinnamon bear of the northwestern region. In the bear obtained in Pennsylvania is represented a condition of semi-albinoism which extends to all parts of the body. The fur is of a clear, golden brown, while the naked portions of the body and the eyes are also brown, but duller.

——— On a pair of abnormal antlers of the Virginia deer.

(Proc. U. S. Nat. Mus., VI, 1883, p. 151, 1 fig.)

The specimen in question represents a pair of antlers in which the tynes of the left axis are normally developed, while on the right side only a single, long brow-tyne is present.

——— Movement of the arms in walking.

(Science, I, 1883, p. 11.)

TRUE, FREDERICK W.—*Ziphius* on the New Jersey coast.

(Science, II, 1883, p. 540.)

In this note is recorded the first authenticated case of the occurrences of a species of *Ziphius* on the east coast of North America.

——— A new sperm whale.

(Science, I, 1883, p. 470.)

The Museum received in May, 1883, from the New Jersey coast a specimen of a pygmy sperm whale (*Kogia*), the first recorded from the North Atlantic. It was named *Kogia Goodei.* [The author is at present of the opinion that but one species of this genus, *K. breviceps*, exists, and that the species referred to above is invalid.]

——— The Atlantic right whales.

(Sci. and Lit. Gossip, I, 1883, pp. 72–73.)

Contains a brief review of Dr. Holder's paper upon *Balæna cisarctica.*

——— Anatomy of the Æluroidea. (Abstract.)

(Science, I, 1883, p. 24.

——— A monstrous orang. (Abstract.)

(Science, I, 1883, p. 24.)

——— Direct communication between the median vaginal cul-de-sac and uro-genital canal in marsupials after parturition. (Abstract.)

(Science, I, 1883, p. 24.)

——— Mammals of Northeastern New York. (Abstract.)

(Science, I, 1883, p. 24.)

——— Distribution of the genus Macroscelides. (Abstract.)

(Science, I, 1883, p. 53.)

——— Anatomical and external characters of *Zalophus Gillespii*. (Abstract.)

(Science, I, 1883, p. 53.)

——— Mammals of Essex County, England. (Abstract.)

(Science, I, 1883, p. 53.)

——— Asymmetry of the turbinated bones in man. (Abstract.)

(Science, I, 1883, p. 53.)

——— Muscles of the raccoon's limbs. (Abstract.)

(Science, I, 1883, p. 82.)

——— Myology of Proteles. (Abstract.)

(Science, I, 1883, p. 82.)

——— Singing mice. (Abstract.)

(Science, I, 1883, p. 82.)

——— The evolution of deer-antlers and atavism in the hog-deer. (Abstract.)

(Science, I, 1883, p. 184.)

——— Behavior of the American flying-squirrel in confinement. (Abstract.)

(Science, I, 1883, p. 181.)

TRUE, FREDERICK W.—Taxonomy of the hoofed quadrupeds. (Abstract.)

(Science, I, 1883, p. 182.)

——— On *Halichœrus grypus*. (Abstract.)

(Science, I, 1883, p. 204.)

——— The arrangement of the turbinal bone in the fissiped carnivores. (Abstract.)

(Science, I, 1883, p. 289.)

——— Harder's glands in rodents. (Abstract.)

(Science, I, 1883, p. 289.)

——— The color of horses. (Abstract.)

(Science, I, 1883, p. 289.)

——— The baleen whales. (Abstract.)

(Science, I, 1883, p. 289.)

——— The domestic animals of Camargue. (Abstract.)

(Science, I, 1883, p. 317.)

——— The nature of elephants' milk. (Abstract.)

(Science, I, 1883, p. 317.)

——— American sirenians. (Abstract.)

(Science, I, 1883, p. 346.)

——— Duration of fecundity in man. (Abstract.)

(Science, I, 1883, p. 346.)

——— The intermedius of the carpus in man and other mammals. (Abstract.)

(Science, I, 1883, p. 346.)

——— The bottle-nose whale. (Abstract.)

(Science, I, 1883, p. 555.)

——— A hybrid between the gayal and zebu. (Abstract.)

(Science, II, 1883, p. 89.)

——— Homologues of the parts of the temporal bone. (Abstract.)

(Science, II, 1883, p. 113.)

——— Color-markings of mammals. (Abstract.)

(Science, II, 1883, p. 144. Quar. Jour. Royal Micros. Soc., III, 1883, p. 631.)

——— Epiphyses on the centra of the vertebræ of the manatee. Abstract.)

(Science, II, 1883, p. 207.)

——— The Os intermedium of the foot. (Abstract.)

(Science, II, 1883, p. 448.)

——— The species of hogs. (Abstract.)

(Science, II, 1883, p. 548.)

——— Sexual variation of Rhytina. (Abstract.)

(Science, II, 1883, p. 694.)

WALCOTT, CHARLES DOOLITTLE.—Injury sustained by the eye of a Trilobite at the time of the moulting of the shell.

(Amer. Jour. Sci., Oct., 1883, vol. XXVI, p. 302.) Description of the injury received by the eye of *Illænus crassicauda* during the life of the animal.)

——— New species of fossils from the Trenton group of New York.

(Pamphlet in advance of 35th Rept. N. Y. State Museum, Nat. Hist., issued Oct. 15, 1883, 8 pp., 8 vo., 1 pl.)

One new genus of crinoidea, *Merocrinus*, and the following species are described: *Merocrinus typus, Merocrinus corroboratus, Glyptocrinus argutus, Glyptocrinus? subnodosus, Iocrinus Trentonensis, Dendrocrinus retractilis, Calceocrinus Barrandii, Metoptoma Billingsi, Beyrichia bella, Leperditia (I) armata.*

——— Cambrian System in the United States and Canada (abstract).

(Bulletin Philosophical Soc., Washington. Read Nov. 24, 1883. Vol. VI, p. 97.)

Defines the formations included within the Cambrian system on stratigraphic evidence.

——— Pre-Carboniferous strata in the Grand Cañon of the Colorado, Arizona.

(Amer. Jour. Sci., Dec., 1883, vol. XXVI, pp. 437–442 and p. 484.)

Describes the Potsdam and pre-Potsdam horizons of the Cambrian.

——— Fresh-water shells from the Paleozoic rocks of Nevada. Notes and figures of.

(Science, Dec. 21, 1883, vol. II, No. 46, p. 809.)

One genus, Zaptychius, and the following species are mentioned and illustrated by outline figures: *Zaptychius Carbonaria*, n. g., n. sp., *Physa prisca*, n. sp., *Ampullaria Powelli*, n. sp.

WARD, LESTER F.—Captain C. E. Dutton on the Hawaiians.

(Science, February 9, 1883, I, pp. 9–10.)

Report of an oral communication made by Captain Dutton before the Anthropological Society of Washington, January 2, 1883, on the above subject, from notes taken down and written out.

——— Plant life, past and present.

(Science, May 4, 1883, I, pp. 358–359.)

Abstract of a lecture delivered at the National Museum February 24, 1883. Gives the system of botanical classification proposed in the lecture, and a table showing the number of species of fossil plants belonging to each of the principal groups for the several geological horizons, as also the number of living plants of each group known or estimated.

——— Dynamic sociology, or applied social science, as based upon statical sociology and the less complex sciences.

Two volumes, 12mo. Vol I, xx + 706 pp., vol. II, vii + 690 pp. New York, D. Appleton & Co., 1883 (published June 2).

The principal aim of this work is to point out the superiority of the method of intelligent design over that of spontaneous self-adjustment in the attainment of the objects of desire and of social advancement. It is a plea for the legitimacy of intelligent action on the part of society in securing its own interests and advantage as against the philosophy of inaction which, in recognizing the great secular effects of non-intellectualized activities, neglects the factor of mind which entered into the problem at a certain point, and which tends to discourage the exercise of the legitimate power that mind is capable of exerting for the general good. The work is an argument against the *laissez faire* doctrine and in support of a general policy of regulation applied to social operations according to the same principles as those on which physical phenomena are regulated by the inventive genius of man.

WARD, LESTER F.—Marsh and aquatic plants of the Northern United States, many of which are suitable for carp ponds.

Bulletin U. S. Fish Com., III, Sept. 6, 1883, pp. 257–265.)

The geographical range of the species is given, and those specially designated that are found in the District of Columbia and vicinity of Washington.

——— On the position of the Gamopetalæ.

(Proceedings of the American Association for the Advancement of Science, Montreal, 1882 [Salem, 1883], vol. XXXI, pp. 460–462).

Abstract of a paper read before the biological section, designed to show that the Gamopetalæ are the most highly developed type of Dicotyledons, were latest developed, and should occupy the highest place in the systematic arrangement.

——— The organic compounds in their relations to life.

(Proceedings of the American Association for the Advancement of Science, Montreal, 1882 [Salem, 1883], vol. XXXI, pp. 493–494.)

Abstract. This paper was published in full in the American Naturalist, Dec. 1882, XVI, pp. 968–979, and its title appears in the report of the assistant director of the National Museum for 1882, pp. 67–68.

——— Classification of organisms.

(Proceedings of the American Association for the Advancement of Science, Montreal, 1882 [Salem, 1883], vol. XXXI, pp. 493–494.)

Abstract of a paper read before the biological section. Organisms are classified according to their ability to appropriate nutriment from inorganic or only from other organic bodies. The paper was read from proof sheets of chapter iv of "Dynamic Sociology," (vol. I, pp. 347-355,) then passing through the press.

——— Report to the Director of the United States Geological Survey on the operations of the division of paleobotany during the fiscal year 1882–'83.

(Fourth Annual Report of the U. S. Geological Survey (Report of the Secretary of the Interior, vol. III), pp. 50–51. Washington, Government Printing Office, 1883.)

——— Scientific notes communicated to Science:

1. On the preliminary study of a collection of fossil plants from the Lower Yellowstone.

(Science, June 15, 1883, I, p. 559.)

2. On Gray and Trumbull's review of De Candolle's "Origine des plantes cultivées."

(Science, June 29, 1883, I, p. 616.)

WARD, LESTER F.—Continued.

3. On a collection of fossil plants from the Fort Union group made by the writer during the months of July and August, 1883, in the Yellowstone and Missouri Valleys.

(Science, October 12, 1883, II, p. 517.)

4. On the descent of the Missouri River from Fort Benton, Mont., to Bismarck, Dak., in an open boat by a geological party of which the writer was a member, made in August and September, 1883.

(Science, October 12, 1883, II, pp. 517–518.)

——— Remarks before the Anthropological Society at its fifty-eighth meeting, held November 7, 1882, upon the address of Dr. J. C. Welling, vice-president of the Section of Sociology, on the "Turning-point of modern sociological science."

(Transactions of the Anthropological Society of Washington, II, pp. 31–33, Washington, 1883.)

Criticism of the views of Messrs. Herbert Spencer, W. R. Greg, and others who oppose all humanitarian enterprises, on the ground that they are contrary to the law of the survival of the fittest, and that they tend to produce social degeneracy. It was held that all distinctively human activity is opposed to the natural method of development, and is far more effective.

——— The department of fossil plants in the U. S. National Museum, 1882.

(Report of Assistant Director U.S. Nat. Mus. for 1882, (1883). Smithsonian Report for 1882 (1884) pp. 150–151, 183–186.)

WHITE, C. A.—Glacial drift in the Upper Missouri River region.

(American Journal of Science, March, 1883, vol. XXV, p. 206.)

——— On the Macrocheilus of Phillips, Plectostylus of Conrad, and Soleniscus of Meek and Worthen.

(Proceedings U. S. National Museum, 1883, vol. VI, p. 184.)

——— Progress of Invertebrate Palæontology in the United States for the year 1882.

(American Naturalist, June, 1883, vol. XVII, p. 598.)

——— Burning of Lignite *in situ*.

(American Journal of Science, July, 1883, vol. XXVI, No. 151, p. 24.)

——— Commingling of Ancient Faunal and Modern Floral Types in the Laramie Group.

(American Journal of Science, August, 1883, vol. XXVI, p. 120.)

——— Existence of a deposit in Northeastern Montana and Northwestern Dakota that is possibly equivalent with the Green River Groups.

(American Journal of Science, June, 1883, vol. XXV, p. 411.)

——— The Department of Fossil Invertebrates in the U. S. National Museum in 1882.

(Report Asst. Director U. S. Nat. Museum for 1882. Report Smithsonian Institute for 1882 (1884), pp. 149–150, 186, 221–222.)

WINSLOW, FRANCIS.—Great International Fisheries Exhibition. London, 1883. (Section D.) Catalogue of the economic mollusca and the apparatus and appliances used in their capture and preparation for market exhibited by the United States National Museum. 8vo. pamphlet, 86 pages. Washington: Government Printing Office. 1883.

YARROW, H. C.—Bulletin of the United States National Museum, No. 24. Check List of North American Reptilia and Batrachia, with catalogue of specimens in U. S. National Museum, by H. C. Yarrow, M. D., Honorary Curator, Department of Reptiles. Washington: Government Printing Office. 1883. 8vo. pp. i–v, 1–249.

——— Accessions to the Department of Reptiles in the U. S. National Museum, 1882.

(Report Asst. Director U. S. Nat. Mus. for 1882 (1883), pp. 86–87; Report Smithsonian Institution for 1882 (1884), pp. 204–205.)

YEATES, WILLIAM S.—Accessions to the Department of Minerals, U. S. N. M., 1882.

(Report Asst. Director U. S. Nat. Mus. for 1882 (1883), pp, 104–105; Rep. Smithsonian Institution for 1882 (1884), pp. 222–223.)

III.—PAPERS BY INVESTIGATORS NOT OFFICERS OF THE MUSEUM.

[ANONYMOUS].—Microscopical objects at the Fisheries Exhibition.

(Am. Monthly Micro. Journ., IV, No. 7, pp. 128, 129, July, 1883.)

Describes briefly a collection of American fresh-water sponges, prepared by Mr. Edward Potts, of Philadelphia, and exhibited at the London Fisheries Exhibition by the National Museum.

BELDING, L.—Catalogue of a collection of Birds made at various points along the western coast of Lower California, north of Cape Saint Eugenia. (Edited by R. Ridgway.)

(Proc. U. S. Nat. Mus., vol. V, pp. 527–532.)

——— Catalogue of a collection of Birds made near the southern extremity of Lower California. (Edited by R. Ridgway.)

(Proc. U. S. Nat. Mus., vol. V, pp. 532–550.)

——— List of Birds found at Guaymas, Sonora, in December, 1882, and April, 1883.

(Proc. U. S. Nat. Mus., vol. VI, pp. 343–344.)

——— Second catalogue of a collection of Birds made near the southern extremity of Lower California. (Edited by R. Ridgway.)

(Proc. U. S. Nat. Mus., vol. VI, pp. 344–352.)

BREWSTER, WILLIAM.—On a collection of Birds made by Mr. F. Stephens in Arizona. (Concluded from vol. VII, p. 212.)

(Bull. Nutt. Orn. Club, vol. VIII, Jan., 1883, pp. 21–36.)

Based in part upon "material in the National Museum"; see under *Callipepla squamata castanogastris*, p. 34.

BREWSTER, WILLIAM.—On an apparently New Gull from Eastern North America.

(Bull. Nutt. Orn. Club, vol. VIII, Oct., 1883, pp. 214–219.)

Larus kumlieni, Brewster, the type being No. 76225, U. S. National Museum, from Cumberland Sound.

BUSH, KATHARINE J.—Catalogue of Mollusca and Echinodermata dredged on the coast of Labrador by the expedition under the direction of Mr. W. A. Stearns, in 1882.

(Proc. U. S. National Museum, 1883, vol. VI, pp. 236–247, pl. 9.)

Enumerates seventy-nine species of Mollusca and fifteen species of Echinodermata, and gives a list of the species previously obtained in the same region by Prof. A. S. Packard, jr., and not found by Mr. Stearns. Of the Echinodermata, three species belong to the *Holothuridæ*, two to the *Echinoidea*, five to the *Asteroidea*, and five to the *Ophiuroidea*. Brief notes are given on the localities of occurrence, depths, &c. The collections of Mr. Stearns now belong to the National Museum.

COUES, ELLIOTT.—Note on "Passerculus caboti."

(Bull. Nutt. Orn. Club, Jan., 1883, vol. VIII, p. 58.)

Based upon "specimen No. 62373; Mus. Smiths. Inst., from Nahant, Mass."

——— Note on the Mississippi Kite.

(Bull. Nutt. Orn. Club, Jan., 1883, vol. VIII, p. 61.)

Referring to specimen No. 89570, U. S. Nat. Mus., from Bluffton, South Carolina.

GILL, THEODORE.—On the family Centropomidæ.

(Proc. U. S. Nat. Mus., vol. VI, Feb. 28, 1883, pp. 484–485, plate xi.)

——— Nomenclature of the Xiphiids.

(Proc. U. S. Nat. Mus., VI, Feb. 28, 1883, pp. 485–486.)

——— On the family and subfamilies of Carangidæ.

(Proc. U. S. Nat. Mus., VI, Feb. 28, 1883, pp. 487–493.)

——— Note on the Leptocardians.

(Proc. U. S. Nat. Mus., VI, March 21, 1883, pp. 515–520.)

——— Note on the Petromyzontids.

(Proc. U. S. Nat. Mus., VI, March 21, 1883, pp. 521–525.)

——— Supplementary note on the Pediculati.

(Proc. U. S. Nat. Mus., VI, March 21, 1883, pp. 557–558.)

——— Note on the Pomatomidæ.

(Proc. U. S. Nat. Mus., VI, March 21, 1883. p. 557.)

——— Note on the Affinities of the Ephippioids.

(Proc. U. S. Nat. Mus., VI, March 23, 1883, pp. 557–560.)

——— On the relations of the family Lobotidæ.

(Proc. U. S. Nat. Mus. VI, March 23, 1883. pp. 560–561.)

——— Note on the relationship of the Echeneidids.

(Proc. U. S. Nat. Mus., VI, March 23, 1883. pp. 561–566, pl. xii.)

——— Note on the genus Sparus.

(Proc. U. S. Nat. Mus., VI, March 23, 1883, pp. 566–567.)

GILL, THEODORE.—On the proper name of the Bluefish.

(Proc. U. S. Nat. Mus., March 23, 1883, vol. VI, pp. 567–570.)

——— Diagnosis of new genera and species of deep-sea fish-like vertebrates.

(Proc. U. S. Nat. Mus., Nov. 27, 1883, vol. VI, pp, 253–260.)

GILL, THEODORE, and JOHN A. RYDER.—Diagnoses of new genera of Nemichthyoid eels.

(Proc. U. S. Nat. Mus., Nov. 27, 1883, vol. VI, pp. 260–262.)

——— On the anatomy and relations of the Eurypharyngidæ.

(Proc. U. S. Nat. Mus., Nov. 27, Dec. 13, 1883, vol. VI. pp. 262–273.)

HARGER, OSCAR.—Reports on Results of Dredgings, under the supervision of Alexander Agassiz, on the east coast of the United States, during the summer of 1880, by the U. S. Coast Survey steamer Blake, Commander J. R. Bartlett, U. S. N., commanding. (XXIII.) Report on the Isopoda, by Oscar Harger.

(Bull. Mus. Comp. Zool. of Harvard College, XI, No. 4, September, 1883, pp. 91–104, pl. i–iv.)

Enumerates 9 species, of which nearly all are described at some length, as follows:

Cirolana spinipes Bate & Westwood, pl. 1, figs. 2–2*d*; pl. ii, figs. 1–1*c*, p. 91.
Cirolana impressa, sp. nov., pl. 1, figs. 3–3*d*; pl. ii, figs. 3–3*c*, p. 93.
Æga psora Kröyer (not descr.), p. 95.
? *Æga Webbii* Schiödte & Meinert (not descr.), p. 95.
Æga incisa Schiödte & Meinert, pl. 3, fig. 1, p. 96.
Rocinela oculata, sp. nov., pl. iii., figs. 2–2*a*; pl. iv, fig. 1, p. 97.
Rocinela americana Schiödte & Meinert, pl. iii, figs. 3–3*a*, 4; pl. iv, figs. 2–2*a*, p. 98.
Rocinela, sp. (not descr.), p. 99.
Sycenus infelix Harger, pl. iii, figs. 5–5*a*; pl. iv, figs. 3–3*h*, p. 100.

Three of these species are also recorded from the collections of the U. S. Fish Commission—*Cirolana impressa*, *Rocinela Americana*, and *Sycenus infelix*. The plates are photo-lithographs, from drawings by J. H. Emerton.

HUBRECHT, A. A. W.—En verwaarloosd Volksbelang.

(De Geds, Utrecht No. 7, 1883.)

——— Fish culture as seen at the London Exhibition, with special references to its history, apparatus, and the methods used in the United States.

(Bull. U. S. Fish Commission, III, pp. 337, 348.

A description of the American section of the Fishery Exhibition and its teachings. A translation of the above.

JORDAN, DAVID S., and CHARLES H. GILBERT.—On certain neglected generic names of Lacépède.

(Proc. U. S. Nat. Mus., March 23, 1883, v, pp. 570–573.)

——— On the synonymy of the genus *Bothus*, Rafinesque.

(Proc. U. S. Nat. Mus., v, pp. 576–577.)

JORDAN, DAVID S., and CHARLES H. GILBERT.—Description of a new species of *Artedius* (*Artedius fenestralis*) from Puget Sound.

(Proc. U. S. Nat. Mus., April 19, 1883, v, pp. 577–579.)

——— Description of a new species of *Urolophus* (*Urolophus asterias*) from Mazatlan and Panama.

(Proc. U. S. Nat. Mus., April 19, 1883, v, pp. 579–580.)

——— Notes on a collection of fishes from Charleston, S. Carolina, with description of three new species.

(Proc. U. S. Nat. Mus., May 12, 1883, v, pp. 581–620, April 19.)

123 species are enumerated, 20 not before known north of Key West. *Gobius encæomus*, n. s., p. 611; *Gobius thalassinus*, n. s., p. 612; *Prienotus sarritor*, n. s., p. 615.

——— List of fishes now in the museum of Yale College, collected by Prof. Frank H. Bradley, at Panama, with description of three new species.

(Proc. U. S. Nat. Mus., May 12, 1883, v, pp. 620–632.)

96 species are mentioned, 18 new to Panama. A set of the duplicates is in the National Museum: *Sidera Verrillii* n. s., p. 623; *Emblemaria*, n. g., p. 627; *Emblemaria nivipes*, n. s., p. 627; *Dactyloscopus*, n. s. (?), p. 628; *Arothron erethizon*, n. s., p. 631.

——— Description of two new species of fishes (*Myrophis vafer* and *Chloroscombrus orqueta*) from Panama.

(Proc. U. S. Nat. Mus., May 12, 1883, v, pp. 645–647.)

Myrophis vafer, n. s., Panama, p. 645; *Chloroscombrus orqueta*, n. s., Panama p. 646.

——— Description of a new eel (*Sidera castanea*) from Mazatlan.

(Proc. U. S. Nat. Mus., May 12, 1883, v, pp. 647, 648.)

Sidera castanea, n. s., Mazatlan, p. 647.

——— On the nomenclature of the genus *Ophichthys*.

(Proc. U. S. Nat. Mus., May 12, 1883, v, pp. 648–651.)

17 species are enumerated.

——— Notes on the nomenclature of certain North American fishes.

(Proc. U. S. Nat. Mus., vol. VI, pp. 110, 111, July 27, 1883.)

——— Description of two new species of fishes (*Aprion ariommus* and *Ophidium beani*) from Pensacola, Florida.

(Proc. U. S. Nat. Mus., Sept. 20, 1883, vol. VI, pp. 142–144.)

——— A review of the American *Caranginæ*.

(Proc. U. S. Nat. Mus., Oct. 5, 1883, vol. VI, pp. 188–207.)

——— Note on the genera of *Petromyzontidæ*.

(Proc. U. S. Nat. Mus., Oct. 5, 1883, vol. VI, p. 208.)

——— Description of a new *Murænoid* eel (*Sidera chlevastes*) from the Galapagos Islands.

(Proc. U. S. Nat. Mus., Oct. 5, 1883, vol. VI, pp. 208–210.)

JORDAN, DAVID S., and CHARLES H. GILBERT.—Description of a new species of *Rhinobatus* (*Rhinobatus glaucostigma*) from Mazatlan, Mexico.

(Proc. U. S. Nat. Mus., Oct. 5, 1883, vol. VI, pp. 210–211.)

JORDAN, DAVID S., and JOSEPH SWAIN.—List of fishes collected in the Clear Fork of the Cumberland, Whiteley County, Kentucky, with description of three new species.

(Proc. U. S. Nat. Mus., Nov. 27, 1883, vol. VI, pp. 248–251.)

JOUY, PIERRE LOUIS.—Ornithological notes on collections made in Japan from June to December, 1882.

(Proc. U. S. Nat. Mus., vol. VI, pp. 273–318.)

An important annotated list of 100 species, nearly all represented by numerous specimens now in the National Museum collection.

LUCE, THOMAS R.—Occurrence of *Balistes capriscus*, Gmelin (Leather-jacket or File-fish), at New Bedford, Mass.

(Bull. U. S. Fish. Com., vol. III, Dec. 7, 1883, p. 469.)

LAWRENCE, GEORGE N. (New York City.)—Characters of a new species of pigeon of the genus *Engyptila*, from the island of Grenada, West Indies. The Auk, vol. I. April, 1884, pp. 180, 181. (*E. wellsi*, Lawr., type in U. S. National Museum collection.)

LINDENKOHL, C.—Notes on the model of the Gulf of Maine, constructed for the United States Fish Commission.

(Bull. U. S. Fish Com., III, pp. 449–454.)

LOWELL, JAMES RUSSELL.—Success of the United States Exhibit at the London International Fisheries Exhibition. (Dispatch No. 55 to Hon. Frederick T. Frelinghuysen, Secretary of State.)

(Bull. U. S. Fish Com., III, pp. 447–8.)

NEWBERRY, JOHN S.—Brief descriptions of fossil plants, chiefly tertiary, from Western North America.

(Proc. U. S. Nat. Mus., Feb. 28, 1883, V, pp. 502–574.)

58 new species are described, chiefly from the collection of Dr. F. V. Hayden.

NUTTING, C. C.—On a collection of birds from the Hacienda "La Palma," Gulf of Nicoya, Costa Rica.

(Proc. U. S. Nat. Mus., 1883, V, pp. 382–395.)

Contains also a few notes on the mammals of that region.

NYE, WILLARD, jr.—Eels (*Anguilla rostrata*) in New Bedford water-pipes. Mackerel abundant in Amherst River.

(Bull. U. S. F. C., vol. II, 1882, Mar. 21, 1883, p. 272.)

RYDER, JOHN A.—On the thread-bearing eggs of the silversides (*Menidia*).

(Bull. U. S. Fish Com., III, pp. 193–196.)

——— Preliminary notice of the development and breeding habits of the Potomac Catfish, *Amiurus albidus* (Le Sueur) Gill.

(Bull. U. S. Fish Com., III, pp. 225–230.)

RYDER, JOHN A.—Rearing oysters from artificially-fertilized eggs, together with notes on pond culture, &c.

(Bull. U. S. Fish Com., III, pp. 281–294.)

——— Report on the abnormal appearance of some shad eggs from a fish kept in confinement at Havre de Grace, Md.

(Bull. U. S. Fish Com., III, p. 440.)

——— Rearing oysters from artificially impregnated eggs.

(Science, II, pp. 60–62.)

——— The law of nuclear displacement and its significance in embryology.

(Science, I, pp. 275–277, with cut.)

——— Development of the membrane bones of the skull of the pike.

(Science, I, p. 513.)

——— The protozoan parasites of the oyster.

(Science, I, p. 567.)

——— Oyster culture in Holland.

(Science, II, p. 79.)

——— Rearing oysters from artificially fertilized eggs at Stockton, Md.

Science, II, pp. 463–464.)

——— Primitive visual organs.

(Science, II, pp. 39–40.)

(See, also, under GILL and RYDER, in Part II.)

SAUNDERS, HOWARD.—On the birds exhibited in the International Fisheries Exhibition.

(The Ibis, fifth series, Oct., 1883, vol. IV, pp. 346–352.)

Contains a very favorable notice of the U. S. National Museum exhibit of North American aquatic and fish-eating birds, on pp. 350, 351.

SCLATER, P. L.—Review of the species of the family Icteridæ. Part i, Cassicinæ.

(The Ibis, fifth series, April, 1883, vol. IV, pp. 145–163, pls. vi, vii.)

Frequent reference to National Museum specimens.

——— A review of the species of the family Icteridæ. Part ii, Icterinæ.

(The Ibis, fifth series, July, 1883, vol. IV, pp. 352-374, pl. xi.)

Contains frequent mention of National Museum specimens, loaned for examination.

SMITH, ROSA.—On the life coloration of the young of *Pomacentrus rubicundus*.

(Proc. U. S. Nat. Mus., May 23, 1883, V, pp. 652–653.)

Specimen from La Jollas, near San Diego, Cal.

——— The life colors of *Cremnobates integripinnis*.

(Proc. U. S. Nat. Mus., Oct. 5, 1883, vol. VI, 1883, pp. 216-217.)

——— Note on the occurrence of *Gasterosteus williamsoni*, Grd., in an artesian well at San Bernardino, Cal.

(Proc. U. S. Nat. Mus., Oct. 5, 1883, vol. VI, 1883, p. 217.)

SMITH, ROSA.—Notes on the fishes of Todos Santos Bay, Lower California. (Proc. U. S. Nat. Mus., Oct. 25, 1883, vol. VI, 1883, pp. 232–236.)

SMITH, SIDNEY I.—Preliminary report on the Brachyura and Anomura dredged in deep water off the south coast of New England by the U. S. Fish Commission in 1880, 1881, and 1882.

(Proc. U. S. National Museum, vol. VI, 1883, pp. 1–57, pll. i–vi.)

This report includes "all the species of Brachyura and Anomura obtained off Martha's Vineyard, at depths greater than 50 fathoms. * * * The last season's dredging off Martha's Vineyard reveals the total, or almost total, disappearance of several of the larger species of crustacea, which were exceedingly abundant in the same region in 1880 and 1881." Thirty-one species are included in the report, and of these seven are new. Three new genera are also described. Very full notes, with complete lists of the localities, including depths, nature of the bottom, dates when collected, number of specimens obtained, &c., are given under each species. Tables of measurements of many species are also given. The new genera described are: *Sympagurus* (p. 37), *Eumunida* (p. 44), and *Anoplonotus* (p. 50). The new species described are as follows:

Brachyura.—Amathia Tanneri, p. 4; *Collodes robustus*, p. 5; *Cymopolia gracilis*, p. 20.

Anomoura.—Sympagurus pictus (pl. 5, figs. 2, 2*a*; pl. 6, Figs. 5–8), p. 37; *Munida valida* (pl. 1), p. 42; *Eumunida picta* (pl. 2, fig. 2; pl. 3, figs. 6–10; pl. 4, figs. 1–3*a*), p. 44; *Anoplonotus politus* (pl. 2, fig. 1; pl. 3, figs. 1–5*a*), p. 50.

——— List of the crustacea dredged on the coast of Labrador by the expedition under the direction of W. A. Stearns, in 1882.

(Proc. U. S. National Museum, 1883, vol. VI, pp. 218–222.)

Enumerates 36 species distributed among the following groups: Brachyura, 2 species; Anomura, 2 species; Macrura, 9 species; Schizopoda, 1 species; Cumacea, 1 species; Amphipoda, 16 species; Isopoda, 2 species; Copepoda, 1 species; Cirripedia, 1 species; Rhizocephala, 1 species. Full notes are given on the localities of occurrence, depth, character of bottom, character of specimens, &c., and also, in some cases, on the sizes of specimens. This collection was made by W. A. Stearns, of Amherst, Mass., and a party of students from Yale College. The specimens belonging to Mr. Stearns were turned over to the National Museum, and those belonging to the remainder of the party to the Museum of Yale College.

——— Review of the marine crustacea of Labrador

(Proc. U. S. National Museum, 1883, vol. VI, pp. 223–232.)

Enumerates 65 species of crustacea as follows: Brachyura, 4 species; Anomura, 2 species; Macrura, 13 species; Schizopoda, 1 species; Cumacea, 1 species; Phyllocarida, 1 species; Amphipoda, 29 species; Isopoda, 7 species; Ostracoda, 1 species; Copepoda, 1 species; Cirripedia, 4 species; Rhizocephala, 1 species. The localities in which each species was obtained are given, when known, and also occasional notes on abundance, &c. The material on which this review is based was principally obtained by Prof. A. S. Packard, jr., in 1860 and 1864, and by W. A. Stearns in 1882. Almost the only previous source of information in regard to the crustacea of Labrador had been Professor Packard's "A list of the animals dredged near Caribou Island, Southern Labrador, during July and August, 1860" (Canadian Naturalist and Geologist, December, 1863), VIII, pp. 401–429 (1–29), and his "View of the recent invertebrate fauna of Labrador" (Memoirs, Boston Soc. Nat. History, 1867, I, pp. 262–303, pll. 7, 8.) The collection of W. A. Stearns is now in the possession of the National Museum.

STEWART, T. E., M. D., Ph. G.—The Relation of pharmacy to Therapeutics. A lecture delivered before the Alumni Association of the Philadelphia College of Pharmacy.

(Druggists Journal, Dec., 1883; also separate, unpaged, 5 pages.)

Suggests the plan of founding at Washington, in connection with the Smithsonian Institution, a laboratory of experimental pharmacology, with new apparatus and means for doing scientific work on drugs. After discussing this paper it was voted by the meeting "that it is the sense of this meeting that this suggestion be adopted, and the founding of such a laboratory at Washington, in connection with the Smithsonian, be recommended."

SWAIN, JOSEPH.—Description of a new species of *Hadropterus* (*Hadropterus scierus*) from Southern Indiana.

(Proc. U. S. Nat. Mus., Nov. 27, 1883, vol. VI, p. 252.)

(See also under JORDAN & SWAIN.)

SWAIN, JOSEPH, and GEORGE B. KALB.—A review of the genus *Noturus*, with a description of one new species.

(Proc. U. S. Nat. Mus., V, May 23, 1883, pp. 638–644).

Seven species are mentioned, *Noturus elassochir*, n. s, Illinois R., 639.

SWAN, JAMES G.—Report of investigations at Neah Bay, Wash., respecting the habits of fur seals of that vicinity, and to arrange for procuring specimens of skeletons of cetacea.

(Bull. U. S. Fish Com., III, pp. 201–207.)

TARR, R. S.—Life at the bottom of the sea.

(Forest and Stream, New York, Nov. 29, 1883, vol. XXI, pp. 344, 345.)

A popular account of the deep-sea explorations of the U. S. Fish Commission.

THOMAS, CYRUS.—Note on certain Maya and Mexican manuscripts.

(Science, vol. I, No. 20, pp. 585, 586.)

VERRILL, A. E.—Reports on the results of dredging, under the supervision of Alexander Agassiz, on the east coast of the United States, during the summer of 1880, by the U. S. Coast Survey steamer "Blake," Commander J. R. Bartlett, U. S. N., commanding. (XXI.—) Report on the Anthozoa, and on some additional species dredged by the "Blake" in 1877–'79, and by the U. S. Fish Commission steamer "Fish Hawk," in 1880–'82. By A. E. Verrill.

(Bull. Mus. Comp. Zoology, at Harvard College, No. 1, July, 1883, XI, pp. 1–72, pl. i–viii.)

Enumerates 59 species, of which 23 are new. One new family and 5 new genera are also defined. A large number of the old species are also described and figured, and the remainder are accompanied by more or less full notes and tables of synonymy. The plates are well-executed photo-lithographs from drawings by J. H. Emerton.

The following are newly described:

Families.—*Ceratoisidæ* Gray (emended), p. 9; *Chrysogorgidæ*, nov., p. 21; *Primnoidæ* (emended), p. 28.

Genera.—*Acanella* Gray (emended), p. 13; *Lepidisis*, nov., p. 18; *Iridogorgia*, nov., p. 26; *Stenogorgia*, nov., p. 29; *Actinauge*, nov., p. 50; *Actinostola*, nov., p. 56.

New species.—*Kophobelemnon scabrum*, pl. 1, figs. 5–5c, p. 7; *Acanella spiculosa*, p. 17; *Acanella simplex*, p. 17; *Lepidisis caryophyllia*, pl. iv, figs. 1–1c, p. 18; *Lepidisis longiflora*, pl. iv, figs. 4, 4*a*, p. 19; *Lepidisis vitrea*, p. 20; *Dasygorgia Agassizii*, pl. ii, figs, 4–4*b*, p. 22; *Dasygorgia elegans*, p. 23; *Dasygorgia spiculosa*, pl. ii, fig. 5, p. 23; *Dasygorgia squamata*, p. 24; *Dasygorgia splendens*, p. 25; *Chrysogorgia Fewkesii*, p. 26; *Iridogorgia Pourtalesii*, pl. ii, figs. 7 7*a*, p. 27; *Primnoa Pourtalesii*, pl. ii, figs. 2–2*e*, p. 28; *Stenogorgia casta*, pl. ii, figs. 1–1*b*, p. 30; *Acanthogorgia muricata*, p. 34; *Paramuricea grandis*, pl. iii, figs. 3–3*b*, p. 37; *Paramuricea tenuis*, p. 38; *Eunicella modesta*, pl. ii, fig. 3, p. 39; *Gersemia longiflora*, pl. iii, figs, 6, 6*b*, p. 44; *Sagartia*, *Acanellæ*, pl. vi, figs. 2, 2*a*, p. 46; *Actinauge nodosa*, Verrill, var. *coronata*, nov., pl. vi, figs. 8, 8*a*, p. 53; var. *tuberculosa*, nov., pl. vi, fig. 7, p. 53; *Actinauge longicornis* Verrill, var. *Caribæa*, nov., p. 55; *Actinauge nexilis*, pl. vi, figs. 4, 5, p. 55.

VERRILL, A. E.—Reports on the results of dredging, under the supervision of Alexander Agassiz, in the Gulf of Mexico and in the Caribbean Sea (1878–79), by the U. S. Coast Survey steamer "Blake," Lieut.-Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., commanding. XXIV.—Supplementary report on the "Blake" Cephalopods, by A. E. Verrill.

(Bull. Mus. Comp. Zool., at Harvard College, No. 5, 1883, XI, pp. 105–115, pl. 1–3.)

Two new genera—*Nectoteuthis* (p. 108) and *Opisthoteuthis* (p. 113)—are defined, and four new species are described as follows:

Nectoteuthis Pourtalesii, pl. iii, figs. 1–1 b, p. 108; *Rossia brachyura*, pl. iii, fig. 2, p. 110; *Octopus pictus*, pl. iii, fig. 3, p. 112; *Opisthoteuthis Agassizii*, pl. 1, fig. 1, pl. ii, fig. 1, p. 113.

Four additional species are described, which have also been taken by the U. S. Fish Commission. They are *Abralia megalops* Verrill, *Sthenoteuthis Bartramii* (Les.) Verr.(?), *Cheiroteuthis lacertosa* Verr., and *Heteroteuthis tenera* Verr. The plates are photo-lithographs from drawings by J. H. Emerton.

——— Descriptions of two species of Octopus from California.

(Bull. Mus. Comp. Zoology at Harvard College, No. 6, 1883, XI, pp. 117–124, pl. iv–vi.)

The two species described are: *Octopus punctatus* Gabb, pl. iv, pl. v, fig. 2, p. 117; and *Octopus bimaculatus* Verrill, sp. nov., pl. v, figs. 1–1a, pl. vi, p. 121.

The descriptions were partly drawn up from specimens furnished by the National Museum. The plates are photo-lithographs, from drawings by J. H. Emerton.

——— Recent explorations in the region of the Gulf Stream off the eastern coast of the United States by the U. S. Fish Commission.

(Science, 1883, vol. I, pp. 443–447, 531–534; vol. II, pp. 153–155; eight woodcuts, charts and diagrams.)

Descriptive of the physical and other characteristics of the regions explored, and of the various appliances used, with a brief account of the animal life. The paper is divided into the following sections: 1. Introductory (historical); 2. Physical features of the region; 3. Influence of the Gulf Stream; 4. Nature and origin of the deposits; 5. Fossiliferous magnesian limestone nodules.

WALKER, S. T.—Fish mortality in the Gulf of Mexico.

(Proc. U. S. Nat. Mus., July 27, 1883, vol. VI, 1883, pp. 105–109.)

APPENDIX C.—LIST OF CONTRIBUTORS TO THE MUSEUM IN 1883.

Abbe, W. A. Specimens of menhaden scraps from Massachusetts. Accession 12552.

Abert, J. T., U. S. Engineers. Large collection of choice minerals collected by Col. I. I. Abert, contained in four double cabinets which have been stored for many years with the Smithsonian Institution. Accession 12689.

Adams Brothers. Slab of slate; from Adams Brothers' quarry, Lynchburg, Va. Accession 13385.

Adams, J. B. Box containing living toads, lizards, snakes, bird-skins, and insects; from New Mexico. Accessions 13431, 13662.

Adams, J. C. Modern Indian game (bone, wood, and strings); from Wisconsin. Accession 12672.

Adams, Mayhew. Specimen of harpoon with semi-revolving head; from Massachusetts. Accession 13174.

Adams, W. H. Three boxes, specimens of minerals and fossils; from Illinois. Accession 12537.

Adcox, J. E. Box of Indian relics; from Arkansas. (Purchased.) Accession 13541.

Agassiz, Prof. Alexander, Mus. Comp. Zool., Cambridge, Mass. Thirty-six species of echini (of the Blake collection). Accession 13738.

Alaska Commercial Company, San Francisco, Cal. One pair of walrus tusks (loaned); from Alaska. Accession 12703.

Albemarle Soapstone Company. Specimens of soapstone and talc; from Albemarle County, Virginia. Accession 13319.

Aldrich, J. B. Specimen of Indian implement; dug from mound in Southeastern Colorado. Accession 13287.

Alexander, Charles W. Specimens of bird-eggs; from Illinois. Accession 13714.

Allabach, P. H. Specimen of wood thrush; from District of Columbia. Accession 13093.

Allen, Frederick S. Model of life raft (presented); three swordfish irons (purchased). Accessions 12554, 12954.

Allison, Hon. W. B. Package of minerals; from Iowa. Accession 12851.

Auburndale Watch Company, Boston, Mass. Sample of metallic thermometer. Accession 13043.

American Ship Windlass Company, Providence, R. I. Model of steam windlass (loaned). Accession 12778.

Ames, F. P. Fragments of bones from old Indian camp in Ohio. Accession 13419.

Anderson, Rev. D. Stuffed specimen of duck (*Anas boschas*); from Canada. Accession 13167.

Anderson, Miss L. Z. Specimens of sulphide and carbonate of copper. Accession 13227.

Andrews, Byron. Bird's nest and skin of pocket gopher (*Geomys talpoides bulbivorus*); from Dakota. Accessions 13207, 13661.

Andrews, E. F. Life-size oil painting and frame of the late Charles Darwin. Accession 12563.

Apgar, Austin C. About one thousand specimens of mollusks, pisidium, and sphoerium; from New Jersey. Accession 13597.

Appleton, John W. M. Specimen of quartz, crystals, fossils, and lizard (*Plethodon glutinosus*); from West Virginia. Accessions 13272, 13699.

Appleton, Nathan. Two photographs showing the American ambulance at Paris during the siege 1870 and 1871. Accession 13103.

Arendell, Dr. M. F. (through S. G. Worth). Samples of Yopon tea. Accession 13015.

Arnheim, J. S. Specimens of silk-worms, insects, and snail shells; from California. Accession 13616.

Atchison, Topeka and Santa Fé Railroad (through John S. F. Batchen). Specimens of building stones; from Arizona, New Mexico, and Texas. Accession 13448.

Atkins, A. L. Specimen of ore; from Louisiana. Accession, 12902.

Atkins, Charles G. Alcoholic specimens of salmon eggs and embryos, and photo-negatives; from Maine. Accessions 12566, 12832, 12848.

Atkins, Dr. H. A. Specimen of Towhee Bunting (*Pipilo erythrophthalmus*), partial albino in flesh, and specimen of *Hylocichla aliciæ;* from Michigan. Accessions 12866, 13005.

Atwood Brothers. Model of center-board for small sail-boats and skiffs; from New York. Accession 12589.

Atwood, N. E. Oil-can taken from stomach of large cod near Race Point, Massachusetts. Accession 12808.

Babcock, O. E. Two living alligators, juv. Accession 13170.

Bailey, Arthur H., & Co. One can each mackerel roe, fresh mackerel, and Nantucket sturgeon; from Massachusetts. Accession 12844.

Bailey, H. L. Skin of duck; from Washington Territory. Accession 13348.

Baker, George O., & Co. Samples cotton seed and its products, including the refined oil. Accession 12766.

Baker, M. Specimens of minerals; from California. Accession, 12698.

Barber, Julia Langdon. Two living specimens of alligators, juv. Accession 13487.

Barbour, Hon. John S. Specimens of minerals and ores; from Virginia. Accessions 12837, 12901, 13056, 13589.

Barker, Henry L. Specimens of *Siren lacertina*, living water-snakes, and rattlesnake (*Caudisona miliaria*); from South Carolina. Accessions 12888, 13045, 13102.

Barker, S. C. Specimen of living siren; from Florida. Accession 12985.

Barnes, William M. Beak and fins of sail-fish; from Ocean Island, Pacific Ocean. Accession 12676.

Barnett, Edward (through Felix R. McManus). Pieces of the wood from spring-house which was used by General Washington as headquarters when he surveyed the Shenandoah Valley. Accession 13704.

Bartlett, I. H., & Son. One slab each of Arctic and humpback whale-bone. Accession 12822.

Barton & Logan. Specimen of monkey (*Chlorocebus sabæus*); from West Africa. Accession 13558.

Batchen, John S. F. Twenty-seven packages building stones, granite and marble, from various States and Territories, also five photographs of old engines; from the Chicago Exhibition of 1883. Accessions 12770, 12841, 12916, 12929, 12950, 12969, 12993, 13000, 13003, 13027, 13041, 13088, 13117, 13163, 13186, 13199, 13224, 13299, 13327, 13368, 13433, 13443, 13445, 13460, 13477, 13511, 13534, 13556, 13576, 13708.

Beall, L. A. Specimen of iron ore; from Maryland. Accession 13796.

Beall, O. R. Specimen of pig (*Sus scrofa*) with two perfectly formed mouths; from Maryland. Accession 12984.

Bean, Barton A. Tank of alcoholic fishes, reptiles, and invertebrates; from Susquehanna River, at Bainbridge, Pa. Accessions 12913, 13467.

Bean, Dr. T. H. Specimens of the shad, herrings, rock-fish, and pickerel; from Washington Market. (Purchased.) Accession 12935.

Beck, A. R. Carved stone pipe; from Pennsylvania. Accession 13548.

Beckwith, Miss Lizzie. Large leaf-shaped stone implement; from Alabama. Accession 13607.

Beetle, James. One model of whale-boat. (Purchased.) Accession 12909.

Belding, L. Collections of bird-skins, Indian relics, bones, reptiles, &c.; from Lower California. Accessions 12828, 12911, 13115.

Belfrage, G. W. (deceased). Specimens of natural history; from Texas. Accession 13253.

Bell, James. Large collection of living snakes, bird-skins, eggs, insects, &c.; from Florida. Accessions 12746, 12814, 13016, 13081, 13114, 13270, 13533, 13778.

Bell, Dr. Robert. Alcoholic specimens of lizard (*Amblystoma*), fishes (*Cliola storeriana=Rutilus storerianus*), and lamprey eel; from Canada. Accession 13038.

Bendire, Charles, U. S. A. Collection of 223 bird-skins and 18 nests; from Oregon. Accession 12650.

Benedict, J. E. Collection of worms, also bird-skins (*Cymochorea leucorrhoa*, and *Oceanites oceanicus*); from Atlantic Ocean. Accessions 12856, 13753.

Bereman, T. A. One box of geodes, 43 specimens, also 33 specimens (*Lithostrotion canadense*); from Iowa. Accession 13438.

Bertha Zinc Company. Specimens of pure spelter and zinc ore (silico-carbonate of zinc); from Virginia. Accession 13266.

Bessels, Dr. E. Specimen of bird-skin (*Coccyzus americanus*). Accession 13166.

Bhanmaugre, Somdet Chowfa (*director-general of posts and telegraphs*), *Bangkok, Siam.* Collection of postage-stamps; from Siam, Hong-Kong, and Singapore. Accession 13706.

Bickford, Rev. W. F. Specimens of orthoclase crystals; from Colorado. Accession 13751.

Biddle, Miss Lydia S. Specimen of an embroidered quilt over one hundred years old; from Carlisle, Pa. Accession 13288.

Bille, Carl Steen Andersen de (*minister resident and consul-general of Denmark*). Specimen of sonorous or singing sand; from Bornholm, Denmark. Accession 13770.

Binney, W. G. Twelve species of land shells; from New Jersey. Accession 13639.

Bishop, J. Specimen of insect (*Phobetron pithecians*); from Ohio. Accession 13470.

Bishop, John. Model of "Grand Banker," full rigged, complete. Scale, ½ inch. (Purchased.) Accessions 12644, 12800.

Black, Alexander C. One box of Indian implements and fossils; from Indiana. Accession 12897.

Blackford, Eugene G. Living and fresh specimens of fishes, among which were *Salmo gairdneri*, *Salvelinus malma*, *Salvelinus fontinalis*, *Salmo salar*, *Brevoortia tyrannus*, *Salmo pleuriticus*, *Seriola lalandii*, *Scomber scombrus*; also large collection of alcoholic specimens of West Indian and South American fishes, collected by J. C. Brevoort; large collection of oyster and clam shells, fresh specimen of lobster weighing 18 pounds, one box of corals, one large tortoise, and fresh specimen of manatee (*Trichechus manatus*), from Brazil, and box of salamander eggs (*Siredon pisciformis*). Accessions 12505, 12515, 12521, 12557, 12585, 12639, 12659, 12684, 12687, 12747, 12759, 12826, 12978, 13065, 13138, 13146, 13157, 13178, 13196, 13539, 13620, 13626, 13737, 13759, 13808.

Bland, Thomas. Water-color drawing of hunting monkeys with blow-gun, made by native Indian artist at the gold mines of Marmato in Antioquia, New Granada. Accession 13040

Blinn, A. S. Specimens of minerals; from Oregon. Accession 13785.

Blochman, L. A. Small box of shells; from California. Accession 13031.

Bloomer, William. Bones of whale (*Balænoptera rostrata*) 16 feet long, taken off Monomoy Point light-house, Harwick Port, Mass. Accession 13344.

Blozier, H. Specimen of fish (*Dorosoma heterurum*); from Ohio. Accession 13784.

Boardman, G. A. Specimen of fish (*Coregonus nigripinnis*); from Minnesota; also stone relic; from Maine. Accessions 12906, 13702.

Bogart, George A. Twenty specimens of Niagara fossils; from Indiana. Accession 13225.

Bonnell, George W. Specimen of stone ax; from District of Columbia. Accession 12920.

Booth, A., & Co. One barrel, 2 boxes, 2 bales of canned fish and oysters; also, specimen of (steel-headed salmon) *Salmo gairdneri;* from Puget Sound. Accessions 12941, 13746.

Bostick & Anderson. Box Indian relics supposed to have been dug from Indian battle grounds in Sumter County, Florida. Accession, 13164.

Bostwick, H. R. Specimen of insect (*Papilio asterias*); from Kansas. Accession 13251.

Bowles, William B. Flag of the "Geneva Cross" carried by the American ambulance during the siege of Paris, 1870 and 1871. Accession 13104.

Bowron, William M. Specimens of shells; from Tennessee. Accession 13198.

Brackin, A. H. Specimen of pyrite in hornblende rock; from North Carolina. Accession 13647.

Bradstreet, E. C. Specimens of minerals; from Colorado. Accessions 13069, 13605.

Brand, James H. Specimen of No. 2 Brand whaling-gun, with Brand's darting-bomb and eight bomb-lances. Accessions 12531, 12548.

Bransford, Dr. J. F. Two stone images; from "Pacuare Cut," Limon Railroad, Costa Rica. Accession 13513.

Brazilian National Museum. Four boxes, 129 specimens of fossils and 64 species fossil shells (cretaceous); from Brazil. Accessions 12699, 12885.

Brightwell, Dr. O. H. Two specimens of percoid fishes; from District of Columbia. Accession 13313.

British Museum, London. Stuffed specimen and skeleton manatee, (*Manatus senegalensis*). Accessions 13030, 13091.

Bromley, John, & Sons. One box containing an assorted lot of floor rugs. Accession 12816.

Bronaugh, J. W. Specimen of fish (*Ambloplites rupestris*) 14 inches in length; from Manchester, Va. Accession 13010.

Brown, A. G. Specimen of elephant seal (*Macrorhinus angustirostris*); from California. Accession 13245.

Brown, Ernest C. One box Indian relics and fragments of pottery; from Illinois. Accession 13667.

Brown, E. L. Specimens of diatoms found in peat bogs in Wisconsin. Accession 12854.

Brown, J. Hare. Specimens of pyrites in quartz; from New Mexico. Accession 12567.

Brown, James Temple. Seal-skin suit made from skins of the hooded seal (*Cystophora cristata*) and harbor seal (*Phoca vitulina*) worn by whalers during the winter season. Accession 13286.

Brown, P. Stanley. Three specimens birds in flesh (*Cupidonia cupido*); from Kansas. Accessions 12536, 12636.

Brown, W. C. Box, 117 specimens, of rude Indian implements and fossils; from Pennsylvania. Accession 13698.

Brush Electric Company. One light machine No. 4 and one lamp No. 7. Accession 13071.

Bryan, E. C. Skeleton of bat (*Vesperugo serotinus*). Accession 13250.

Burgoyne, Burbiges & Co., (*London, England*). Six jars of colors used in confectionery, viz, super lemon-yellow, jetoline black, apricot-yellow, cherry-red, damson-blue, and apple-green. Accession 13829.

Bureau of Arts (*Paris, France*), *through John Durand.* Two boxes of porcelain and Sevres wares. Also, card of yarns used in the manufacture of tapestry. Accessions 13132, 13749.

Burks, James L. Specimens of limonite iron ore; from Eagle Rock Mine, Virginia. Accession 13280.

Burns, Frank. Eight boxes of Indian and mound relics, pottery, fossils, shells, stone mortars, and trough supposed to be used for burying the dead by the Mound Builders; from Alabama. Accessions 12840, 13047, 13237, 13292, 13545, 13574, 13688.

Burnham, O. Nine hogsheads, 1 box whalebones; from the coast of Florida, near Cape Canaveral; also two specimens of whale's teeth (*Catodon macrocephalus*). Accessions 12869, 13375.

Burr, George. Specimen of clay shale; from New York. Accession 13037.

Butler, A. W. Eleven specimens of bird-skins; from Indiana. Accession 12761.

Cadbury Brothers. Eighteen specimens illustrating the processes of manufacturing cocoa and chocolate; from Birmingham, England. Accession 13833.

Caldwell, J. P. Specimen of fossil tooth (*Equus caballus*); from South Carolina. Accession 13233.

Caldwell, John W. Specimens of multiple mortar and soft stone ax; from Tennessee. (Loan.) Accession 13822.

Calhoun, W. H. Specimen of compressed asphalt. Accession 12922.

Calverley, William. Three specimens of mice (*Mus musculus*) caught in Brooklyn, N. Y., in 1851; specimen of crab (*Libinia dubia*), with oyster attached; specimen of crab (*Libinia emarginata*), with worm tubes; from New Jersey. Accessions 13570, 13666.

Cameron, J. P. Specimens of minerals; from Texas. Accessions 12568, 13617, 13663.

Campbell, C. D. Specimen of fossil; from Texas. Accession 12966.

Carlock, Mrs. R. D. Wedgewood ware box, said to be over 100 years old. (Deposited.) Accession 13440.

Caro, Lewis. Specimen of clay; from California. Accession 13665.

Carpenter, Charles. Specimen "camel-back buoy" tin; from Ohio. Accession 12754.

Carpenter, Lieut. W. L. Two skins of snow bunting (*Plectrophanes nivalis*); from Nebraska. Accession 12774.

Carruthers, Thomas N. Small quartz arrow-head; from Virginia. Accession 13442.

Carson, N. R. Specimens of minerals; from California. Accession 13781.

Castleman, T. W. Arrow-head; from Indian mound near Saint Joseph, La. Accession 13410.

Centennial Committee. One block of black marble, 18 by 20 inches; from the quarry of Finch, Fruyn & Co., Glens Falls, N. Y. Accession 13001.

Central Museum, Madras, India. Cinchona bark, with illustrative botanical specimens. Accession 13057.

Century Company, New York. Package of sketches and proofs. Accession 12868.

Chapin, Alvin. Specimen of Virginia fox squirrel (*Sciurus niger*, var. *ludovicianus*); from Virginia. Accession 13621.

Chapman, W. A. Specimens of fossils; from Arkansas. Accessions 13447, 13483, 13596.

Charlie (son of Duke of York), chief of Chalam Indians (through James G. Swan). Specimen of club made by "Charlie" by tying a knot in a small fir sapling about three years ago; from Washington Territory. Accession 13244.

Chase, O. M. Specimen of whitefish (*Coregonus clupeiformis*); from Lake Erie. Accession 12829.

Chenworth, J. S. Specimen of mineral; from Ohio. Accession, 13456.

Cherry, Dr. E. D. Specimens of fossil shells; from Virginia. Accession 13446.

Cherry Valley Iron Works. Specimen of coke; from Ohio. Accession 13241.

Clark, Edward (Architect of United States Capitol). Specimen of breccia marble, 2 by 3 by 1½ inches; from near Point of Rocks, Md. Accession 13642.

Clark, Frank N. Two boxes alcoholic fishes and embryos; from Lake Michigan; also model of the hatching station at Northville, Mich. Accessions 12556, 12587, 12712, 12737, 12838.

Clarke, Prof. F. W. Collective exhibit of minerals; from various localities. Accessions 13355, 13388, 13523, 13567, 13568, 13719, 13818.

Clark's (Thomas E.) Sons. Specimen of fish (*Selene setipinnis*); from New Bedford, Mass. Accession 13497.

Clark, T. W. B. Collection of fresh and alcoholic oysters; from Massachusetts and Chesapeake Bays. Accessions 12542, 12683, 12895.

Clements, Hon. J. C. Specimen of mica schist; from Georgia. Accession 12616.

Coale, H. K. Specimen of bird-skin (*Pipilo arcticus*); from Kansas. Accession 12736.

Coffin, C. E. Specimens of iron ore, gypsum, clay, charcoal, iron slag, and pig-iron; from Maryland. Accession 13812.

Coldenstroth, George W. Alcoholic specimen of chicken with one head and neck, four legs and wings; from Maryland. Accession 13095.

Cole, Daniel. Specimen of porpoise in flesh (*Phocæna lineata*); from Wellfleet, Mass. Accession 12972.

Cole, Luther. Specimen of whale harpoon. Accession 12513.

Cole, Norman. Two specimens of stone relics. (Loaned.) Accession 13788.

Cole, O. O. Specimens of siliceous pebbles coated with iron; from New York. Accession 13475.

Coleman, David J. Specimen limestone concretion; from Wyoming. Accession 13017.

Coleman, James E. Specimen of finback calf 30 inches long; from Massachusetts. Accession 13160.

Collins, Joseph W. Specimen fished up with cod-net; from George's Bank. One box fishing apparatus; from Gloucester, Mass. Specimen of Collins's patent fog alarm, with extra horns and reeds. Model of ideal schooner; from Massachusetts. Accessions 12596, 12640, 12705, 12785.

Collins, P. E. Two oil paintings of fishing scenes. Accession, 12595.

Collins, T. H. Alcoholic specimen of cat (*Felis domesticus*), with two bodies and one head. Specimen of dog (*Canis familiaris*), with seven legs; from Washington, D. C. Accessions 13498, 13517.

Colorado Coal and Iron Company. Specimen of coke; from Crested Butte and El Moro, Colo. Accession 13142.

Colvard, J. B. Two specimens soapstone; from Jefferson, Ashe County, North Carolina. Accession 13474.

Conrad, Leonard. Specimens of hematite; from Ohio. Accession 12762.

Conroy & Bissett. Collection of fishing tackle, camp equipments, &c. Accession 12525.

Cook, H. and S., & Co. Builder's model of schooner "Lizzie Mathews." (Loaned.) Accession 12818.

Corbel, Malachi. Specimen of fish (*Astroscopus anoplus*); from North Carolina. Accession 13073.

Cordery, Daniel C. Specimen of lumpfish (*Cyclopterus lumpus*); from New Jersey. Accession 12949.

Cornell University (through Burt G. Wilder). Specimen of baby orang (*Simia satyrus*). Accession 13332.

Cory, Charles B. Eight specimens of bird-skins; from Hayti; also 6 specimens from the United States. Accessions 13660, 13841.

Coues, Dr. Elliott, U. S. A. Specimens of bird-skins, nests, and eggs; from Colorado; also skin of Southern fox-squirrel; from Virginia. Accessions 13023, 13400, 13401.

Cox, L. A. Plaster cast of crinoid (*Poteriocrinus coxanus*); from Iowa. Accession 13815.

Craig, Dr. Thomas C. Specimen of bird-skin (*Daption capensis*). Accession 12502.

Crandonis, M. A., & Bro. Nine specimens of ancient lamps; from Greece (Purchased.) Accession 13668.

Crane & Porter. Specimen of Indian flute, captured by General Porter, commanding the constitutional forces of the Muskokee or Creek Indians during a recent march in pursuit of Ispar, chief of the rebel faction; Indian Territory. Accession 12989.

Cranford, H. L. Specimen of granolithic pavement (Stuart's patent); from Princes street, Edinburgh, Scotland, showing four years' wear. Accession 13145.

Crary, John S. Human skull (*Homo sapiens*); from 12 miles above Knoxville, Tenn. Accession 12805.

Crawford, Capt. E., U. S. A. Package of wild potatoes; from New Mexico; also specimen of insect (*Strategus julianus*); from Arizona. Accessions 13029, 13377.

Crooks, William. Two boxes of fossils, bones of mastodon, fragments of pottery, &c.; from salt mines near New Iberia, La. Accessions 13140, 13205, 13346.

Crosbie, John G. Specimen of plant and fiber (*Yucca filamentosa*); from Tennessee. Accession 13347.

Cunningham, A. G. Specimen of schist with graphite; from Arkansas. Accession 13425.

Curtis, J. E. Two alcoholic fishes (*Coregonus williamsonii* and *Salmo virginalis*); from Montana. Accession 13122.

Cutting Packing Company, San Francisco, Cal. Five boxes of canned goods (fishes, &c.); from California and Oregon. Accession 13011.

Government of Ceylon. Eleven specimens of cultivated cinchona barks; from India. Accession 13203.

Dale, Dr. F. C. Specimens of Japanese cabbage seed. Accession 13315.

Dall, Rev. C. H. A. Specimens of the common food grains of India, also shells, one Hookah, with three bowls, paste, charcoal, balls, shoes, sandals, water brushes (*khus khus*), Ceylon grass mat, glass bangles, and lotah for water, &c.; from India. Accession 13837.

Day, Dr. Francis (through R. Hitchcock). Specimens of *Amphioxus*; from Ceylon. Accession 13830.

Dayton, F. C. One box of oysters; from Long Island. Accession 12651.

Delawder, G. W. Model of trout spawning box; from Maryland. Accession 12833.

Deming, M. One box of oysters; from Rhode Island. Accession 12798.

De Motte, William. Specimen of mineral. Accession 13681.

Dewey, F. P. Specimens of minerals, iron, gold, copper, lead, tin ores, and rocks; from Maryland, Virginia, Ontario, and New York. Accessions 12971, 13246, 13490, 13520, 13546, 13586, 13799.

Deweese, H. G. Specimens of limestone; from Ohio. Accession 12921.

Dewhurst, W. W. Three specimens of coquina; from Saint Augustine, Fla. Accession 13594.

Dexter, Newton. Scales of horse-mackerel; from Maine. Accession 12727.

Diemar, Miss Maude. Specimen of Angora cat (*Felis domestica angoriensis*). Accession 12987.

Doron, T. S. Specimen of fresh rockfish (*Roccus saxatilis*); from Alabama River. Accession 12988.

Dorsey, Miss (through Rev. William Brayshaw). Skeletons of birds and specimens of stone relics; from Maryland. Accession 13454.

Dowell, John. Specimens of herring (*Clupea vernalis*); from Potomac River. Accession 12914.

Dresel, H. G., Ensign, U. S. N. Specimen of bird-skin (*Larus glaucus*); from Northumberland Island. Accession 13752.

Dudley, Dr. C. B. Specimens of anthracite and bituminous coal and samples of coke; from Crested Butte, Colo. Accession 13144.

Dunan, Winfield S. Samples of dry fish scraps and fish oils. Accession 12541.

Duncan, G. A., & Co. Specimen of fire clay; from Colorado. Accession 12671.

Dungan, R. M. Specimens of ores; from California. Accession 13302.

Dunn, Horace D. Specimen of oyster shell (*Ostrea virginica*). Accession 13645.

Dutcher, William. Specimen of bird-skin (*Passerculus princeps*); from Oyster Bay, Long Island. Accession 12605.

Dwight, William B. Three hundred specimens of larvæ of king-crab, horseshoe-crab (*Limulus polyphemus*); from Martha's Vineyard, Mass. Accession 12725.

Dyer, E. R. Package of sand; from West Virginia. Accession 13018.

Eckel, John C. Specimen of kerosene shale; from Australia. Accession 13371.

Edwards, J. B., Superintendent Life-Saving Station (through E. G. Blackford). Specimen of shark 9 feet 3 inches long (*Pseudotriakis microdon*); from near East Hampton, Long Island. Accession 12701.

Edwards, Vinal N. Alcoholic specimens of Chætoplerus, scaly worm, phosphates, fish scraps, samples of old rope, alcoholic invertebrates, specimens of stone relics, fresh fish (*Ctenolabrus adspersus*), alcoholic fishes (*Boleosoma olmstedi*), copepod and leech parasites of fishes, fresh fishes (*Stenotomus chrysops, Osmerus mordax, Stomateus triacanthus, Centropristes nigricans*, &c.), bones of *Phoca vitulina;* from Wood's Holl, Mass. Accessions 12512, 12536, 12586, 12786, 12835, 13177, 13389, 13648, 13659, 13745, 13850.

Eller, Charles. Specimen of crab (*Callinectes hastatus*); from Potomac River. Accession 13480.

Ellis & Co. Specimens of mineral; from Lauderdale County, Alabama. Accession 13510.

Ellis, A. L., & Co. Specimens of horseshoe-crabs, glass icicles, and glass fish-eyes; from Rhode Island. Accessions 12924, 12925.

Eltonhead, Mrs. William B. Sample of raw silk raised in the United States and reeled in the rooms of the "Womans' Silk Culture Association of the United States," at Philadelphia, Pa. Accession 12887.

Emeric, H. F. Specimen of gum (*Larrea mexicana*), alcoholic specimens of lizards and Indian relics; from Guaymas, Mexico. Accessions 13035, 13165.

Emmert, John W. Three specimens of bones; from mound in North Carolina. Accession 13191.

Emrick, G. W. Specimens of stone relics; from Pennsylvania. (Purchased.) Accession 13758.

Endlich, Dr. F. M. Specimen of turquois (ornament); from the Pueblo Indians in New Mexico. Accession 12539.

Engelmann, Dr. George J. One box, collection of musical instruments; from the Kankasas Mountains. Accession 13300.

English, Earl, U. S. N. Two specimens of gophers (*Testudo polyphemus*). Accession 13019.

Engle, J. E. Specimen of deformed fruit; from Falls Church, Va. Accession 13543.

Evans, G. L. Specimens of mound relics; from Iowa. Accession 13417.

Evans, R. D., U. S. N. Alcoholic specimens of snakes, invertebrates, coral, and fishes (*Hypleurochilus germinatus*, *Gobiesox*, *Gobiosoma boscii*); from Maryland, Virginia, and the James, York, and Potomac Rivers. Accessions 13151, 13265, 13455.

Evans, S. B. (*through G. Mendoza*). Cast of the Tesceoco calendar stone of Mexico. Accession 12865.

Evans, W. W. Specimens of some of the bronze castings of the ancient Peruvians, small head of burnt clay, piece of woven paper, seven boxes of Peruvian pottery, and specimens of arrow-points, &c.; from China, Peru, and Chili. Accessions 13028, 13687, 13838.

Fairhurst, A. Specimens of stone implements; from Kentucky. Accession 13248.

Fair, H. D. M. Specimen of mineral; from New York. Accession 13264.

Fairup & Gorsird (*through Almont Barnes*). Specimens of mammal bones; from Aves Islands, about 70 miles off the coast of Venezuela. Accession 13297.

Farlow, W. G. Specimens of algæ. Accession 12983.

Faucher, G. L. Specimens of Indian relics. Accession 13162.

Fayette Coal and Coke Company. Samples of coke; from West Virginia. Accessions 13053, 13127, and 13129.

Fearon, R. N. Specimens of fossil fishes; from Ohio. Accessions 12637, 12771.

Ferguson, T. B. Specimens of bird-skins; from Florida. Accession 12956.

Ferry, C. M. Specimens of ores, shells, moths, cocoons of apple-tree worms, fossil shells, and one specimen of Indian relic (loaned); from New York. Accession 13492.

Fillette, St. Julian. Skull (*Homo sapiens*) of chief of Marquesas Islands; taken from native tomb (deposited), and specimens of minerals (*Pseudomalachite*); from Napa Valley, California. Accessions 12878, 12928, 13012.

Fish, Alexander. Specimens of oysters; from New Jersey. Accession 12520.

Fish, E. J. Specimens of minerals; from near Chattanooga, Tenn. Accession 13756.

Fitzhugh, D. H. Specimens of fishes (*Percopsis guttatus*); from Michigan. Accession 12827.

Fitzhugh, R. K. Specimens of copper and lead ores, and specimen of graphite; from Virginia. Accession 13797.

Fitzgerald, L. Specimens of minerals. (Purchased.) Accession 12806.

Fletcher, James. Alcoholic specimen of mouse-fish (*Rhamphocottus richardsonii*). Accession 13039.

Flournoy, Jacob A. Specimen of ore; from Alabama. Accession 13197.

Flynn, R. O. Basket containing thirty-six Peruvian weaving spindles, with samples of cloth and yarn; from Peru. Accession 13435.

Foote, A. E., & Co. Specimens fresh clams, and clam shells; from Connecticut. Accessions 12516, 12626, 12692, 12704.

Foote, J. Howard. Collection of musical instruments. Accession 12809.

Ford, Frank. Specimen of red-head duck in flesh (*Athyia americana*). Accession 12996.

Fortune, W. H. Specimens of nuts; from Gallatin County, Illinois. Accession 13593.

Foster, Al. Photograph of steamboat, with passengers fishing, off the Jersey coast. Accession 12940.

Fox, W. H. Specimen of *Dendrœca blackburniæ*; from New Hampshire. Accession 13550.

Francis, George D. Three varieties of fishing tackle; from Massachusetts. Accession 12859.

Frazar, G. B. Specimens of pottery, shell implements, bears' teeth, prongs of deer antlers, shell-rock, and alligators' eggs. Accession 13614.

Frazee, John H. Specimens of stone relics. (Loaned.) Accession 12825.

Frazier, Mrs. George W. Frame containing wreath of fish-sclae ornaments, &c.; from Florida. Accession 12767.

Freeman, Gideon H. Specimens of Indian arrow-heads, &c. (Loaned.) Accession 12581.

Freere, Mrs. Elizabeth. Alcoholic specimens of insects (*Passalus cornutus, Buprestis rufipes, Epeira insularis*); from Virginia. Accession 13343.

Fuller, A. N. Specimens of birds' eggs; from Kansas. Accessions 12543, 12602.

Ferguson, Mr. Specimen of coke; from Freeport, Pa. Accession 13795.

Galbraith, Frank G. Specimens of stone relics; from Pennsylvania. Accessions 13033, 13290, 13504.

Galvin, C. D. Specimen of clay; from New York. Accession, 13106.

Gamner, George F. Specimens of bird-skins (Flamingo), skin of a turkey (*Meleagris ocellata*); from Yucatan (purchased); and bats; from New Mexico. Accessions 12823, 13716, 13721.

Gant, James. Specimen of nest and eggs of the song sparrow; from the grounds of the Smithsonian Institution. Accession, 13404.

Gardner, Prof. James T. Specimens of Laramie fossils; from Mexico. Accession 12615.

Garnier, Dr. J. H. Alcoholic specimens of reptiles (*Ophthalmidion longissimum, Rana circulosa, Rana nigricans*), and specimens of frogs (*Rana septentrionalis, Eutænia dorsalis, Rana catesbiana, Rana halecina, Rana clamitans*), and tadpoles; from Canada. Accessions 13372, 13636.

Garrison, George T. Specimen of borer, and shells of oysters destroyed by the borer, &c.; from Matompkin Bay, Virginia. Accession 13119.

Gary, E. Stanley. Specimen of stone relic; from Howard County, Maryland. Accession 13643.

Gatewood, Dr. W. Emmet. Specimen of stone relic; from site of an old Indian camp. (Purchased.) Accession 12858.

Geofroy, Antonie and George de. Specimen of live alligator. Accession 13193.

Gere, J. E. Specimens of fossils and Indian relics; from Wisconsin. Accession 13806.

Gerking, George N. Specimen of iron pyrites; from Illinois. Accession 13223.

Gernerd, J. M. M. Specimen of paint stones used by aborigines; found on bank of Susquehanna River, on site of old Indian encampment. Accession 12603.

Gesner, William. Specimen of iron ore; from Alabama. Accession 12549.

Gibbons, Isaac W. Specimen of mineral (*Cassiterite*); from Virginia. Accession 13542.

Gibson, A. M. (*through Frank Burns*). Specimens of Indian relics; from Alabama. Accession 13296.

Gilbert, Charles H. Six boxes and one tank alcoholic specimens of fishes; from Panama. Accessions 12694, 12957, 12999.

Giles & Pearce. Specimens of chloride of silver and silver assay button; from Grant County, New Mexico. Accession 13585.

Gilham, F. M. One hundred and twelve specimens of arrow-points; from California. Accession 13262.

Gilmore, C. D. Samples of muscovite with inclosed magnetite; from Montgomery County, Maryland. Accession 13744.

Glascock, Alfred E. Specimen of live snake; from Washington, D. C. Accession 13303.

Gloucester Isinglass Company. Five boxes of exhibits of isinglass, glues, &c.; from Massachusetts. Accession 12758.

Godman, F. D. (*through William Wesley*). Specimens of bird-skins; from England. Accession 13509.

Godwin, Dr. J. R. Specimen of beetle (*Dynastes tityus* Linn.); from Virginia. Accession 13428.

Goss, N. S. Specimens of bird-skins (*Dendrœca æstiva*); from Kansas and Western Guatemala. Accessions 12904, 13021, 13235.

Gray, Prof. Asa. Specimens of Indian materia medica, dye-stuffs, and tanning materials. Accession 13813.

Green, Monroe A. Three dozen barbless fish-hooks. Accession 12681.

Greenfield, James M. Specimen of quartz; from Michigan. Accession 12873.

Grey, J. W. (*through Barnett Phillips*). Two specimens of shells; from Hartford, Conn. Accession 13711.

Gridley, N., & Son. Specimens of pig-iron and iron ores; from Dutchess County, New York. Accessions 13311, 13761.

Grigsby, C. S. Specimens of stone relics; from Tennessee. (Purchased.) Accessions 12653, 12740, 13222, 13293, 13336, 13353, 13373, 13399.

Guesde, L. Specimen of cactus plant (*Melocactus*). Accession 13415.

Gurney, J. H. Specimens of bird-skins; from Norwich, England. Accession 12917.

Haag, Mrs. Specimen of Mexican hairless dog (*Canis familiaris*). Accession 12634.

Hachenberg, Dr. G. P. Specimen of air plant (*Tillandsia recurvata*); from Texas. Accession 13747.

Hague, Arnold. Package of chips for microscopic slides. Accession 12726.

Hague, T. O. Two samples of cotton (ginned and unginned); from Persia. Accession 12720.

Halderman, John A. Autograph letter in Siamese; from the King of Siam. Accession 12599.

Hall, C. D. Oyster dredge; from Connecticut. (Purchased.) Accession 12529.

Hall & Pearsall. Three kits of assorted mullets (large, small, and medium); from North Carolina. (Purchased.) Accession 12955.

Hammersley, W. H. Specimen of fresh sea catfish (*Ælurichthys marinus*); from Quantico, Va. Accession 13472.

Hampton, Hon. Wade. Part of skull and lower jaw of alligator gar (*Litholepis spatula*); from Mississippi River; and three live specimens of soft-shell turtles; from South Carolina. Accessions 12584, 13226.

Harrington, James (*through F. Stussy*). Two stone images; from Tampico, Mexico. Accession 13515.

Harris, N. H. Specimen of clay; from Hinds County, Mississippi. Accession 13124.

Harvey, F. L. Specimens of Indian relics. (Loaned.) Accession 12611.

Hassett, Burdett. Specimen of owl, in flesh (*Asio wilsonianus*); from Iowa. Accession 13622.

Hawes, Dr. George W. (*deceased*), (*through Mrs. Daniel Tainter*). Collection of minerals, rocks, and ores; from various localities. Accession 13843.

Hawley, E. H. Specimens of shells, snails, newt (*Diemyctylus miniatus miniatus*), and Albino rat; from Niagara River, Chautauqua County, New York, and Washington, D. C. Accessions 13486, 13608.

Hayden, C. S. Specimens of minerals and rocks; from Maine. Accessions 12559, 12961.

Hayden, William P. Specimens of minerals; from Maine. Accession 12775.

Haydon, Walton. Eleven photographs of Indians; from H. B. T. Accession 13686.

Hays, jr., John W. Alcoholic specimens of snake, insects, crustaceans; from North Carolina. Accession 13316.

Hayward, F. W. Specimen of mud eel (*Siren lacertina*); and specimen of decomposed shell limestone, mainly carbonite of lime; from South Carolina. Accessions 13183, 13773.

Hazen, W. B., U. S. A. Specimen of Kyak (skin-covered) and ivory mounted with paddles; from Greenland. (Deposited.) Accession 12561.

Haines, Peter C., U. S. Engineers. Samples of dredgings and specimen of rock; from the Potomac River. Accession 13731.

Hemphill, Henry. Specimens of shells; from Florida, Texas, Mississippi, and Louisiana. Accessions 13044, 13268, 13733.

Hempstead, Elias (*through C. W. Smiley*). Specimen of fossil bone and portion of tooth and rib; from Tampa Bay, Florida. Accession 13514.

Hereford, Frank. Specimen of chlorite schist; from West Virginia. Accession 13768.

Herrick, C. L. Specimens of Indian relics and alcoholic specimens of crabs, shrimps, and cray-fish; from Alabama. Accession 12509.

Hetton, B. A. Specimen of specular hematite; from Hazel Spring, Va. Accession 13494.

Higgins & Gifford. Three boat models and one seine-boat pump; from Gloucester, Mass. (Purchased.) Accessions 12526, 12590.

Hilgard, J. E. Chart representing the model of Atlantic coast, together with fifty copies of a reduced chart of depths and temperatures, also chart relating to the Long Island Sound shell fisheries. Accession 13110.

Hillon, B. A. Specimen of pyrite and graphite in schist. Accession 13020.

Hill, L. S., & Co. Two frames spoon baits and two automatic baits. (Loaned.) Accession 12891.

Hillman, Prof. Uno H. Fish albumen and two specimens haddock (*Melanogrammus æglefinus*), preserved by new solution; from Massachusetts. Accessions 12576, 12963.

Hillyen, W. P. Specimen of fish (*Fistularia tabaccaria*); from Chesapeake Bay. Accession 13599.

Hinde, Alfred W. Specimens of shells; from California. Accession 13429.

Hirschfelder, C. A. Photograph of Huron Indian skull, said to be over two hundred and thirty years old. Accession 12688.

Hiscox, W. H. Specimens of fossils. Accession 13628.

Hitchcock, George N. Specimen of sponge; from San Diego, Cal. Accession 13509.

Hitchcock, Romyn. Collection of foods (purchased) and two bottles alcoholic specimens of eels. Accessions 13827, 13828, 13836.

Hobbs, George S. Specimens of oysters; from Georgia and Florida; also fresh specimen of the embryo of cat (*Felis domestica*). Accessions 12765, 12768, 13569.

Hoffman, J. Specimen of porpoise (*Tursiops subridens*); from "Turkey Gut," near Cape May, N. J. Accession 13554.

Hoffman, Dr. W. J. Specimen of mammal skin (*Arctomys monax*); from Michigan. Accession 13655.

Hofman, Michael. Specimen of ore; from Missouri. Accession 12899.

Hogg, George. Specimens of minerals; from Texas. Accession 13774.

Holberton, W. Specimen of pack basket, fly books, and fishing tackle. (Purchased.) Accession 12666, 12673.

Holladay, Ben. Specimen of live owl. Accession 13059.

Holl, Dr. Specimen of child's shirt, made by the Cakchiguel Indians of Guatemala. Accession 13260.

Holmes, Frank. Folding canvas boat; from Ohio. Accession 12580.

Holmes, W. H. One hundred and ninety-four specimens of rocks; from the Yellowstone Park, Wyoming. Accession 13024.

Hopkinson, J. Specimen of a white oak, about 5 inches in diameter, with 12-inch board driven 8 feet through it by the storm which passed through the town of Wesson, Miss., April 22, 1883. Accession 13282.

Hopson, *W. B.* Two volumes of the Sea World and Packer's Journal, and picture of W. B. Hopson. Accession 12934.

Horan, *Joseph.* Three specimens of live snakes; from Virginia. Accession 13171.

Hornaday, *W. T.* Alcoholic specimen of bat; from Washington, D. C. Accession 13439.

Hotchkiss, *Jed.* Samples of coke; from Pennsylvania and West Virginia. Accessions 13054, 13070, 13136.

Howard, *Ernest.* Specimens of minerals, hematite and chalcopyrite, hematite and asurite, chalcocite, and malachite, &c.; from Loudoun County, Virginia. Accession 13625.

Howard, *E. L.* Specimen of soapstone; from near Falls Church, Va. Accession 13562.

Howarth, *James W.* Specimens of minerals, green feldspar, orthoclase, muscovite, limonite, garnet, &c.; from Pennsylvania. Accession 13525.

Howe, *H. W.* Medal or calendar, dug from an Indian burial ground in 1842; from Ohio. (Loaned.) Accession 13376.

Howes, *R. A.*, *& Co.* Specimen of a human skeleton. (Purchased.) Accession 13793.

Howland, *H. S.* Porpoise (*Kogia goodei*) 9 feet long, found on beach at life-saving station No. 8, fourth district, New Jersey. Accession 13060.

Hubbard Brothers. Specimen of porpoise; from Fire Island, New York. Accession 12959.

Hudson, *Dr. G. L.* (*through F. L. Donnelly*). Stuffed specimen of alligator (*Alligator mississippiensis*), pelican (*Pelecanus fuscus*), muskrat (*Fiber zibethicus*), fox, and female opossum (*Didelphys virginiana*), with young attached (*Sciurus niger* var. *niger*). Accession 13739.

Hughlett, *Thomas.* Specimens of fresh fish (*Mugil albula*, *Caranx hippus*, *Semotilus bullaris*, &c.); from Maryland. Accessions 13032, 13603, 13718.

Humlong, *William.* Specimen of cast of carved stone-head; from mound in Iowa. Accession 13471.

Hunt, *Charles N.* (*through John P. Rogan*). Specimens of Indian relics; from Wilkes County, North Carolina. Accession 13217.

Hunt & Roberts. Specimen of weevil web, larva of *Ephistia zeæ*. Accession 13834.

Huntington, *Dr. D. L.* Specimen of fresh fish. Accession 13334.

Huske, *C. J.* Alcoholic specimens of fishes (*Nothonotus*). Accession 13432.

Hutchinson, *Mrs. H. M.* Specimen of live eagle. Accession 13540.

Jackson, *Charles A.* Model of "carry-away" boat: from Long Island. (Purchased.) Accession 12749.

Jackson R. H. (*through F. L. Donnelly*). Specimens of Indian relics and bones (*Homo sapiens*); from Georgia. Accession 13740.

Jacob, Edwin, U. S. N. (*through Mrs. Captain Jouett*). Two leaves of silver-tree (*Leucodendron argenteum*); from Cape of Good Hope, South Africa, near Tabee Mountain. Acession 12574.

Jamaica, Government of. Specimens of cinchona; from the Government plantations; J. Hart, superintendent. Accession 13384.

James, Henry H. Specimen of whip-poor-will, in flesh, and shed skin of a snake (*Tropidonotus sipedon*); from District of Columbia. Accessions 13289, 13304.

James, Isaac (*through Frank Burns*). Specimens of fossiliferous limestone; from Blount Spring, Ala. Accession 12937.

James, U. P. Eighty-seven species of invertebrate fossils; from Ohio. Accession 13216.

Jardine, D. B. Specimens of iron ores; from Bethlehem Iron Company's mine, Wilbur, Ontario, Canada. Accession 13734.

Jeffreys, Dr. J. Gwyn. Large collection of shells; from Europe. Purchased. Accessions 13083, 13424, 13508.

Jewell, Willard. Sketches of Indians made by Duncan in 1853. Accession 13050.

Johnson, Samuel. Specimens of arrow-heads; from Wood County, West Virginia. Accession 13488.

Johnson & Young. Specimens of fresh lobsters; from the Boston Market. Accession 12661.

Jones, George C. Cast of pierced-stone implement. Accession 12630.

Jones, J. F. Specimen of live catfishes (*Amiurus marmoratus*); from Georgia. Accession 13807.

Jones, T. S. Specimen of worm; from Virginia. Accession 13322.

Jouy, P. L. Large collection of general natural history and ethnologica; from Japan. Accessions 13306, 13360.

Kales, Dr. J. W. Specimens of Indian arrow-heads; from New York. Accession 12967.

Karns, T. C. Specimen of stone relic; from Knox County, Tennessee. Accession 13411.

Karr, Anton. Specimen of pug dog (*Canis familiaris*), in flesh; from Washington, D. C. Accession 13651.

Karr, W. W. Specimens of petrified moss and beach leaves; from Clarke County, Indiana. Accession 13601.

Kaufman, Joseph F. Alcoholic specimen of snake; from Virginia. Accession 12973.

Keam, Thomas V. (*through James Stevenson*). Specimens of two live rattlesnakes, used by the Moqui Indians in their snake dances. Accession 13705.

Keith, Minor C. (*through Hoadly & Co.*). Specimens of twelve stone images, with pieces found at a point called Dos Novillos, on the line Costa Rica Railroad, some 49 miles from the coast, at from 2 to 5 feet below surface. Accession 13254.

Keith, Nathan. Alcoholic specimen of fishes; from Massachusetts. Accession 13580.

Kelly, jr., D. D. Model of "double-ender boat;" from Maine. (Purchased.) Accession 12594.

Kelly, John F. Alcoholic specimens of snails; from Washington, D. C. Accessions 12986, 13062.

Kemeys, E. Collection of clay models of American animals. Accession 13111.

Kengla, L. A. Collection of bones (*Homo sapiens*); from Indian graves in West Virginia. Accession 13726.

Kent, A. S. (through John P. Rogan). Specimens of Indian relics; from Caldwell County, North Carolina. Accession 13479.

Kerr, W. C. Specimens of building stones and soapstones; from North Carolina. Accessions 12646, 13826.

Kettle, Mr. Specimens of vein gold; from Culpeper County, Virginia. Accessions 13312, 13326.

King, Arche Gracie. Specimen of granite; from New York. Accession 13008.

King, F. H. Specimens of eel (*Petromyzon argenteus* and *Blarina talpoides*); from Wisconsin. Accessions 13485, 13720.

King, F. M. Specimens of stone relics; from San Jacinto Mountains, California. Accession 13623.

King, J. R. Specimens of stone relics; from Ohio. (Loaned.) Accession 13256.

King, Peyton R. Alcoholic specimens of fishes (*Cyprinoids*) and specimens of fossils; from Alabama. Accessions 13318, 13420.

Knott, W. T. Specimens of copper implements; from mound near Lebanon, Ky. Accession 12812.

Knowles, Herbert M. Specimens of fresh fish (*Fistularia serrata*, *Cyclopterus lumpus*); from life-saving station at Point Judith, Rhode Island. Accessions 13613, 13653.

Kohn, A. H. Specimens of Indian arrow-heads and quartz; from South Carolina. Accession 13179.

Korts & Bean. Alcoholic specimen of cray-fish; from Potomac River. Accession 12943.

Kortz, Charles. Alcoholic specimens of snake and cray-fish; from Potomac River. Accession 13063.

Kreager, John. Specimens of minerals; from Colorado. Accession 13578.

Kuehling, J. H. Specimen of living turkey buzzard, juv.; from Virginia. Accession 13285.

Kummerfeld, J. F. Specimen of stone relic; from Pottawattamie County, Iowa. Accession 13676.

Kurrachee Municipal Library and Museum. One box specimens of mammal skins and skulls and one box (277) specimens of drugs; from India. Accession 12523.

Lamson, John S., & Bro. Specimens of pottery, stone implements, gold and bronze images; from the Chiriqui graves; also large collection of antiquities, arrows, chisels, and other implements of modern Indians of Chiriqui; collected by J. A. McNiel. Accessions 13654, 13670.

Lanphear, George S. Photograph of the fishmongers' association. Accession 13078.

Lathrop, W. H. Specimen of coke; from Virginia. Accession 13798.

Lawler, D. J. Specimens of boat models, menhaden steamer and fish-market boat. Accession 12821.

Leas, Henry C., Son & Co. Specimen of double-crested comorant skin; from Howard County, Maryland. Accession 13792.

Lee, Henry B. (through John B. Wiggins). Specimen of fossils; from New York. Accession 13559.

Lee, John W. Specimens of minerals; from Maryland. Accession 13036.

Leffel, James, & Co. Model of the Leffel double-turbine water-wheel; from Springfield, Ohio. Accession 13105.

Leonard, Henry. Specimen of canary bird, aged thirteen years and six months. Accession 13084.

Leslie, C. C. Specimens of oysters; from South Carolina. Accession 12780.

Lesquereux, Prof. L. Specimens of fossils; from Ohio. Accession 13321.

Le Van, Mrs. M. J. Three specimens of old-style lamps. Accession 12620.

Lewis, Duff Green. Alcoholic specimen of four-legged chick of domestic fowl; from Jefferson County, West Virginia. Accession 12714.

Lighton, W. R. Specimens of fossils and unios; from Iowa; and head of an idol; from an Aztec tomb in Mexico. Accessions 12960, 13356, 13537.

Lilly, C. A. Specimens of ores; from Hall County, Georgia. Accession 13538.

Lincoln, Charles P. Specimen of a Siamese cat (*Felis domestica*); from Bangkok, Siam. Accession 12898.

Lindley, C. T. Specimens of stone relics; from Illinois. (Loaned.) Accession 12658.

Lloyd, C. H. Specimens of arrow-heads; from Virginia and Maryland. Accessions 12890, 13159.

Lloyd, J. M. Specimen of jasper arrow-head; from Charles County, Maryland. Accession 12547.

Lochman, C. L. Photographs of plants. Accession 12550.

Lockwood, Samuel. Specimen of stone relic; from New Jersey. (Loaned.) Accession 12982.

Logan, Hon. John A. Collection of copper and silver ores; from Illinois, Accession 12286.

Logan, W. E. (*through Hon. M. W. Ransom*). Specimen of iron ore; from North Carolina. Accession 12734.

Loomis, Plumb & Co. Two automatic reels (bronze and nickel plate); from New York. Accession 12784.

Lopp, John F. Specimen of black-oak root, with pine root grown through it; from Arkansas. Accession 13089.

Lorillard, Pierre (*through Désiré Charnay, of Paris*). Large collection of casts of many of the most notable inscriptions and bas-reliefs existing in the ruined cities of Mexico and Central America. Accession 13211.

Love, Thomas J. Specimens of oysters; from New Jersey. Accession 12618.

Love, William B. Four specimens of native gold in quartz; from Culpeper County, Virginia. Accession 13092.

Love, W. G. (*through F. W. Taylor*). Specimen of gold; from near Richardsville, Culpeper County, Virginia. Accession 13803.

Lowell, Stephen A. Specimen of mineral (*Epidote with Grossularite in quartz*); from Hebron, Me. Accession 13386.

Ludworth, George B. Alcoholic specimens of snakes; from Michigan. (Loaned.) Accession 13426.

Lugger, sr., O. Specimens of bird-skins; from Demerara, South America. Accession 13552.

Lummis, Charles. Copies of "Birch Bark Poems." Accession 13689.

Lytle, William. Specimen of limonite dendrite on limestone; from Illinois. Accession 12797.

MacLean, J. P. Specimen of cane, made of cedar log, from 85 feet below surface, fragment of bone implement and prong of deer's antler; from an earthwork in Highland County, Ohio. Accessions 13604, 13723.

Macleay, William. Specimen of dugong skin (*Halicore dugong*); from Sydney, Australia. Accession 12813.

Mais, H. C. (*through W. W. Evans*). Specimens of tusks, teeth, and claws of extinct species of kangaroo (*Diprotodon*), found 18 inches below surface of swampy land near Millicent, in the southeast district of South Australia. Accession 12988.

Mallet, jr., Edmond. Specimen of hen's egg; from Washington, D. C. Accession 13004.

Mallory, H. P. Specimens of slides of diatoms; from Pensacola Bay, Florida. Accession 13329.

Mallet, Dr. J. W. Specimens of minerals; from Texas. Accession 13817.

Mann Brothers. Samples of oyster tubs. Accession 12528.

Mann, Charles L. Sample of piercing tool and fish-hook, made from hammered copper and rolled in shape. (Loan.) Accession 12621.

Manning, P. C. Specimens of gneiss and collection of small stones; from Maine; also porphyry and quartz; from Placer County, California. Accessions 12792, 13002, 13434.

Marnock, G. W. Alcoholic specimens of reptiles; from Texas. Accession 13729.

Marshall, H. Specimen of duck in flesh. Accession 13635.

Marshall, S. N. Live specimen of duck, from Peck's Beach, New Jersey. Accession 13629.

Martin, Horace. Specimen of stone ax and pipe; from Missouri. Accession 12693.

Martin, S. I. Specimens of five playing cards taken from pouch of codfish hauled up in 90 fathoms of water in latitude 42 south on the 18th of September, 1882; also box of net formers; from Massachusetts. Accessions 12564, 12781.

Mason, John (through George P. Merrill). Specimens of diabase, epidotic rock, &c.; from Goose Creek, near Leesburg, Va. Accession 13407.

Mather, Fred. Alcoholic fishes (*Salvelinus fontinalis, Coregonus quadrilateralis, Catostomus commersonii, Amiurus catus, Luxilus cornutus,* &c.); from "Adirondacks." Accessions 13085, 13214, 13811.

Matthews, John. Specimen of marble containing 90 per cent. carbonate of lime, and one bottle of powdered snow-flake marble; from New York. Accession 13489.

Mattes, M. R. Specimens of six metallo-plastic fishes (loan), and ten photographs of the West Indian fishes; from Surinam. Accessions 13201, 13496.

Mattson, Hans (through consul-general, Calcutta). Collection of roots and plants; from India. Accession 13402.

Maxey, Hon. S. B. Pair of horns, with section of skull attached (*Bos taurus*). Accession 12905.

May, William R. Specimen of supposed gold-bearing slate. Accession 12656.

McBride, R. O. Specimen of stone ax; from Missouri. Accession 12631.

McCaskill, J. C. I. Samples of mineral water and small specimen of ore; from Texas. Accession 12779.

McCeney, E. P. Specimen of eocene mollusks; from marl bed in Prince George's County, Maryland. Accession 13717.

McCormick, L. M. Skeleton of squirrel (*Sciurus carolinensis*); from Falls Church, Va.; specimen of cat (*Felis domestica*); from Smithsonian grounds; and collection of birds, skeletons, and bones; from District of Columbia. Accessions 13150, 13606, 13779.

McElroy, S. W. Box of crude material; from Kansas. Accession 13099.

McFarland, Prof. R. W. (through Hon. H. L. Morey). Specimens of cedar, from 85 feet below surface; from near Oxford, Ohio. Accession 13821.

McGlothlin, G. W. Specimens of minerals; from Texas. Accessions 13090, 13357.

McKay, C. L. (deceased). Collection of ivory, bone, and wood ornaments, alcoholic specimens of mammals, insects, fishes, invertebrates, frogs, and stone relics, minerals, pumice-stone, birds' nests and skins, shells, plants, dried insects, and fossil shells, &c.; from Alaska. Accessions 13527, 13824.

McKenzie, A. (through James G. Swan). Specimen of snowy owl; from Massett, British Columbia. Accession 13844.

McKesson & Robbins (New York). Two hundred samples of oils, one hundred specimens of miscellaneous drugs, one box of commercial sponges, and one box specimens of cuprea leaves, bark, and fruit. Accessions 12579, 12942, 13128, 13219, 13369.

McKleroy, John M. Specimen of shed skin of snake. Accession 13229.

McLachlen, A. M. (through Hon. S. R. Peters). Specimens of ores. Accession 13819.

McLain, M. Three boat models. (Purchased.) Accession 12545.

McLean, John J. Specimens of stone relics and flint chippings, skeleton of large seal (*Eumetopias stelleri*), two skins of seals (*Zalophus californicus*), specimen of shell, rocks, showing work of boring mollusks, and pumice-stone; from California. Accession 13805.

McManus, Felix R. Specimen of fossil shell. Accession 13713.

McMenamin & Co. (Virginia). Eight boxes of canned oysters and crabs. Accession 12510.

McNiel, J. A. (through J. S. Lamson & Bro.). Alcoholic specimens of fishes, eels, shrimps, and crabs, shells, and frogs; from Chiriqui River and streams flowing from Mount Chiriqui; and alcoholic specimen of snake (*Pelamis bicolor*); from Pacific Ocean, off the Island of Quibo. Accession 13473.

Mead, B. F. Specimen of black sand (*Menaccanite*); from Kansas. Accession 12655.

Meadows, J. A. Specimens of silver and copper ores; from New Mexico. Accession 12802.

Meigs, M. C., U. S. A. Specimens of sandstone; from quarries at Manassas, Va. Accession 12992.

Melville, George W., U. S. N. Suit worn by him during the retreat from the Jeannette and search for De Long and comrades in Siberia. Accession 12796.

Mercer, R. W. Specimens of stone relics; from Kentucky, Ohio, Georgia, and West Virginia; and two stone pipes; from Tennessee and Georgia. (Loaned.) Accessions 13449, 13684.

Merchant, jr., George. Two boxes and six bundles of fishing apparatus. Accessions 12619, 12629.

Merriam, Dr. C Hart. Three boxes and one keg specimens of seal skins and skulls (*Phoca grœnlandica, Cystophora cristata*), samples of seal oil; from Newfoundland; and skins of seals with skulls and flippers attached (*Phoca grœnlandica*); from north shore of Gulf of Saint Lawrence. Accessions 13108, 13116, 13149, 13518.

Merrill, George P. Alcoholic specimens of fishes, snail, bat, and reptiles; from Maine; also collections of rocks and minerals; from Massachusetts, Virginia, Maryland, and District of Columbia. Accessions 13395, 13405, 13501, 13502, 13506, 13516, 13519, 13565, 13690, 13764, 13801.

Merrill, L. H. Specimens of rocks; from Maine. Accession 13584.

Metcalfe, P. Herbert. Collection of dried and alcoholic insects; from New Zealand. Accession 13846.

Meyer, A. B. Specimens of jadeite; from Yunan and China; also specimen of jade; from China, New Zealand, New Caledonia, Turkestan, and Siberia. Accessions 13418, 13722.

Michigan Carbon Works. One box samples of animal charcoal; from Michigan. Accession 15188.

Middleton, Carman & Co. Specimen of fish (*Paralichthys dentatus*) upper eye on top of head. Accession 13619.

Middleton, J. Y. (through Hon. J. W. Throckmorton). Sample of mineral water; from Texas. Accession 13786.

Milam, B. C. Specimen of nickel-plate fishing-reel; from Kentucky. (Loaned.) Accession 12807.

Miller, Benjamin. Alcoholic specimens of fishes, snakes and lizards. Accession 13461, 13683.

Miller, David. Specimen of mole (*Condylura cristata*); from Pennsylvania. Accession 12877.

Miller, H. H. Specimens of birds in flesh; from Maryland. Accession 12669.

Milligan, J. D. (through P. L. Jouy). Collection of clay figures; from Tientsin, China. Accession 13680.

Mills, William, & Son. Two boxes fishing tackle. (Loaned.) Accessions 12716, 12728.

Minton & Co. (through L. Straus & Sons). One cask decorated china drinking vessels; from their works, England. Accession 13710.

Mintzer, William A., U. S. N. Specimens of minerals; from North Carolina. Accessions 13281, 13640.

Mitchell, Lemuel. Specimen of live crab. Accession 13367.

Mitchell, Lewis G. Specimen of fresh fish (*Pomacanthus arcuatus*); from Barnegat, N. J. Accession 13671.

Mitchell, J. E. Column of grind-stones composed of thirteen varieties. Accession 13324.

Mitchell, Dr. S. W. Specimen of rattlesnake 6½ feet long; from Florida. Accession 13064.

Moffat, H. F. Specimen of worm; from New Hampshire. Accession 13387.

Monroe, Prof. Charles E. Specimen of orrellite on bituminous coal; from Newburgh, W. Va. Accession 13847.

Monroe, M. Four bottles samples of boiled and steamed refined seal oils; from Saint John's, Newfoundland. Accession 13391.

Monumental Bronze Company (*Connecticut*). Bronze statue of soldier and specimen of ore, &c.; product from ore, a head, hands, and pieces of the metal showing manner of putting together, &c. Accession 12997.

Mooers, L. M. Specimen of silicified wood; from Virginia. Accession 13413.

Moore, F. L. Six hundred and thirty pounds of gypsum; from Windsor, Nova Scotia. Accession 13101.

Moores, I. R. Box of fish eggs and alcoholic specimens of Rocky Mountain white-fish (*Coregonus williamsonii*); from Oregon. Accessions 12853, 13777.

Moore, James A. K. Specimen of great-horned owl (*Bubo virginianus*) and box of owl eggs; from Virginia. Accessions 12742, 12980.

Moorman, Charles R. Specimen of eagle-skin (bald). Accession 12524.

Morris, Dr. Robert T. Phial containing parasite taken from brook-trout. Accession 13141.

Moser, Jeff. F., Lieutenant, U. S. N. Collection of minerals, reptiles, insects, rocks, chrome iron, fossils, and fragments Indian skulls, shark-skin, and bird-skin; from Central and South America. Accession 13481, 13507, 13755.

Murphy, William M. (*through General M. La Rue Harrison*). Specimen of wood from 60 feet below surface; from Perry County, Illinois. Accession 13061.

Museum of Comparative Zoology. Set of "Blake" corals, alcoholic specimens of cray-fish; from Massachusetts. Accessions 12782, 12842, 13560.

Musser, George. Specimen of strap-worm (*Ligula digrama*); taken from a Potomac shad. Accession 13230.

Nation, William. Two specimens of bird-skins; from Peru. Accessions 13499, 13634.

Neafie & Levy. Two full-rigged boat models. Accession 13328.

Neal, Dr. James C. Three boxes of mammal bones; from Florida; also alcoholic specimen of salmander (*Amblystoma tigrinum*). Accessions 13544, 13591, 13632, 13701.

Neill, Allen. One box of oysters in the shell; from New Jersey. Accession 12530.

Nelson, C. Samples of canvas, rope, and netting. Accession 12874.

Nelson, John. Box of clothing used by the Gloucester fishermen. (Purchased.) Accession 12607.

Nelson, Dr. Wolfred. Bottle of alcoholic serpents; from Central America. Accession 12951.

New Bedford Cordage Company. One box of whaling lines. (Purchased). Accession 12606.

Newton, W. A. One box of kaolin; from Missouri. Accession 12976.

Nichols, Edward. Living specimen of rattlesnake; from Georgia. Accession 13249.

Nichols, Henry E., U. S. steamer "Hassler." A valuable collection of birds, mammals, reptiles, fishes, &c.; from Alaska and Sonora. Accessions 12570, 13757.

Nickerson & Baxter. Two books sample fish-hooks. Accession 12700.

Nickerson, George Y. Bone from whale. Accession 13658.

Nixson, W. A. One box of minerals; from North Carolina. Accession 13013.

Nutting, C. C. Large and valuable collection of antiquities, stone-idol, birds, and mammal skins; from Central America. Accessions 12748, 13208, 13252, 13258.

Nye, jr., Willard. Valuable collections of fishes, invertebrates, Indian relics, shells, &c.; from Massachusetts; bird and mammal skins, insects, fungus, &c.; from Utah and Montana. Accessions 12791, 12933, 13212, 13362, 13657, 13730.

Ober, F. A. Specimen of pottery; from Chihuahua, Mexico. Accession 13674.

Offutt, T. J. Specimen of tarantula found in bunch of bananas; from West Indies. Accession 13692.

Ogdin, W. H. Specimen of beetle (*Dynastes tityus*); from West Virginia. Accession 12593.

Olmsted, Charles F. Specimen of fossil; from Ohio. (Loaned.) Accession 13645.

Orcutt, Charles R. Valuable collection of bird and mammal skins, living and alcoholic reptiles, samples of fibers and articles made by Indians of Lower California. Accessions 12820, 13430, 13436, 13457, 13512, 13600.

Oregon Packing Company. Six cans of salmon; from Columbia River. Accession 12830.

Orton, Prof. Edward. Three samples of coke; from Ohio. Accession 13135.

Osgood, N. A. Two portable canvas boats. Accession 12930.

Ostermoor, H. D., & Son. Model of life-saving mattress. Accession 12732.

Packwood, F. J. Specimen of beetle (*Dynastes tityus*); from Florida. Accession 13269.

Page, John R. Two albino robins; from Virginia. Accession 12964.

Palmer, Dr. Edward. Collections of Indian relics, pottery, shells, minerals, fibers, plants, &c., used as medicines and in cooking; from North Carolina, Tennessee, Alabama, Arkansas, and Texas. Accessions 12601, 12995, 13267, 13294, 13365, 13743, 13762.

Palmer, William. Mold of large copper hoe, three skins of ground-squirrels, and bottle of alcoholic reptiles; from Michigan. Accession 13273.

Parsons, William B. Old style of lantern used on shipboard prior to 1840. Accession 12739.

Pearce, Jason S., & Co. Basket of shell oysters; from Rhode Island. Accession 12519.

Peary, R. E., U. S. N. Fine specimen of coral attached to a crow-bar, found in 6 fathoms of water at Key West, Fla. Accession 13478.

Peña, H. D. Specimen of common frying-pan covered with barnacles and large coral; from Bay of La Paz, Lower California.

Pengelly, William. Chest of fossil bones; from Kent's Cavern, near Lamoma Torquay. Accessions 13075.

Perry, N. H. Collection of sixty-four specimens of minerals; from Maine. Accession 13524.

Peters, T. E. Specimen of insect; from Virginia. Accession 13257.

Petroff, Ivan. Tobacco pouch and pair of buck mittens; from Indians of Alaska. Accession 12802.

Pharmaceutical Society of Great Britain. Specimen of fruit of the double cocoanut. Accession 13831.

Phillips, Barnet. Pair of Turkish slippers, game of thirty-one, fresh mackerel (*Scomber scombrus*), and specimens of the leaves and fruit of the Ogeechee lime; from near Savannah, Ga. Accessions 12757, 13066, 13350, 13711.

Phillips, William, & Son. One slab each of Japan Sea, Northwest, and South Sea whalebone. (Purchased.) 12825.

Picking, Henry T., U. S. N. A nickel-plated working model of the Courtenay automatic whistling buoy. 12836.

Pierce, Eugene. Specimen of living water-snake; from Virginia. Accession 13232.

Pike, Nicholas. Alcoholic collection of reptiles and worms; from Mauritius. Accession 13444.

Poey, Prof. Felipe. Valuable collection of alcoholic fishes, alligator, sharks' jaws, and stuffed specimen of seal; from Cuba. Accessions 13463, 13561.

Poole, George. Specimen of raccoon (*Procyon lotor*); from Virginia. Accession 13725.

Potts, Edward. Collection of fresh-water sponges in alcohol and microscopic slides. Accession 12752.

Powell, J. W. Collection of thirteen hundred and twenty-nine stone implements, specimens of tufa and obsidian, six packages of rocks, collected by the United States Geological Survey, two plaster casts of the Grand Cañon of the Colorado, and two of the Henry Mountains, and sample of water; from Athbert Lake, Oregon. Accessions 12667, 12697, 12931, 12962, 13121, 13283, 13618, 13652, 13769, 13791.

Powers & Weightman (Philadelphia, Pa.). Ten boxes containing a large and collective exhibit of chemicals of their own manufacture. Accession 12787.

Prang, L., & Co. (Boston, Mass.) A complete exhibit showing the process and materials used in the art of lithography. Accessions 13100, 13125, 13168.

Prather, John G. Dried skin of alligator gar (*Lepidosteus spatula*); from Black River, Arkansas. Accession 12745.

Price, Dr. Henry M. Specimen of iron sulphide; from Virginia. Accession 13441.

Priestley, Miss Frances D. Large collection of philosophical apparatus used by her father, the late Dr. Joseph Priestley. Accession 13305.

Pringle, H. L. Box of minerals; from Vermont. Accession 13748.

Proctor, G. W. Specimen of harpoon; from California. Accession 12819.

Pumpelly, Prof. R. Thirteen boxes of minerals collected by the Tenth Census. Accession 12786.

Pusey and Jones Company (*Wilmington, Del.*). Model of U. S. Fish Commission steamer "Albatross." Accession 12883.

Quinnipiac Fertilizer Company. One box of fish scrap and guano. Accession 12675.

Raley, John B. Specimen of quartz and pyrite; from North Carolina. Accession 12927.

Rathbun, Richard. Two specimens of deep-sea turtles; from off the coast of Massachusetts. Accession 12923.

Rau, Dr. Charles. Fragment of fishing-net; from Ancon, Peru. Accession 13592.

Rayner, Eli. Collection of nineteen species of minerals and ores for exchange. Accession 12907.

Reilly & Bros. Two specimens of building stones; from Kentucky. Accession 13301.

Renneberg, Edward. Model of apparatus for steaming oysters. (Purchased.) Accession 12881.

Reynolds, E. R. Pair of loons; from Swan's Point, Maryland. Accession 13112.

Rhode Island Society of Domestic Industry. First spinning-frame of twenty-four spindles, and first carding-machine to accompany it, the progenitor of all cotton machinery in the country. Set up in 1790, at Pawtucket, by Samuel Slater; also, complete set of the old apparatus for breaking, hatchelling, and spinning flax. Accession 13137.

Richards, S. J.; J. H. Specimens of fossils, coral (*Astrea* sp.), and pharyngeal bone of the sheep's-head; from near Fort Washington, Potomac River. Accessions 13123, 13466.

Riddleberger, Hon. H. H. Specimen of galena; from Virginia. Accession 13587.

Ridgway, D. Specimen of snake (*Farancia abacura*) and eggs; from Indiana. Accession 13370.

Ridgway, J. H. Fresh specimen of juv. whale (*Ziphius curvirostris*) ♀; from Barnegat City, N. J. Accession 13564.

Ridgway, Robert. A valuable collection of birds' skins, nests, and eggs, mammals, reptiles, crawfishes, shells, insects, fishes, Indian and stone relics, minerals, fossils, &c.; from Indiana, Illinois, and Utah. Accessions 12614, 13046, 13067, 13079, 13097, 13130, 13139, 13215, 13259, 13274, 13277, 13314, 13741.

Ridgway Patent Refrigerator Company (*Philadelphia, Pa.*). Model of Ridgway patent refrigerator. Accession 12880.

Rivett-Carnac, J. H. Box of stone implements and chippings; from the Banda district, Northwest India. Accession 12824.

Roane Iron Company. Samples of coke; from Rockwood, Tenn. Accession 13143.

Robbins, J. W. (*U. S. surveyor-general, Tucson, Ariz.*). One hundred and ninety specimens of ores; from Arizona. Accession 13790.

Roberts, C. T. (*agent*). Specimen of iron ores; from Paint River and Mastodon mines, Michigan. Accession 13358.

Robeson, Mrs. George M. One pair deer horns. Accession 13754.

Roberts, J. M. One box of Indian and stone relics; from Louisiana. Accession 12773.

Robinson, A. A. (*chief engineer*), *A. T. & S. F. R. R.* Eighteen boxes of building stones; from various localities along their railroad. Accession 12635.

Robinson, George F. Box of fossils from Las Vegas, N. Mex. Accession 13298.

Robinson, H. Three specimens of minerals; from Kansas. Accession 13649.

Robinson, J. E. Stone pestle; from Cambridge, Md. Accession 13814.

Robinson, Hon. J. S. Box of copper and stone implements and ornaments; from mound in Hardin County, Ohio. Accession 12871.

Robinson, jr., Norborne. Two specimens of living alligators, juv.; from Florida. Accession 12721.

Robinson, William S., & Co. Samples of oyster tubs and pails. Accession 12910.

Rodgers, Mrs. John. Specimen of large palm-leaf fan; from Samoan Islands. Accession 13414.

Rosenstein Brothers. Two boxes of canned lobsters and fish; from Maine. Accessions 12665, 12764.

Rosecrans, Miss. Specimen of moth (*Telea polyphemus*); from East Washington, D. C. Accession 13184.

Rosecrans, Hon. W. S. Three specimens of ores. Accession 13185.

Rowe, N. Bound volume of "American Field." Accession 12896.

Royal Museum of Natural History, Leiden, Netherlands. One tank containing sixty-three species of alcoholic fishes; from Indian Archipelago. Accession 13058.

Ruby, Charles. Specimen of black-footed ferret (*Putorius nigripes*), bird-skin (*Calamospiza bicolor*), and two skulls of Cheyenne Indians; from Wyoming. Accessions 13096, 13742.

Rusby, Henry H. Seven boxes of plants and two of geological specimens; from Arizona. Accessions 12753, 13394, 13416, 13526, 13635, 13809.

Russell, D. E. Box of specimens of ores; from Texas. Accession 13379.

Russell, I. C. Specimens of crystals of gay-lussite; from Nevada. Accession 13624.

Russell Mills Company. Twenty-one samples of sail duck. Accession 12722.

Russia Cement Company. Samples of liquid glue, mucilage, and various samples illustrating its use in the manufactures. Accessions 12507, 13638, 13672.

Rust, Horatio N. Specimen of basket mortar, with granite base, and pestle; from California. Accession 13823.

Sally & McCray. Box of pottery and stone relics; from mounds on banks of Ouachita River, Arkansas. Accession 13354.

Sampson, F. A. Specimens of land and fresh-water shells; from Missouri. Accession 12815.

Sargent, C. S. Seventy-seven specimens of drawings of forest trees; from Massachusetts. Accession 12820.

Scammon, C. M. Volume on marine mammals, together with an account of the American whale-fishery, also specimen of horse-fish (*Hippocampus*); from Rio Grande, Texas. Accessions 12864, 12912.

Scharf, Samuel. Box of fossils. Accession 12696.

Schieffelin, W. H., & Co. Two boxes of specimens of materia medica, also package of Chinese smoking opium. Accessions 12572, 13034, 13086.

Schneck, Dr. J. Two living specimens of owls, specimens of terrapins, living specimen of milk-snake (*O. doliatus*), and skin of bird; from Illinois.

Sclater, P. L. Skin of *Geothlypis spiciosa;* from British Museum, London, England. Accession 12977.

Sellars, L. H. One bottle alcoholic specimens of astrophytons; from about 100 miles south of Pensacola, Fla. Accession 13765.

Sergeant, J. D. Specimen of sea-weed found on coast of New Jersey. Accession, 13536.

Server, Matt. T. Living specimen of alligator, juv.; from Florida. Accession 12506.

Seton, Ernest E. T. Specimens of birds' skins and eggs, plants, bone, Indian relics, &c.; from Manitoba. Accessions 13206, 13383, 13503.

Shafer, C. B. Six specimens of mineral waters. Accession 13120.

Shaffer, Dr. J. M. Bottle of alcoholic parasites; from stomach of pelican. Accession 13776.

Shannon, W. R. Specimen of mineral; from Texas. Accession 13598.

Shaw, R. E. Specimen of fish; from Alabama. Accession 12968.

Sheldon, Prof. D. S. Six living specimens of soft-shell turtles, one living snake, and alcoholic crustaceans; from Iowa. Accessions 13153, 13291, 13307, 13491.

Shelton, Mr. Specimen of rutile; from Roseland, Va. Accession 13800.

Shepard, J. H. Two specimens of parasites from the gills of bluefish; from Sandy Hook Bay, New York. Accession 13531.

Sherman, W. T. Specimen of whetstone; from the quarries at Hot Springs, Ark. Accession 13207.

Shipley, A. B., & Son. Two packages of fishing tackle. Accessions 12755, 12863.

Shmedtie, August. Stone sinker; from cave near Santo Domingo, Isthmus of Tehuantepec, Mexico. Accession 12612.

Shoemaker, C. W. Specimen of herring gull. Accession 12743.

Shoemaker, Mrs. D. L. Specimen of alligator, juv.; from Florida. Accession 13051.

Shoemaker, George. One box of bird-skins; from Florida. Accessions 12974, 13118.

Shufeldt, R. W., U. S. A. Large collection of mammals, birds, eggs, nests, reptiles, fishes, crustaceans, insects, &c.; from Louisiana. Accessions 12504, 12738, 13048, 13087, 13236, 13279, 13309, 13333, 13335, 13427, 13547.

Shulze, Miss E. J. Three colored and three uncolored plates, as specimens of lithography. Accession 13072.

Siam, King of (*through John A. Halderman*). Two boxes and one bundle of Siamese fishing apparatus for fresh and marine fishing. Accession 13192.

Siler, A. L. Two packages specimens of fossils and minerals; from Utah. Accession 13835.

Silliman, Prof. B. J. Thirty-four specimens of rocks for microscopical sections. Accession 12817.

Simms, James. Gang of fishing-vessel rigging. Accession 12817.

Slade, Elisha. Two young specimens of ducks from twelve to forty-one days old; also specimen of *Hippa talpoida*; from Massachusetts. Accessions 13345, 13349.

Skinner, A. Specimen of rodent; from Arlington, Va. Accession 12562.

Small, Albert. Specimens of diatomaceous earths; from near Hagerstown, Md. Accession 12538.

Smith, A. J. M. (*through P. L. Jouy*). Feather coat made from puffin skins; from Kuriles, Japan. Accession 13845.

Smith, Edwin. Specimen of kee wee (*Apteryx*); from New Zealand. Accession 13696.

Smith, J. A., M. D. Specimen of boat-shaped implement and small arrow-head; from Arkansas. Accession 12623.

Smith, Prof. James M. Three stone relics, two specimens of quartz, and one iron battle-ax; from North Carolina. Accession 13528.

Smith, J. R. Specimen of mineral from West Virginia. Accession 13595.

Smith, Miss Rosa. Living specimens of lizard (*Gerrhonotus grandis*), snake (*Pityophis sayi* Bellona), and horned frogs (*Phrynosoma coronatum*); from California. Accessions 13113, 13181, 13392, 13408.

Smith, Walter H. Bottle containing alcoholic specimens of brook shrimp; from California. Accession 13469.

Smithmeyer, J. L. Package of minerals; from Hot Springs, Ark. Accession 13476.

Spainhour, J. M. Collection of mound relics; from the Yadkin River, North Carolina. Accession 13775.

Spencer, W. A. Specimens of marine invertebrates and parasites; from France. Accessions 12715, 13173.

Sperry, E. A. Specimen of asbestos; from Colorado. Accession 13615.

Spicer, William E. One fyke-net. (Purchased.) Accession 12799.

Stabler, James P. Specimen of owl; from Sandy Spring, Md. Accession 13703.

Stanley, Henry O. Pencil sketch of Rangeley trout on birch bark; from Maine. Accession 12643.

Stavanger Museum, Stavanger, Norway (through Joseph Lorange). One skin of moose (*Alces malchis*). Accession 13077.

Stearns, Robert E. C. Large and valuable collection of general natural history, Indian relics and manufactures, pottery, ores, &c.; from the Pacific coast of the United States. Accessions 12958, 13080, 13421, 13707.

Stearns, Silas. Large tank of alcoholic fishes; from the coast of Florida, and rock covered with marine animals. Accessions 12991, 13736.

Steele, Robert L. Specimen of insect; from North Carolina. Accession 13351.

Stejneger, Dr. Leonard. A large collection (thirty-nine packages) of general natural history; from Commander Islands and Kamtchatka. Accession 13728.

Stephenson, Chauncy. Specimen of ore; from Massachusetts. Accession 12843.

Stephenson, J. A. D. Box of Indian relics and specimen of lizard (*Opheosaurus ventralis*); from North Carolina. Accessions 13189, 13571.

Sterling, Dr. E. Specimen of unfinished nest of wood-pewee; from Ohio. Accession 12633.

Stevenson, Col. James. Three specimens of mammal skins; from Arizona. Accession 13820.

Stilwell, G. M. Tin transportation can for fish, with sample pump for aereating water in same. Accessions 12657, 12794.

Stine, William. Specimen of insect (*Belostoma americanum*); from Ohio. Accession 13107.

Saint Louis Ore and Steel Company. Box with samples of 72-hour coke; from Illinois. Accession 13175.

State Board of Agriculture, Raleigh, N. C. Specimen of pine log illustrating the turpentine industry. Accession 13700.

Stoddard, Mrs. M. T. Specimen of living owl; from the District of Columbia. Accession 13549.

Stolley, George. Forty-seven boxes of fossils and a collection of general natural history; from Texas. Accessions 13109, 13220, 13239, 13255, 13317, 13338, 13352, 13451, 13566.

Stone, Livingston. Two boxes of living snakes, one box of birds' nests and eggs; from California. Also models of fish-culture apparatus and a large alcoholic collection of salmon embryos; from New Hampshire. Accessions 12709, 12892, 12915, 12946, 13464.

Story, W. W. A collection of forty-five specimens of marble; from Italy. Accession 13495.

Strauss, L., & Sons. A large vase of Sevres ware, valued at $2,000; also a cask of decorated china drinking vessels; from Europe. Accessions 12575, 13709.

Stuart, H. C. Alcoholic specimen of hair-tailed scabbard fish (*Trichiurus lepturus*); from Guatemala. Accession 13339.

Stuckey, Major. Four specimens of minerals; from West Virginia. Accession 13588.

Sulzbacher Brothers. Alcoholic specimens of fish; from Tennessee. Accession 12534

Sutherland, John. Specimen of shell (*Argina pexata*); from New York. Accession 13148.

Swan, James G. A very large collection of whaling and fishing apparatus, alcoholic and dried fishes, Indian relics, implements, and manufactures, boat models, photographs, costumes, specimens of stones, fossils, fibers, canned and salted fishes, skins of birds, specimens of coal, lichens, &c.; from various points of the coast of the extreme Northwest United States and Alaska, Vancouver and Queen Charlotte Islands. Accessions 12647, 12648, 12690, 12783, 12882, 13243, 13261, 13594, 13780, 13804.

Sweeney, Stephen. Two specimens of rock; from Washington Territory. Accession 13363.

Syenite Granite Company. Two 4-inch cubes of granite; from Missouri. Accession 12776.

Symmes, Francis M. Two small models of toy axes, made from soft hematite. Accession 12810.

Talbot, D. H. Specimen of *Salmo salar;* from Labrador; and two alcoholic specimens of bull-snake; from Iowa. Accessions 13180, 13242.

Tarr, R. S. Collection of one hundred cray-fishes and four cray-fish nests; from the Potomac River. Specimen of danatite and specimen of bat; from Massachusetts. Accessions 13076, 13154, 13848.

Taylor, Dr. F. W. Collection of minerals; from Pennsylvania and Virginia. Accessions 13611, 13612, 13638, 13802, 13816.

Taylor, Dr. G. H. Specimens of carved pipe, pottery, gar fish scales, diatoms, &c.; from Alabama. Accessions 13271, 13310.

Taylor, G. S. Ten specimens of fossil insects from Wyoming. Accession 13484.

Taylor, Leon. Two cocoons of insect from cottonwood tree. Accession 12654.

Taylor, William. One box of Indian implements, two hundred and fifty-two specimens; from Ohio. (Loan.) Accession 12645.

Taylor, William (Portland, Me.). Specimen of harpoon. Accession 12522.

Taylor, William J. Collection of alcoholic mammals, reptiles, fishes, invertebrates, and insects; from Georgia. Accessions 12994, 13098.

Terry, Alfred H., U. S. A. Four specimens of large, round stones; from Cannon Ball River. Accession 13308.

Thaxter & Sons. Three packages of mariners' books and charts. Accessions 12532, 12533.

Thomas, Prof. Cyrus. Specimen of skull taken from stone grave in mound in Alexander County, Illinois. Accession 13055.

Thompson, Franklin. Model of porgy factory and two boat models; from Maine. (Purchased.) Accessions 12750, 12839.

Thompson, H. V. Two living specimens of carp; from Virginia. Accession 13691.

Thompson, J. S. B. Specimen of magnetic iron ore; from Virginia. Accession 13771.

Thorpe, Rev. T. M. Specimen of terminal bud; from North Carolina. Accession 13789.

Tobias, Herman. Specimen of tarantula; from Georgia. Accession 12680.

Todd, Aurelius. One pair of showtl skins and five specimens of beetles; from Oregon. Accessions 13231, 13234, 13240.

Tower, A. J. Two boxes of fishermen's oiled clothing; from Massachusetts. Accessions 12551, 12764.

Tower, Moses B. Specimen of king crab in process of casting shell. Accession 13678.

Towne, F. H. Specimen of water-snake; from Virginia. Accession 13393.

Townsend, Charles H. A large collection of birds' skins, nests, eggs, and three living snakes; from California. Accessions 13361, 13467, 13553, 13693.

Traill, Charles. Collection of shrubs, seeds, &c.; from New Zealand. Accession 13341.

True, Frederick W. Specimens of water-snake, musk-rat, two specimens of bats; from the District of Columbia; specimen of sandstone; from Kentucky; and a specimen of limestone; from Essex County, New York. Accessions 13009, 13183, 13366, 13412, 13529, 13572, 13573.

Turner, Charles J. Three boxes of stone relics; from Missouri. (Purchased.) Accession 13382.

Turner, Lucien M. One tierce, one barrel, and two kegs of general natural history specimens; from Hudson Bay territory. Accession 13724.

Turner, Mrs. Mary E. Nest of Bewick's wren, with eleven eggs; from Mount Carmel, Ill. Accession 13275.

Tuttle, R. M. Two small specimens of mound pottery; from Idaho. Accession 13187.

Ullman, Samuel. Two cutting tools, twenty-nine arrow-heads; from Mississippi. Accession 13664.

Union College, Schenectady, N. Y. Two boxes containing a collection of worms. Accession 12893.

Union Fish Company, Camden, Maine. Model of works and two boxes of sample cans of goods. Accession 12694.

Van Ess, Ira. One box of Indian relics; from New York. Accession 12719.

Van Patten, Dr. C. H. Collection of general natural history; from Costa Rica. Accession 13204.

Van Vliet, Stewart, U. S. A. Specimen of potato growing through piece of bone; from New Jersey. Accession 13540.

Van Wyck, Hon. Charles H. Head, skin, and antlers of deer (*Cervus macrotis*). Accession 13839.

Velie, Dr. J. W. Specimen of *Ardea occidentalis*; from Florida. Accession 13551.

Vernon, M. R. Specimen of ore; from Arizona. Accession 13161.

Verrill, Prof. A. E. Large and valuable collection of alcoh lic marine invertebrates; from off the coast of New England. Accessions 12652, 12674, 12678, 12945.

Very, Samuel W., U. S. N. A collection of general natural history; from Santa Cruz, Patagonia. Accession 13209.

Von Behr (through E. G. Blackford). Three living specimens of German carp; from Germany. Accession 12578.

Von Tagen, F. A. Specimen of asbestos; from North Carolina. Accession 12682.

Voss, Albert. Two boat winches; from Massachusetts. Accession 12514.

Wagner, Paul. Photograph of septarium; from Texas. Accession 13202.

Walke, E. H. Seven stone implements and specimen of leech, with young attached to stomach of mother; from North Carolina. Accessions 12926, 12936.

Walker, J. Carter. Specimen of insect from Virginia. Accession 13364.

Walker, John G., U. S. N. Collection of Polaris relics found by Sir Allen Young in the yacht Pandora, on Littleton Island, and a Russian trunk, generally used for transportation of effects or materials in Northern Siberia on the backs of horses or reindeer. Accession 13026.

Walker, S. T. Specimens of fossils; from Tampa Bay, Florida. Accession 12831.

Wallace, John. One box of bird-skins. (Purchased.) Accession 13595.

Ward, C. W. Collection of bird-skins and general natural history; from Florida. Accessions 13156, 13763, 13842.

Ward, Prof. H. A. Specimen of *Audubonia occidentalis.* Accession 12849.

Ward, William A. Specimen of living snake from Virginia. Accession 13695.

Warsaw Salt Company. Three bottles containing samples of salt; from Warsaw, N. Y. Accession 13677.

Washington, D. C.:

Biological Society. Living specimen of turtle; from the District of Columbia. Accession 13074.

Treasury Department:

U. S. Life Saving Service. Thirty pieces of apparatus and four boxes of exhibits, loaned for the International Fisheries Exhibition at London, England, 1883. Accessions 12947, 12948. (See also under name of *Henry E. Nichols.*)

Light-House Board. Twenty models of light-houses, &c., loaned for the International Fisheries Exhibition at London, England, 1883.

War Department:

Medical Department. (See under names of *Drs. R. W. Shufeldt, Henry C. Yarrow*, and *Hospital Steward Charles Ruby.*)

Quartermaster's Department. (See under name of *M. C. Meigs.*)

Engineer Department (See under names of *O. E. Babcock, Peter C. Hains*, and *George M. Wheeler.*)

Signal Service, U. S. A. A collection of twenty-three boxes, three tanks, four kegs, and two bales of general natural history specimens; from the Point Barrow Expedition, Lieut. P. H. Ray, in charge, assisted by Profs. John Murdock and Middleton Smith. (See also under names of *W. B. Hazen, John J. McLean*, and *Charles L. McKay* (deceased).

United States Army. (See under names of *Alfred H. Terry, E. Crawford, Charles Bendire, W. L. Carpenter*, and *Stewart Van Vliet.*)

Navy Department:

Bureau of Medicine and Surgery. (See under name of *Dr. John F. Bransford.*)

Bureau of Navigation, John G. Walker, chief of bureau. Seven packages of general natural history specimens; from Greenland, taken by United States steamer Yantic, Commander Frank Wildes. (See also under names of *H. F. Picking, John K. Winn, William M. Wood, Francis Winslow, Jefferson F. Moser*, and *H. G. Dressel, A. A. Ackerman*, and *Ernest Wilkinson.*)

Bureau of Provisions and Clothing. (See under names of *Samuel W. Very* and *Henry E. Nichols.*)

Bureau of Engineering. (See under names of *George W. Melville, William A. Mintzer* and *Robert E. Peary.*)

Washington, D. C.—Continued.

Interior Department:

Bureau of Ethnology (*J. W. Powell, director*). A very large collection of stone implements, amounting to nearly 2,700 specimens, collected from the mounds of the United States. (See also under names of *James Stevenson, Prof. Cyrus Thomas, Dr. Edward Palmer*, and *W. H. Holmes.*)

Patent Office. The Lewis collection of Washington relics, with many others, which have been for years past exhibited in that building.

Land Office. (See under name of *James Bell.*)

United States Fish Commission (*Prof. Spencer F. Baird, Commissioner*). Packages of general marine and other collections, obtained by the steamers Albatross, Fish Hawk, Lookout, and assistants from along the Atlantic sea-board. (See also under names of *Dr. Tarleton H. Bean, James E. Benedict, John E. Brown, Frank N. Clark, Joseph W. Collins, Vinal N. Edwards, T. B. Ferguson, Richard Rathbun, Silas Stearns, Livingston Stone, James G. Swan*, and *R. S. Tarr.*)

United States Geological Survey (*J. W. Powell in charge*). A large and valuable collection of geological specimens and set of census illustrations. (See also under names of *Profs. F. W. Clarke, W. C. Kerr, R. Pumpelly, Dr. C. A. White*, and *Henry Gannett.*)

Watkins, L. Specimens of Indian relics; from Missouri. Accession 13423.

Watkins, Peter. Box of shell oysters; from Hog Island and Egg Harbor, New Jersey. Accession 12518.

Watkins, Thomas. Specimen of skunk; from Wood's Holl, Mass.; and fossils; from the phosphate beds of South Carolina. Accessions 13555, 13631.

Watkins, W. D. Specimens of Indian pottery, bones, and bantam eggs; from Ohio. Accession 13221.

Watts, W. G. Specimen of moth and larva; from Massachusetts. Accession 13380.

Weakly, B. F. Specimen of Indian implement; from West Virginia. (Purchased.) Accession 13340.

Webster, Moses. Photographs of marble quarries at Vinal Haven, Me. Accession 13521.

Weedon, W. C. Specimen of guinea-pig and white rat, domesticated. Accessions 12953, 12970.

Weeks, Seth. Can containing living salmon fry; from Corry, Pa. Accession 12713.

Werthner, William. Alcoholic specimens of snakes; from Ohio. Accession 13210.

Wheeler, George M., U. S. A. Five boxes containing nearly three hundred specimens of minerals and ores from the surveys west of the 100th meridian. Accessions 13641, 13715.

Whitall, Tatum & Co. Three boxes, three barrels, and one hogshead, containing part of their exhibit illustrative of the manufacture of glass. Accession 12706.

White, Dr. C. A. Two large specimens of oyster shells; from Sheepscot River, Maine. Accession 12558.

Whiting, Frank H. Specimen of spider (*Lycosa carolinensis*); from Connecticut. Accession 13669.

White, George. Four specimens of snails (*Limax* sp.). Accession 13459.

White, George D. Three specimens of ore; from Oregon. Accession 12870.

White, John C. Specimens of sandstone and lignite; from Texas. Accession 13022.

Whitlock, R. B. Samples of ores; from Virginia. Accession 13542.

Wiggins, John B. Specimens of minerals and fossils; also an insect; from New York. Accessions 13228, 13331, 13644.

Wilcox, Crittenden & Co. Model of latest pattern of seine-boat steering oar-lock, with Late's band socket; also stem brace. Accession 12777.

Wilcox, W. A. Specimen of crab (*Lithodes maia*) caught off Half Way Rock, between Boston and Gloucester, Mass. Accession 13175.

Wilkinson, Ernest, U. S. N. A collection of minerals, ores, rocks, and coal; from Colorado. Accessions 13465, 13557.

Williams, Prof. F. S. Collection of insects; from Dakota. Accession 13330.

Williams, Jere. Specimen of ore; from Virginia. Accession 13682.

Wilcox, Joseph. A large and very valuable collection of ores, minerals, &c. (Deposited.) Accessions 13602, 13782.

Williams, J. Frank. Specimen of quartz conglomerate; from Pennsylvania. Accession 13200.

Williams, Miss Nellie. Alcoholic specimen of bat; from Georgetown, D. C. Accession 13422.

Wilson, A. A. Box of quahogs; from Rhode Island. Accession 12503.

Wilson, Capt. Joseph. Specimens of minerals; from Canada. Accession 13581.

Wiltheiss, C. T. Cast of stone pipe, representing an animal; found near Piqua, Ohio. Accession 13735.

Winn, J. K., U. S. N. Two boxes specimens of coral formation; taken from bottom of an old iron buoy and from the chain, about 2 fathoms from the surface of the water in the harbor of Dry Tortugas, Fla. Accession 13095.

Winslow, Francis M., U. S. N. One box of sea-coast oysters; from Virginia. Accession 12789.

Wise, George Young. Specimen of tree gnawed off by beaver, with head, jaws, and teeth of the beaver, and the trap that caught the beaver. Accessions 12879, 13390, 13679.

Wittfeld, William. Box of alcoholic mammals and reptiles; from Florida. Accession 13810.

Wolf, S. Specimen of mineral; from Tennessee. Accession 13155.

Wolle, sr., A. Ten specimens of bird-skins; from Demerara. Accessions 13453, 13590.

Woltz, George. Model of Potomac River shad-boat and specimen of white rabbit in flesh (*Lepus cuniculus*); from Virginia. Accession 12754.

Wonson, Everett P. Five specimens of stuffed fishes and cast of young codfish, caught in Gloucester Harbor, Massachusetts. Accessions 12731, 13582.

Woodman, Ellinwood. Two oak leaves and insect that infests the same; from Kansas. Accession 13458.

Wood, J. W. Specimen of shrew found in the timber lands of Wisconsin. Accession 12857.

Wood, Reuben. Specimen of fishing tackle. Accession 12769.

Wood, W. M., U. S. N. Box of fossil shells; from Chesapeake Bay, and young specimen of fish-hawk. Accessions 13284, 13762.

Wooster, A. F. Specimens of bird-eggs, bat and nest, and two minerals; from Connecticut. Accessions 13276, 13398, 13569.

Wooten, J. M. Three small specimens of pottery and three stone relics; from Alabama. Accession 13295.

Worthen, C. K. Thirty-one specimens of bird-skins; from Illinois. Accessions 12735, 13263, 13750, 13772.

Wright, Lyman E. Specimen of harlequin duck in flesh; from Maine. Accession 13627.

Yarrow, Dr. H. C., U. S. A. Clay vessel; from child's grave in Caldwell County, North Carolina; and two specimens of snakes; from Virginia. Accessions 12772, 13397.

Yarrow, John. Specimen of squirrel (*Sciurus carolinensis*); from the Smithsonian Grounds, Washington, D. C. Accession 13172.

Yeates, W. S. Specimens of chlorite schist, soapstone, and clay; from the District of Columbia. Accessions 13766, 13840.

Young, Brigham. Specimens of plants; from Arizona. Accession 13006.

Younglove, John E. Specimens of blind cray-fishes; from White's Cave, Kentucky; with specimens of Indian and stone relics, fossil corals, pentremites, &c.; from near Bowling Green, Ky. Accessions 13238, 13325.

Zeledon, José C. Three boxes of alcoholic reptiles, mammals, bird-skins, fourteen pieces of pottery, stone implements, skin and skull of sloth, insects, &c.; from Costa Rica. Accessions 13068, 13381,

GENERAL APPENDIX

TO THE

SMITHSONIAN REPORT FOR 1883.

ADVERTISEMENT.

The object of the GENERAL APPENDIX is to furnish summaries of scientific discovery in particular directions; occasional reports of the investigations made by collaborators of the Institution; memoirs of a general character or on special topics, whether original and prepared expressly for the purpose, or selected from foreign journals and proceedings; and briefly to present (as fully as space will permit) such papers not published in the "Smithsonian Contributions" or in the "Miscellaneous Collections" as may be supposed to be of interest or value to the numerous correspondents of the Institution.

RECORD OF SCIENTIFIC PROGRESS FOR 1883.

INTRODUCTION.

While it has been a prominent object of the Board of Regents of the Smithsonian Institution, from a very early date in its history, to enrich the annual report, required of them by law, with scientific memoirs illustrating the more remarkable and important developments in physical and biological discovery, as well as showing the general character of the operations of the Institution, this purpose was not carried out on any very systematic plan until the year 1880. Believing however that an annual report or summary of the recent advances made in the leading departments of scientific inquiry would supply a want very generally felt, and would be favorably received by all those interested in the diffusion of knowledge, the Secretary had prepared for the report of 1880, by competent collaborators, a series of abstracts showing concisely the prominent features of recent scientific progress in astronomy, geology, physics, chemistry, mineralogy, botany, zoölogy, and anthropology.

The same general programme has been followed in the subsequent reports, with the inclusion of geography and meteorology in the list of subjects. The contributors to this record for the present year, and their several departments or topics, remain the same as in the last report.

With every effort to secure prompt attention to all the more important details of such a work, various unexpected delays frequently render it impracticable to obtain all the desired reports in each department within the time prescribed. In such cases it is designed, if possible, to bring up deficiencies and supply them in subsequent reports.

The value of this annual record of progress would be much enhanced by an enlargement of its scope, and the inclusion, not only of such branches as mathematics, physiology, pathology and medicine, microscopy, &c., but also of the more practical topics of agricultural and horticultural economy, engineering, mechanics, and technology in general; but the space required for such larger digest seems scarcely available in the present channel. The scientific *résumé*, which in 1880 occupied 260 pages, in 1881 extended to 330 pages, in 1882 to 400 pages, and has this year reached 426 pages. An efficient condensation of this matter does not seem easily practicable.

It is hardly necessary to remark that in a summary of the annual progress of scientific discovery so condensed as the present, the wants of the specialist in any branch can be but imperfectly supplied; and very many items and details of great value to him must be entirely omitted. While the student in a special field of knowledge may occasionally receive hints that will be found of interest, he will naturally be led to consult for fuller information the original journals and special periodicals from which these brief notices or abstracts have been compiled.

The plan of devoting some 350 or 400 pages of the annual report to such a compilation is not designed to preclude the introduction into the "General Appendix," as heretofore, of special monographs or discussions that may prove interesting to the scientific student.

SPENCER F. BAIRD.

ASTRONOMY.

By Prof. EDWARD S. HOLDEN,

Director of the Washburn Observatory.

The following record of the progress of astronomy during the year 1883 is in continuation of those of previous years, and it is given in essentially the same form. Abstracts of some of the most important papers of the year are arranged under their appropriate heads. To the professional astronomer the record may serve as a convenient collection of reviews and notes. It is, however, primarily intended for the large and increasing class of those who are interested in astronomy but whose acquaintance with it is more general than special. The writer has made free use of reviews and abstracts of astronomical papers which have appeared in the various scientific journals, more especially in *Nature*, *The Observatory*, *Science*, and the *Sidereal Messenger.*

CONSTITUTION OF THE STELLAR SYSTEM.

In a masterly review of Dreyer's recent work on the *constant of precession*, Dr. Schönfeld has sketched the form of a wider investigation into the question of the existence of a stellar system properly so called.

"If we do not start with the assumption that the true motions of the stars completely neutralize each other for some reason or other, in which case they cannot influence the constant of precession, it is hardly possible, in spite of the commonly-asserted irregularity of their lines of motion, to avoid the assumption that these motions bear some relation to that plane in which the greater part of the stars is accumulated. We may here call this plane the Milky Way, though it does not fully coincide with the central line of the visible Milky Way, especially when we take into consideration the accumulation of nebulæ distant from the Milky Way, and perhaps also the possibly somewhat eccentric position of our solar system.

"The relations which these motions bear to the plane may be conceived of in many ways; the most evident, however, is that the motions of individual stars occur in planes whose inclination to the Milky Way is small and in directions accordingly which among themselves are nearly parallel to the Milky Way.

"Without this assumption of 'rotation in the plane of the Milky Way,' as J. Herschel calls it, it is hardly possible to explain the existence of the visible Milky Way itself. It would necessarily disintegrate more and more with the lapse of time, and it would really be purely by accident that we live at a time when this disintegration has not yet been accomplished—an hypothesis which at least calls for many-sided proofs before it can be accepted as plausible.

"If we take now the galactic co-ordinates of a star, namely, radius-vector, galactic longitude, and latitude ($r.\ l.\ b.$), the simplest form we can give to the above assumption is contained in the equations $dr = 0, db = 0, dl =$ constant, which really are expressive of the conditions that all stars are firmly united or interdependent and rotate together, like the atoms of a planet, about an axis perpendicular to the Milky Way through its center of gravity. This to be sure is noticeably untrue for individual stars (for example, our sun), but for an average of many stars the variations of b and r will vanish, which is the case also for small groups of stars, perhaps even if we take our normal numbers from spaces of 100 to 200 square degrees.

"If we take therefore the foregoing equations as expressing approximately the conditions of the problem, and use them as a basis for our investigations, it is easy to determine the relations which precession, proper motion, and the universal rotation of the fixed stars bear to each other.

"Let all the co-ordinates be referred in the usual way to the equator and the vernal equinox, and let

α, δ, ρ represent the heliocentric (and geocentric), R. A., Declination, and distance of a fixed star;

A. D. R. represent the corresponding galactic co-ordinates of the sun;

σ, τ, c represent the co-ordinates of its apex and its angular velocity, the latter seen at a distance, one perpendicular to the line of sight;

$d\alpha, d\delta$ represent the excess of the star's apparent changes of position over the precessions computed with an assumed constant of luni-solar precession;

$d\psi$ represent the required correction of the assumed precession, referred to the same unit of time as $dl, c, d\alpha, d\delta$;

ω represent the corresponding inclination of the (fixed) ecliptic;

Ω, i represent the R. A. of the ascending node of the Milky Way on the equator, and the mutual inclination of the two planes. Neglecting the correction for the planetary constant of precession, which it may be necessary to make, we have

$$d\ \alpha = \cos\ \omega\ d\ \varphi + \cos\ i\ dl + \text{other terms},$$

$$d\ \delta = (\sin\ \omega\ d\ \psi + \cos\ \Omega\ \sin\ i,\ dl)\ \cos\ \alpha + \text{other terms},$$

and in the treatment of the equations only such stars will be used as have on an average the same distance ρ, that is, for instance, stars of the same magnitude; similar to the attempt made at a previous time in a somewhat different manner by Brünnow (*Sphær. Astr.*, 4 Aufl. p. 252).

"If there are within the limits of the stellar system systematic differences in dl, the latter is certainly not a function of ρ as well as of r; the error resulting from this in the foregoing equations grows smaller, however, as r and ρ grow larger in comparison with R, and therefore in this respect also it is an advantage to determine the constant of precession from faint stars. Moreover it is plain to see, if the supposed rotation of stars in the plane of the Milky Way actually takes place, that neither the precession nor the proper motion of the sun can be determined independently of other assumptions or conditions from the foregoing equations. The equations permit three combinations only of the quantities $d\,\psi$, di, Ω, and i, and instead of obtaining from them the three components of the sun's motion, $c \cos \tau \cos \sigma$, $c \cos \tau \sin \sigma$, $c \sin \tau$, we obtain only the excess of these components over the similar ones obtained from the universal rotation.*

"If dl, then, is at all appreciable, we are possibly still far removed from a knowledge of the real apex of the solar motion (especially if, as is credible for many reasons, R is not small as compared with the average ρ.) What has been considered in the treatment of the problem thus far as the components of precession m and n, is in reality something else, namely, respectively,

$$f = m + \cos i\, dl \text{ and}$$
$$g = n + \cos \Omega \sin i\, dl.$$

and aside from this the third component of rotation $h = \sin \Omega \sin i\, dl$ can be determined. The general precession cannot then be kept pure, but is mixed with that component of dl which is parallel to the ecliptic.

"As Nyrén and Dreyer have restricted themselves to the determination of m, they have from the first neglected the investigation of a possible appreciable value of dl. This possibility can only be substantiated by determining g and h with f, which, in the equation for $d\,\alpha$, cannot on account of the quantity tang. δ, be obtained from the right ascensions of equatorial stars, but on the other hand only from their declinations.

"If dl is appreciable, a value of h must result which is not zero, unless $\sin \Omega$ or $\sin i$ should equal zero. But if this is the case, the coefficients of dl in f and g cannot, at the same time be zero, and the influence of dl will be shown in this, that the constant of precession obtained from f will not coincide with that which may be derived from g. It is only in case the plane of rotation of the fixed stars coincides with the ecliptic, that the rotation would unite entirely and without contradiction with the precession, and would consequently not be recognized as a

* The determination of motion in the line of sight by spectrum analysis gives no new combinations of the unknown quantities either. If we write the last three lines of the equation for d δ — F $\cos \alpha \sin \delta$ + G $\sin \alpha \sin \delta$ — H $\cos \delta$, we obtain the following: $-\frac{d\rho}{\rho} = F \cos \alpha \cos \delta + G \sin \alpha \cos \delta + H \sin \delta$.

rotation. This case is entirely improbable, however, from the position of the visible Milky Way and it is much more to be feared that h will remain appreciable. For if we put accordingly $\Omega = 280° \; i = 62\frac{1}{2}°$ we have (ψ = lunar-solar— and λ = planetary precession):

$$f = 0.92\,\psi + 0.46\,dl - \lambda = (\psi + \tfrac{1}{2}\,dl)\cos\omega - \lambda$$
$$g = 0.40\,\psi + 0.15\,dl \quad = (\psi + \tfrac{1}{2}\,dl)\sin\omega - 0.05\,dl$$
$$h = \qquad - 0.87\,dl$$

and we obtain thereby from f and g, with only a very unimportant difference, the precession with an error of $\frac{1}{2}\,dl$ merely. A value of h exceeding 4″ or 5″ a century is moreover exceedingly improbable for those stars used by Bessel and Struve in the determination of precession, and the limits could be yet more closely drawn if the separation of the unknown quantities had not been made much more difficult by those quantities depending on the motions of the sun, by the systematic errors of the catalogues, and by the unfavorable distribution of the stars (a lack of such having tolerably large negative tang. δ and sin δ).

"A secular rotation amounting to several seconds seems, aside from the smaller influence of the terms marked F, G, H, to be more readily derived from the fainter stars than from the brighter ones (if for no other reason than) because they are available in very large numbers.

"The above equations, however, will not serve to completely separate the quantities ψ and dl unless at least one of the quantities ω and i is known from another source. For this purpose star-gauges, and in fact all more thorough and fundamental astronomical work would, in the present state of our knowledge, be of the greatest value. This method of determining *both* quantities affords us in the determination of ψ and dl from f, g, and h a check which is fully as valuable as the independent determination of g and h from both the co ordinates of stars."

The reviewer does not attempt to carry out in detail all these investigations. He is convinced, however, that the hypotheses which must necessarily be assumed in doing this are not of so indefinite and arbitrary a character, but that the treatment of the precession problem in the manner herein sketched will result in a closer approach to the true method than do those which have been hereto employed.

Even the possible proof that the component of rotation h does not exist even down to the 8^m and 9^m would be of great value. The practical difficulties appear greater, perhaps, than they really are; and will be substantially diminished after the completion of the zone work of the *Astronomische Gesellschaft*, as Dr. Dreyer has particularly pointed out.

*Untersuchungen über die Präcessionsconstante auf Grund der Sterncataloge von Lalande und Schjellerup. Inaugural-Dissertation von F. Bolte.**—In the preceding abstract the views of Professor Schönfeld as to the relations between the precession, the motion of the solar

* Bonn, 1883 (28 pp. 8vo).

system, and a systematic rotation of the fixed stars supposed to take place in a direction parallel to the plane of the Milky Way are given. In the present paper the author endeavors by using Professor Schönfeld's formulæ to determine the amount of the *constant of precession*, and to find whether this hypothetical rotation exists or not. He uses the declinations of the stars common to Lalande and Schjellerup, having first reduced Lalande's declinations anew by von Asten's tables. The comparison showed not only a number of deviations arising from proper motion, but, in a number of cases, a reference to other star catalogues showed that Lalande had erred either 10″.0 or 15″.0. A complete list is given of all these errors, as also of the proper motion detected. The remainder of the investigation is carried on in three different ways, first, making use of all stars which showed large differences (Schj.–Lal.) which could not be clearly explained; next, excluding all these, and finally leaving out all stars possessing a proper motion of 0″.2 or more in a great circle, while in the two first calculations only stars with a proper motion in declination larger than 0″.33 were excluded. The stars were furthermore divided into three groups, the first containing stars fainter than 8.3 mag.; the second, stars from 7.5 to 8.2 mag.; the third, from 5.5 to 7.4 mag.; all the magnitudes being taken from Argelander's and Schönfeld's *Durchmusterungen*. For every hour the mean value of $d\delta$ was taken for each group of magnitudes, and 24 equations of condition were formed of the form $x \cos \alpha + y \sin \alpha + z = d\delta$, where x, y, and z represent the coefficients in Schönfeld's formula for $d\delta$, the third and fourth term being $= 0$, on account of the stars being grouped round the Equator. The three groups did not show any systematic difference in the values of x, y, z, depending on magnitude. They all give the same sign for the change of galactocentric longitude ($d\,l$) of the star, but the numerical values of this change are so small that the agreement of the signs probably only arises from some constant error. The three calculations give corrections to the lunisolar precession ($d\,\psi$), and adopting Peters's values of the planetary precession, etc., the general precession for the year 1800 is found equal to 50″.2197, 50″.2183, and 50″.2234. The author next makes use of the 24 values of $\triangle\,\alpha$ given in *Copernicus*, vol. II, pp. 152–153, first having reduced them to Newcomb's system. They furnish 24 equations of condition, $d\,\alpha = u + v \sin \alpha + w \cos \alpha$, where u, v, and w likewise represent the coefficients in Schönfeld's formula for $d\,\alpha$. The combination of u with x and y gives, however, values of $d\,\psi$ equal to about + 0″.6, while the declinations alone gave about − 0″.8. This discrepancy may either arise from the general uncertainty of the problem, or from the supposition that the plane of rotation of the fixed stars is parallel to that of the Milky Way, but in the latter case we have not data enough to separate the precession from the rotation as long as not either the node or the inclination of the plane of rotation is known through other means.

Combining R. A. and Decl. the three calculations give for the general precession for 1880, 50''.2407, 50''.2417, and 50''.2426.

Dr. Bolte's paper is chiefly interesting as a numerical application of Schönfeld's formulæ, as the materials at present available are not extensive enough to enable us to prove clearly whether systematic motions in the plane of the Galaxy exist or not. As to the values produced of the *constant of precession*, it is significant that the declinations when used by themselves give a value differing much more from the generally adopted value than the right ascensions do. Possibly this may to some extent be explained by errors in Piazzi's or Lalande's declinations.—(*Copernicus*, Nos. 29 and 30, 1883.)

Star-gauges.—In the *Philosophical Transactions* for 1817 (p. 325), Sir William Herschel says, that, "beside the 683 star-gauges published in the *Philosophical Transactions* for 1785 (p. 221), above 400 more have been taken in various parts of the heavens."

These 400 unpublished gauges have lately been extracted from the original observing-books preserved at the Herschel family residence at Collingwood, through the kindness of Sir William Herschel, the present baronet, and of his brother, Major John Herschel; and the manuscript has been presented to the Washburn Observatory, and will be printed in its *Publications*, vol. II.

The original records are in the handwriting of Miss Caroline Herschel, and by her faithful care every detail necessary to their accurate reduction is preserved. It will be observed that only two-thirds of the star-gauges of Herschel have heretofore been known. The new acquisition will be welcomed by those interested in this class of observations. They are a new gift from an inexhaustible mine. In this connection it may be permitted to express the hope that the Bonn Observatory will print the MS. tables prepared by Argelander, which give the counts of stars in each square degree of the *Durchmusterung*.

The systematic motion of the fixed stars.—Freyoid Rancken has published, in the *Ast. Nach.*, No. 2482, a *résumé* of an investigation on the proper motion of the fixed stars, which he has undertaken by the advice of Dr. Gyldén.

The stars employed were, 1st, Argelander's 250 proper motion stars, and 2d, 80 stars whose proper motions have been investigated by Dr. Leo de Ball.

From the stars of these two classes (with the exception of *o* Ceti, and 1830 Groombridge) the magnitude and direction of the solar motion have been determined by formulæ which involve the parallax of each star. The assumptions as to this parallax are derived from the hypothesis of Gyldén, given in *V. J. S. der Astr. Gesellsch.*, vol. XII. Argelander's proper motions in R. A. give the position of the solar apex in R. A. as $A = 284° 58'.0$. Argelander's stars in Dec. give $A = 284° 37'.8$, D = +37° 27′.1, and μ = 10.85 radii of the earth's orbit. μ is the linear motion of the solar system.

Dr. Ball's 80 southern proper motions give from the R. A., A = 273° 46′.6; and from the Declinations, A = 244° 4′.1, D = +170 27′.1 and μ = 4.59 radii. These results differ so much from each other, that the data have been combined anew by introducing the parallax of each star in such a way as to diminish the effect of proper motions much larger than the average. With the new equations the results are from Argelander in R. A., A = 275° 15′.2, in Decl. A = 288° 31′.3, D = +41° 2′.4, and μ = 10.61 radii. Ball's 80 stars give in R. A., A = 281° 2′.8, and in Decl. A = 240° 24′.5, D = +11° 54′.3, and μ = 7.83 radii. This transformation, then, has produced only a greater accordance in the values of the linear motion of the system. Both solutions show that the solar motion alone is not sufficient to account for the proper motions of the stars employed.

The next step in the process is to see if there is not some further systematic motion of the stars which will account for their proper motions.

The first trial is to see if a common motion of all the stars parallel to the plane of the Milky Way will suffice.

The position and motion of each star have been referred to that great circle which best represents the Milky Way. Those stars between + 30° and − 30° galactic latitude whose proper motions are less than 0″.25 have been separately considered. They are 106 in number. From their proper motions in R. A. it follows A = 294° 28′.7. From those in Decl. A = 275° 47′.9, D = + 31° 52′.1, and μ = 9.79 radii of the earth's orbit.

If dw is the systematic motion of the 106 stars paralled to the plane of the Milky Way, there results from the proper motions in R. A., dw = + 0.05645 ± 0.01288, and from those in Decl., dw = + 0·02385 ± 0.01464. These last values of dw have a sufficient agreement to give a great interest to this research and to those which Dr. Rancken intends to carry out using a greater number of stars.

FIXED STARS.

The constant of aberration.—M. Magnus Nyrén has published, in the Memoirs of the St. Petersburg Academy, a valuable paper on the determination of this important astronomical constant. Various determinations of the value of the constant of aberration made by different observers, with different instruments and by different methods, have gradually led astronomers to consider that there is a probobility, or, at all events, a possibility, that W. Struve's value, notwithstanding the small probable error found for it, and notwithstanding the great care and skill bestowed on the observations and on their reduction, may be several hundredths of a second too small. M. Nyrén points out two possible sources of error, viz, the assumed regularity of rate of the clock used for observing the transits and the assumed constancy of the azimuth of the hoizontal axis of the instrument in the interval between the transits of the same star east and west. Struve himself discussed these sources of error some years after the publication of his memoir, and was induced to alter his definitive value of the constant aberration to 20″.463 with probable error of ± 0″.017. (It is strange that Struve's first value, 20″.445 ± 0″.011, has universally been adopted, instead of this corrected value.) M. Nyrén also discusses an objection to the methods which have been adopted at Pulkowa for finding the aberration, raised by M. Yvon Villarceau on the grounds that they take no account of the absolute motion of the translation of the solar system, pointing out that on any reasonable hypothesis as to the velocity of this motion of translation the effect on the value of the constant of aberration would be probably quite inappreciable in the present state of the art of astronomical observation.

The observations which form the materials for the determination in the memoir under consideration were made by M. Nyrén with the same instrument as that used by Struve, the transit in the prime vertical, and reduced and discussed generally in the same manner. The clock used is an excellent one by Dent, and from the attention which has been given to the matter, there is hardly a possibility of error creeping into the result from any error in its assumed rate. With regard to the azimuth of the horizontal axis of the instrument, two azimuth marks have been set up and frequent determinations of this element made, and every care taken to insure accuracy, so that the present series of observations is probably free from any error arising from this source. The number of stars observed is 24 (comparing favorably with Struve's 7), very advantageously situated, having regard to the object in view, and the observations extended from December, 1879, to January, 1882, thus embracing two maxima and two minima of the aberration for each star. The final value found for the constant of aberration is

$$20''.517 + 0.20\pi \pm 0''.014$$

where π is the mean parallax. This latter quantity comes out positive for 10 stars and negative for 14; its mean value is

$$+0''.002 \pm 0.026$$

so that its effect on the deduced constant is quite insignificant. M. Nyrén next proceeds to discuss certain observations of α Ursæ Minoris, δ Ursæ Minoris, and Cephei 51 Hev., made by M. Wagner during the years 1861–'72. These are observations of transits taken—some by the eye-and-ear method and some by registration on a chronograph—and their discussion gives 20″.483 ± 0″.012 for the value of the constant of aberration.

Bringing together, then, the different values of this constant which have been found at Pulkowa from time to time, we have:

1. From declination observations of α Ursæ Minoris, $20''.495 \pm 0''.013$;
2. From R. A. observations of polar stars, $20''.491 \pm 0''.009$;
3. From observations in the prime vertical, $20''.490 \pm 0''.011$;

and, giving the same weight to these three mean values, the definitive value of the constant of aberration is $20''.492 \pm 0''.006$. This must be an extremely accurate value of this important constant, and will probably have to be considered final until it can be corrected by an equally accurate and extensive series of determinations made in the southern hemisphere. Such a determination is at the present time a desideratum in astronomy. In combination with Cornu's determination of the velocity of light, the above gives $8''.777$ for the solar parallax, whilst, if Michelson's determination be adopted, it gives $8''.791$; a striking confirmation of the value of the solar parallax found by Mr. Gill from his heliometer observation of Mars, made at Ascension, in 1877.—(A. M. Downing, in *The Observatory*, December, 1883.)

Professor Peters, of Hamilton College, who is abroad investigating the star catalogue of Ptolemy with a view to an accurate edition, has been fortunate in finding, both at Venice and at Florence, several MSS. (Greek, Arabic, and Latin) of the "Almagest," hitherto not utilized by modern scholars. He is now engaged in a prolonged research in the Vatican library.

The Fundamental Catalogue of the Berliner Jahrbuch.—A very important comparison by Dr. Auwers, of the Fundamental Catalogue of the *Berliner Jahrbuch* with those of the *Nautical Almanac*, the *Connaissance des Temps*, and the *American Ephemeris* appears as a supplement to the *Jahrbuch* for 1884, and the following abstract of it is given. The year 1883 is the first in which such a comparison is possible.

The *Berliner Jahrbuch* contains at present, and will contain for the future, 450 stars whose apparent places are given, and 172 stars for which only mean places are printed, *i. e.*, 622 in all. The places of these stars, both in R. A. and Dec., depend strictly on the system of the Fundamental Catalogue of the *Astronomische Gesellschaft* (publ. xiv). They lie between the north pole and $-31^\circ.3$ declination.

The *American Ephemeris* contains the mean places of 383 stars, for 208 of which ephemerides are given; 44 of these stars lie south of -31°. The *Nautical Almanac* has 197 stars (15 south of -32°), and ephemerides are given for all. The *Connaissance des Temps* has 310 stars between the north pole and -70°, and gives an ephemeris for each.

Dr. Auwers's account of the sources from which the star places of the various almanacs are taken, we omit. It shows how various these are. Four hundred and fifty stars have ephemerides in the *Jahrbuch;* 149 stars (mostly southern) which have ephemerides in the three other almanacs are not contained in the *Jahrbuch.*

A table is given in Dr. Auwers's paper, showing the comparison between each star of each almanac and the *Jahrbuch*. From this table the elements by which the catalogue of each almanac can be reduced to the system of the *Jahrbuch* are deduced. A subsequent table gives the two reductions which must be added to each almanac R. A., and the two reductions which must be added to each almanac Dec., in order to reduce to the system of the *Jahrbuch*.

The catalogue of each almanac, after the application of the systematic reductions from this table, is then compared with the Fundamental Catalogue. For the *Nautical Almanac* the mean difference in declination is 0″.395; in R. A. (from 134 stars), $0^s.0332$. Of the 168 stars common to both almanacs, there are 27 whose R. A. differs more than $0^s.067$, and 8 whose declinations differ by more than 1″. These differences are, in the main, errors of the *Nautical Almanac*, and are largely due to the erroneous proper motions adopted in the Greenwich catalogues.

For the *Connaissance des Temps*, the table shows large systematic errors. After these have been eliminated, the comparison gives for 229 stars, common to the *Connaissance des Temps* and the *Berliner Jahrbuch*, a mean difference of 0″.373 in declination, and a mean difference of $0^s.0282$ (from 162 stars) in R. A. The errors here again are largely due to erroneous proper motions. The correspondence of the reduced positions of the *American Ephemeris* with those of the *Jahrbuch* varies according as one or another basis of comparison is chosen. A complete comparison can only be made for those stars for which ephemerides are given, since the newer stars have their positions derived from several sources, not comparable among themselves.

The declinations of the *American Ephemeris* and those of the *Jahrbuch* agree excellently for those stars which have been investigated by Boss. The mean difference (162 stars) is 0″.177. The other 111 stars do not agree so well, there being 12 differences between 0″.5 and 1″. The stars north of 64° depend upon Gould's R. A.; and, of the 36 stars common to both almanacs, 15 differ by more than $0^s.15$. Of the remaining 126 stars whose ephemerides are given, 8 have differences as great as $0^s.067$. The mean difference for 100 stars between +40° and −20° is $0^s.0127$. For 111 stars without ephemerides, there are seven cases where the difference is more than $0^s.067$.

For the stars south of −32° the *Nautical Almanac* will give the best positions, on account of its data being derived from the most recent catalogues.

A comparison of the system of the *Jahrbuch* 1861–'82 with the new system, and a general table for the reduction of the data of any almanac to the *Berliner Jahrbuch* system, concludes this very important paper. It appears to be highly desirable, in the interests of uniformity, that that the admirable star list of the *Berliner Jahrbuch* be adopted as the standard system, for all *differential* observations at least. The position of every star to the 9th magnitude, inclusive, from the pole to −23°, will in a few years be determined on this system; and, except for weighty and special reasons, it would seem unwise to choose another system for such observations. This system will also be adopted as fundamental by most of the observatories of Europe and by many elsewhere, and the perpetual revision of the system is provided for by the observatories at Bonn, Pulkova, and Strassburg, and by the discussion which these observations and others will receive at the hands of a committee of the Astron. Gesellschaft. For special purposes a selection may be made from the larger list. Professor Hall has suggested that this selection be made by authority, and separately printed.—(*Science*, November 2, 1882.)

New reduction of Lacaille's observations.—A paper by Dr. Powalky is printed as Appendix 21 to the Report of the United States Coast and Geodetic Survey for 1882 (printed 1883), "on a new reduction of Lacaille's observations made at the Cape of Good Hope and at Paris between 1749 and 1756, and given in his *Astronomiæ Fundamenta*, together with a comparison of the results with the Bradley-Bessel *Fundamenta;* and also a catalogue of the places of 150 stars south of declination —30° for the epochs 1750 and 1830."

The principal result of Dr. Powalky's careful reduction is the catalogue of 150 stars south of —30°, which were repeatedly observed with the six-foot sector and the sextant.

It appears that Lacaille's declinations are about of the same precision as Bradley's; the right ascensions are somewhat less precise. This catalogue of Dr. Powalky's must serve as a basis for researches on proper motions of southern stars, and a simple reduction of Stone 1880 to 1830, would determine quite a number with much accuracy.

STAR CATALOGUES.

The Glasgow Catalogue.—Professor Grant, of Glasgow, speaks of the Glasgow Star Catalogue as if it were soon to be printed. It contains 6,415 stars, of which some 5,000 were selected from Weisse's Bessel I. It appears that it must cover part of the field of Schjellerup's 10,000 stars. In the course of his reductions Professor Grant has discovered 43 stars with proper motions. A list of these is given in *Mon. Not. R. A. S.*, January, 1883. Seven of these are noted in Bonn Observations, vol. VII. None of the others seem to be noted in Schjellerup, of whose work Professor Grant, apparently, has made no use in the paper cited.

The Paris General Catalogue of Stars.—In the last annual report issued by Admiral Mouchez we find particulars of the progress of formation of this extensive and important catalogue. It is intended to contain all the stars observed at Paris during the forty-five years, 1837 to 1881 inclusive, about 40,000, but it is mainly the result of the revision of Lalande's stars in the *Histoire Céleste;* indeed, for several years past, the meridian instruments have been almost wholly occupied upon this work, and upwards of 27,000 observations were made during 1882, the year to which the report refers. The entire number of observations upon which the Paris General Catalogue will be founded is about 350,000. The positions are referred to three principal epochs: 1845.0 for the years 1837–'53; 1860.0 for the years 1854–'67, and 1875.0 for the years 1868–82. A specimen of the form in which it is intended to print the catalogue is appended to the report. The right ascensions and declinations are given for each principal epoch, with the number and mean year of the observations. The precessions are reckoned from the year 1875, with the term depending upon the square of the time. The magnitudes and the differences from the positions of the *Histoire Céleste* are annexed, and where a star has not been observed by Lalande a synonym in some other catalogue is given. In the first column we have the ordinal number, and in the second the star's number in the reduced catalogue of the *Histoire Céleste*. It is mentioned in the report that M. Bossert had undertaken a new determination of the places of the stars in that work, making use of the reduction tables of the late Dr. von Asten, which are more exact than the tables of Hansen and Nissen, employed for the catalogue published in 1847. M. Bossert has already effected the reduction of 2,300 stars, a voluntary labor which has occupied his leisure hours. It would add to the value of the columns, showing the differences between the new Paris positions and those of Lalande, if the comparisons could be made with places resulting from the application of von Asten's tables, though it might be necessary to supplement M. Bossert's laudable efforts. In the last Greenwich Catalogue (1872) the precessions are given to four places of decimals in right ascension (time), and to three places in north polar distance; the Paris Catalogue gives these quantities with a figure less, which we are inclined to regard as a retrograde step.

This General Catalogue of the Observatory of Paris is to comprise two parts, which will be published simultaneously; the first part forming the catalogue proper, and the second containing details of the observations upon which the mean positions are founded. Each part will be composed of four volumes; the first volume of each is intended to appear during the year 1884.—(*Nature*, June 21, 1883.)

The revision of Bessel's Zones.—From a review by Dr. Schönfeld of vol. 37 (part I) of the Königsberg Observations (published in 1882 by Dr. Luther), the following abstract is made: It appears that it was Bessel's intention to prepare a special volume on the Königsberg Zone Observations (—15° to + 45°). This he was never able to carry out, but his introductions and remarks on the Berlin Star Charts, and the paper of Winnecke (*Ast. Nach.*, 1168), having showed the importance of a new reduction, the Berlin Academy undertook the expense connected with the plan, and Dr. Luther and Dr. Ruppel of the Königsberg Observatory commenced the work, the first part of which is now printed.

Pages 1–181 of the work contain a list of about 1,300 zone stars in which some correction has seemed to be needed. The positions depend on an entirely new reduction quite independent of Bessel's. The catalogue is in the zone form, and apparently the zero points of the zones are to be made to depend on new observations at Königsberg.

Catalogue of Stars occurring in the Astr. Nach.—Dr. N. M. Kam, at one time assistant at the Leyden Observatory, has formed a catalogue of all the comparison stars which are contained in the first 66 volumes of the *Astronomische Nachrichten.*

It consists of three parts. Part I gives the mean places for 1855 of all stars for which complete observations are published (4,890 numbers). Part II gives places which depend on independent meridian observations combined with places from catalogues (240 numbers). Part III contains stars observed in one co-ordinate only. Accurate precessions, with secular variations, epoch of observation, and observer, are also given. It appears from *A. N.* No. 2548 that the MS. is deposited at the Leyden Observatory.

Resultados del Observatorio Nacional Argentino en Córdoba, B. A. Gould. vol. II, *Observaciones del Año* 1872 (Buenos Aires, 1882, lxxviii, and 296 pp. 4to).—The greater part of this splendid volume is taken up by the first installment of the zone observations which were commenced at Cordoba on September 9, 1872, and closed on August 9, 1875, during which time about 105,000 single observations were made. Of these the present volume contains about 13,000. The zones comprise the part of the heavens between 23° and 80° south declination, and as a security against constant errors the plan included the formation of a more accurate catalogue, containing a number of stars from each zone observed three or four times each with all possible care. The meridian circle was constructed by Repsold; it has a telescope of 122^{mm}, and a circle of 716^{mm} diameter, graduated to 4′. All the constants of the instrument have been investigated, and the results are all given in the introduction. The right ascensions of all the stars observed at Córdoba depend upon those of the United States Coast Survey Catalogue of Fundamental Stars (2d ed., 1866), with a few slight modifications; the declinations are deduced from nadir observations, the latitude being assumed equal to —31° 25′ 15″.0. The zones were 2° in width as far as 47° declination, thence increasing gradually with the declination; they were generally one hundred minutes long. The transits were always observed by Dr. Gould, generally over three wires, and were registered on a chronograph, while an assistant read off one microscope, which was compared with the other three at the beginning and end of the zone. Four hundred and ten catalogue and time stars were observed in 1872, and the separate and mean results for 1875.0 are given. To this epoch the zone stars are also reduced, and as there is an index to the zones observed in 1872 at the end of the volume it is very simple to find any star required.—(*Copernicus*, February, 1883.)

Uranometria Argentina.—The following alphabetical index to the constellations will, I am sure, be found convenient by all who use this uranometry frequently:

Constellation.	Page.	Constellation.	Page.	Constellation.	Page.
Antlia	187	Equuleus	232	Phœnix	157
Apus	134	Eridanus	159	Pictor	149
Aquarius	205	Fornax	186	Pisces	227
Aquila	220	Grus	163	Piscis Austrinus	189
Ara	147	Hercules	233	Puppis	170
Bootes	234	Horologium	148	Pyxis	190
Cælum	174	Hydra	191	Reticulum	149
Cancer	233	Hydrus	133	Sagittarius	178
Canis Major	196	Indus	137	Scorpius	175
Canis Minor	231	Leo	229	Sculptor	184
Capricornus	202	Lepus	204	Scutum	219
Carina	140	Libra	201	Serpens	217
Centaurus	150	Lupus	168	Sextans	226
Cetus	209	Mensa	132	Taurus	230
Chamæleon	134	Microscopium	182	Telescopium	162
Circinus	145	Monoceros	224	Triangulum Australe	145
Columba	183	Musca	144	Tucana	138
Corona Austrina	178	Norma	156	Vela	165
Corvus	213	Octans	131	Virgo	214
Crater	213	Ophiuchus	198	Volans	139
Crux	155	Orion	222		
Delphinus	231	Pavo	135		
Dorado	146	Pegasus	232		

Zone Observations at the Observatory of Santiago de Chile.—From 1855 to 1860 Moesta observed zones between —40° 30′ and —46°, making 10,200 observations. These were ready for printing in 1866. Other zone observations appear to have been made in 1861 and 1862. Both series were to be printed at the expense of the Government, according to a note in the *V. J. S. der Ast. Gesell.* 1866, p. 22, but it is believed these never were printed. The ground is now completely covered by the catalogue of Stone (1880) and the great catalogue and zones of Gould.

Resultate aus den in Pulkowa angestellten Vergleichungen von Procyon mit benachbarten Sternen. Von Ludwig Struve, St. Petersburg, 1883, 48 pp. 4to (*Mém. de l'Acad. Imp. des sciences*, VII. Série).—In 1873 Auwers showed that all the measures of Procyon from neighboring telescopic stars made up to that date agreed well with his circular elements deduced from meridian observations. Since then Procyon has been regularly observed in Pulkowa, and M. L. Struve has now utilized the observations for a new determination of the parallax and orbit. In 1852 M. Wagner commenced with the large transit instrument to observe the differences of R. A. between Proycon and four stars fairly symmetrically situated—

d 8.7 mag. $P - d = +1^m\ 54^s.8\ +3'\ 26''$

b .9 mag. $P - b = +0^m\ 24^s.5\ -1'\ 30''$

c .9 mag. $P - c = -0^m\ 22^s.2\ -0'\ 44''$

a 7.2 and 7.5 mag. $P - a = -0^m\ 42^s.6\ +1'\ 45''$

The star a is the double star Σ 1126, the center being observed (the distance is $1''.3$). The observations were reduced to 1867.0, the mean proper motion of Procyon being taken from Auwers' Fundamental Catalogue.

The results were—

From $P—d$:	$\pi = +0''.390 \pm 0''.055$ $\delta a = 1''.020 \pm 0''.140$
From $P—b$:	$\pi = +0''.327 \pm 0''.073$ $\delta a = 1''.101 \pm 0''.250$
From $P—c$:	$\pi = +0''.307 \pm 0''.071$ $\delta a = 1''.007 \pm 0''.489$
From $P—a$:	$\pi = +0''.383 \pm 0''.055$ $\delta a = 0''.444 \pm 0.''122$

where δa is the correction to the adopted semi-diameter of the orbit, $0''.9805$. These results were found by comparing each observation of Procyon with the single observations of all the comparison stars taken on the same day, so that the four results are not independent of each other. The author next treats the observations from 1863–68, which had been specially intended for a determination of the parallax, by taking a mean of the comparison stars observed on one day and forming the Δa between this mean and Procyon. In this way the relative parallax of Procyon was found $= +0''.299 \pm 0''.038$. The star a is Bradley 1107 and has been very frequently observed on the meridian. From all available observations the proper motion was found $= -0^s.00255 \pm 0^s.00030$, and when this was inserted in the equations for π and δa from $P—a$, π was found $= +0''.398 \pm 0''.061$ and $\delta a = +0''.050 + 0^s.100$, which results agree much better than with Auwers'.

Since 1851 Otto Struve has observed the differences of R. A. between Procyon and the stars b and c, but the observations turn out to be far less accurate than might be expected, so that the instrument cannot have been firmly fixed in R. A. The observations of difference of declination from the same stars were specially intended to determine the irregularity of the proper motion. Those from 1851–'73 were compared by Auwers with his circular elements and found to be very much better represented under the supposition of irregular than of uniform proper motion. The author shows that the entire series (1851–'82) neither agrees with a uniform proper motion nor with Auwers' orbit. The latter certainly gives smaller residuals, but they clearly indicate corrections to the elements. As Procyon has only described about three-fourths of a revolution since 1851, Auwers' period had to be adopted. The following orbit represents the observations well—

$$a = +0''.6980 \pm 0''.0354$$
$$T = 1794.966 \pm 0^j.440$$
$$n = 9^\circ.02993 \pm 0^\circ 08072 \text{ (Auwers).}$$

The epoch agrees well with that found by Auwers, but the semidiameter is much smaller than Auwers' value, the difference being seven times greater than the probable error of either result. One of the two series of observations employed must therefore be affected by systematic errors, and it is evident that this is far more likely to be the case with meridian observations than with the micrometer measures. The value of the semi-axis in the direction of the declination circle, found by M. Struve, satisfies all the observations used by Auwers within the limits of errors of observation, while on the other hand the Pulkowa micrometer measures clearly indicate a correction to Auwers' value. As M. Wagner's observations do not prove the necessity of altering the adopted value of the semi-axis in the direction of the parallel, we are led to the conclusion that the apparent orbit of Procyon is an ellipse, the semi-axis major of which, parallel to the equator, is 0″ 979, while the semi-axis minor is 0″698. The real orbit must therefore be a circle, perpendicular to the declination plane and forming an angle of 45½° with the line of sight.—(*Copernicus*, November 31, 1883.)

Spectroscopic survey of the northern heavens.—Such a survey has been begun at the Astrophysical Observatory at Potsdam, the first thoroughly systematic work of the kind since Secchi, and after him D'Arrest, spectroscopically examined a large number of fixed stars. Professor Vogel intends to prepare a complete spectroscopic star catalogue, and a good portion of the work has already been accomplished. To prepare such a catalogue, says Vogel, is a duty which the present generation owes to posterity. The changes taking place in the stars are of especial interest to us and are of importance to science; and although it may be conjectured that changes in the spectra will show themselves soonest in those stars which have proceeded farther in their development, that is, in the red stars, yet this cannot be positively affirmed *à priori*. Equally with those wonderful spectra of the red stars, which so enchant the eye of the observer, will changes take place in the course of time in the simple spectra of the white and yellow stars, so that investigations of as large a number of star-spectra as possible, without limiting them to particular classes of stars, are absolutely necessary for future researches.

Dr. Dunér, in Lund, has contemporaneously begun, on the same plan, the observation of stars round the North Pole, so that the work is begun on two sides.

Professor Vogel has published part of his investigations—the zone between —1° and +20° declination; the second part, from +20° to +40°, will quickly follow. The stars have been completely surveyed down to the magnitude 7½, and a large number of smaller ones were examined along with them; altogether they number nearly 12,000, and on an average 3 stars were found in a field of view 19′ in diameter, which were examined together.

Vogel has, as is known, arranged all the stars spectroscopically in three chief divisions, of which the first is again subdivided into three and the others into two subdivisions. Of these, no stars belonging to Class I*c* (in which the hydrogen line and the line *D* appear bright) nor to II*b* (in which, besides dark lines and bands, several bright lines also appear) are found in the published zone.

Of the 4051 stars particularized in the catalogue, there are 349 whose spectrum could not be surely made out. The remainder are divided among Vogel's classes as follows; Class I*a*, 2155, Class I*b*, 10, Class II*a*, 1240, Class III*a*, 288, Class III*b*, 9 stars.

Among the brighter stars with very beautifully distinct spectra that therefore can be seen with weaker powers may be mentioned—

In Class I*a*. γ Geminorum, α Leonis, β Leonis, α Ophiuchi, α Aquilæ, α Pegasi.

In Class II*a*. α Tauri, α Bootis, α Serpentis, β Ophiuchi, α Ophiuchi, γ Aquilæ, ε Pegasi.

In Class III*a*. α Ceti, α Orionis, δ Virginis, α Herculis.—(*The Observatory*, November, 1883.)

Photometry of stars.—At the meeting of the Royal Astronomical Society, May 11, 1883, Prof. C. Pritchard, of Oxford, gave an account of his recent expedition to Cairo, and of the work on which he has for the last two years been engaged, viz, the measurement of the magnitude of the stars visible to the naked eye from the pole to the equator, including at present all those brighter than the fifth magnitude. This work is now complete. He found that at Oxford, Laplace's law of alteration of a star's light as measured in magnitude—according to the secant of the star's zenith distance—did not hold good for zenith distances exceeding 65°, and that for stars at lower altitudes the alterations in apparent magnitude were conflicting and not satisfactory. For the purpose of accurately investigating the effect of atmospheric extinction of light under better circumstances, he chose the climate of Upper Egypt, where the atmosphere is uniform and stable, as the proper locality for repeating the Oxford observations, and rendering the research complete. A duplicate set of instruments was left at Oxford in charge of the senior assistant, who observed the same stars with Professor Pritchard at Cairo. The results of both sets of observations are embodied in the formulæ—

Atmospheric absorption

$$\text{At Cairo} = 0.187 \times \text{Sec. Z.D. in magnitude.}$$
$$\text{At Oxford} = 0.253 \times \text{Sec. Z.D. in magnitude.}$$

Thus the whole effect of the atmosphere at Cairo is to diminish the brightness of stars seen in the zenith by about two-tenths of a magnitude, and at Oxford by about one-fourth of a magnitude. At an altitude of about 30°, the stars at Cairo will be brighter than in England by about one-fifth of a magnitude, and consequently many more faint stars are just visible at Cairo than can be seen at Oxford.—(*Science.*)

Professor Pritchard has printed the photometric observations at Oxford, of which the Cairo observations form a part, in the memoirs of the Royal Astronomical Society, but the volume has not reached America at the time of writing.

DOUBLE STARS.

*Sydney double star results.**—An important contribution to our knowledge of the southern heavens has been made by Mr. Russell's publication, in a very compact little volume, of the measures of double stars made at the Sydney Observatory from 1871 to 1881. The catalogue comprises remeasures of about 746 of Herschel's stars and measures of 350 new doubles, the whole representing some 15,000 measures of angle and distance. Of the new pairs, nine are separated by less than one second of arc, and sixty-six by less than five seconds. The search for new pairs has, however, been merely incidental to Mr. Russell's main object, the examination of Sir John Herschel's Cape list between 34° south and the Pole, a work the more important and valuable that no measures of any large numbers of these stars have been published since the appearance of that catalogue. Mr. Russell, however, remarks that though only an evening now and then was devoted to the search for new objects, the number recorded might easily have been doubled had he adopted the same limit of distance as Sir John Herschel. Only a few of the new stars have been repeatedly measured; but of these several show signs of motion.

Mr. Russell gives lists of objects in which his results differ from Sir John Herschel's. Thus in 46 cases he failed to find doubles where Herschel has recorded them, owing, probably, in many cases, to errors in the Cape Catalogue, and in seventeen other instances finds easy doubles in fields which Herschel examined without seeing any. Of these, one of the most striking is *h* 4909, a group of five stars which Herschel described with great particularity, and which now shows a sixth within the pentagon formed by the others, and as bright as three of the exterior stars. Of stars which show real or supposed change since Herschel's observations, *p* or 6 Eridani seems, from the later measures, not to be a binary, as these observations plot into a straight line as if the preceding star had a separate proper motion. The doubles γ and π Lupi both seem to show motion; for whilst Herschel found γ easily separated and π excessively difficult, Mr. Russell has always failed to divide the former, whilst the latter is now an easy object.

The observations up to 1874 were made with a fine 7¼-inch refractor by Merz, the powers ordinarily used being 159 and 330. Since then an 11½-inch refractor of 12½ feet focus by Schröder has been used, with powers from 100 to 1500, 800 being employed for all difficult objects.

Mr. Russell indicates the date of the observations in an unusual manner, three columns being given with the "day of the month," "month of the year," and "year in the nineteenth century," a decidedly less

* Results of double star measures, made at the Sydney Observatory, New South Wales, 1871 to 1881, under the direction of H. C. Russell, B. A., F. R. A. S., Government Astronomer for New South Wales.

convenient method than the usual one of giving the year and fraction of a year.—(E. W. Maunder in *The Observatory*, February, 1883.)

Harvard College Observatory measures of double stars.—"Micrometric measurements of double stars" in vol. XIII, part i, of "Annals of the Astronomical Observatory of Harvard College." This is a catalogue of measures of about 350 stars in upwards of one thousand sets, made with the 15-inch refractor at Harvard College, chiefly in the years 1866–1872, under the direction of Professor Winlock, but including a few obtained by the Bonds, and by Mr. Waldo, which have previously appeared in the *Proceedings* of the American Academy of Arts and Sciences, and in the *Astronomische Nachrichten.* The catalogue includes nearly all the more interesting binaries and many difficult objects. In addition, Professor Pickering publishes a list of 179 double stars discovered at Harvard College Observatory, some of which have been independently detected by Mr. S. W. Burnham; these were found to a considerable extent during an exploration of the southern heavens, occasionally instituted in the intervals of other observations. In the cases of some of the principal revolving doubles the measures extend to the year 1876.

Milan Observatory measures of double stars.—"Measures of the principal double stars in rapid orbital motion," made in the years 1875–1882, with the Merz refractor of the Observatory of Brera, Milan, by Professor Schiaparelli—an important series of results which will be most welcome to those who are engaged in the investigation of double star orbits, since, in most cases, there are measures later than any others available at the present moment.—(*Nature.*)

A second very extensive and important series of measures of double stars made at Chicago has been published by Mr. Burnham in the memoirs of the Royal Academy of Sciences. This is printed too late for detailed mention here, but it may be said that this and its preceding paper represent more and better work than has ever before been done in the same time and under like conditions.

THE SUN.

The eclipse of 1882.—At the present time, when interest is chiefly drawn toward the labors of the astronomers who observed the eclipse of the sun May, 1883, from the small islands in the Pacific Ocean, the results of the eclipse of May 17, 1882, obtained in Egypt, have especial significance. These were briefly stated by Dr. Schuster at a late meeting of the Royal Astronomical Society. During the progress of the eclipse three photographic instruments were at work; one took photographs of the corona itself; a second was a photographic camera with a prism placed in front of it, that is, a spectroscope without a collimator; and the third was a complete spectroscope. Photographs were obtained in all three instruments. The direct photographs of the corona indicate its variations from eclipse to eclipse, a matter of much importance in solar physics.

If the photographs taken during eclipses in the past twenty years are compared with each other, it will be seen that the corona varies in a regular way with the state of the sun's surface, although there are irregular minor charges. At the sun-spot minimum the corona is much more regular than at the maximum. At the minimum there is a large equatorial extension, and near the solar poles a series of curved rays. At the maximum there is practically no regularity at all; the long streamers go up sometimes in one direction and sometimes in another; and this last year near the sun-spot maximum there was absolutely no symmetry in the appearance of the corona. The transparency of the streamers was most striking. One streamer can sometimes be traced through another, showing that the matter, whatever it is, must be very thin. The rifts start from the solar surface in an entirely irregular way, with a tendency very often toward the tangential direction at the lower parts of the rifts. The photographs extend about a diameter and a half from the sun's limb, and a comet appears on the plates about a solar diameter and a half from the sun's center. It must have been very bright, as it appears clearly in the photographs. Measurements seem to indicate a small shift in its position during the interval between the first photograph and the last.

Turning now to the photographs taken with the camera and prism in front—an instrument which gives an image of the prominences as oft-repeated as there are rays in the prominence—the plates employed were sensible to the infra-red as well as violet rays. One prominence gave a great number of lines in the ultra-violet. The fact was brought out in this eclipse, that the brightest lines in the prominences are due, not to hydrogen, but to calcium. Besides these and the hydrogen-lines, there is the line D_3 in the yellow, and the C line of hydrogen in the red, and also a photograph of two prominence-lines in the ultra-red. In addition to the prominences, there are visible in the photographs certain short rings round the moon, which mean that at these places the light sent out by the gaseous part surrounding the moon is not confined to the prominences. It is, as would be expected, the green coronal line which chiefly corresponds to one of those rings. This green line, K 1474, is a true coronal line, and is only very faintly traceable in one of the prominences.

In considering the results obtained with the complete spectroscope, it is a striking fact that some of the lines cross the moon's disk, and especially the two lines H and K. This proves that the calcium-lines H and K were so strong in the prominences that the light was scattered in our atmosphere and reflected right in front of the moon.

The prominence-lines are very numerous; thirty such lines appear in the photograph. The hydrogen-lines are there, including those in the ultra-violet photographed by Dr. Huggins: also *H* and *K*, and other calcium-lines; and still others, chiefly unknown.

Close to the sun's limb we can only trace a continuous spectrum, a very strong one, going up to about a quarter of a solar diameter. The photographs bear out the distinction between the inner and the outer corona, the former being much stronger in light. The boundary at which this continuous spectrum ends corresponds to the extension of the inner corona. The continuous spectrum is stronger on the side where the prominences are weaker. In the corona we first of all see a very faint continuous spectrum, and in that continuous spectrum one can trace at *G* the reversal of the dark Frauenhofer lines. In addition, a series of faint true coronal lines can be traced in the outer regions of the corona. We have not traced any known substances in the solar corona. The greater number of the prominence-lines in the ultra-violet are also unknown, but they seem to be present in Dr. Huggins's photograph of the spectrum of α Aquilæ.—(*Nature.*)

The total solar eclipse of May 6, 1883.—The U. S. S. "Hartford," which sailed from Callao, Peru, March 22, with the American and English astronomers on board, arrived at Caroline Island April 20, sixteen days before the date of the eclipse. The island is in reality a chain of small islands of coral formation, encircling a lagoon, the length of the inclosure being about seven miles and a half, and the breadth one mile and a half. The land is low, but supports an excellent growth of grass and other vegetation, including a number of cocoanut trees. There are no permanent inhabitants; but the island is leased by an English firm which deals in guano, cocoanuts, and other products of this and similar Pacific islands. An agent of this firm visits the island occasionally and superintends the work of those employed. Seven persons were found living on the island for the time being, having been brought there from Tahiti two months before. These were four men, one woman, and two children. There were two large frame houses in excellent condition, besides several smaller houses which furnished comfortable accommodations for the party, and also for the French astronomers, who arrived two days later in the "Eclaireur." The latter party was composed of the following scientific men: M. Janssen, of Meudon; M. Tacchini, of Rome; M. Palisa, of Vienna, formerly of Pola; M. Trouvelot, of Meudon, formerly of Cambridge, Mass.; and M. Pasteur, photographer, also of Meudon.

The landing of the heavy cases containing the instruments was accomplished with difficulty, as even the ship's small boats could not come within several hundred feet of the shore, which was composed of rough coral rock. The cases were taken from the boats by men standing in about two feet of water, and carried to the shore, thence across several hundred feet of coral rock to the land, and about a quarter of a mile farther to the site selected for the observations. After the completion of the landing, the men-of-war steamed away to Tahiti, leaving selected members of their companies to assist in the work. The American party was favored with the help of Messrs. Qualtrough, Dixon, Fletcher, and Doyle, officers of the "Hartford," and of ten seamen.

The two weeks preceding the eclipse were occupied in mounting the instruments and in other preparations. Pendulum observations during this time were made by Messrs. Preston and Brown, under instructions from the United States Coast and Geodetic Survey. The weather was in general pleasant, though there was one severe rain-storm, and nearly every day there were flying clouds with slight showers, as is not unusual in the region of the trade-winds. The wind was usually strong, and blew steadily from a direction varying from north to east, but never south of east, though the island is in the heart of the southeast trade region. Eight inches of rain fell during the seventeen days which the party spent on the island, more than half of this in one storm on May 4.

The weather on the morning of May 6 was cloudy and threatening, but after several showers the sky cleared shortly before the time of first contact, and remained clear the remainder of the day, with rapidly moving clouds. One of these partially concealed the corona for about twenty seconds in the first minute of totality, and the sun was wholly in a cloud soon after the close of totality; but the observations were not interfered with, though there was at all times haze in the atmosphere.

The observations planned were carried out successfully, with results which will be given in full detail in the official report of the expedition. A summary of these results can, however, be given at the present time. Professor Holden swept for intra-mercurial planets, but none existed in the region examined. Spectroscopic observations were made by Dr. Hastings and Messrs. Rockwell, Brown, and Upton, with interesting results. Dr. Hastings had devised a spectroscope by which the spectra of two opposite sides of the sun were brought into juxtaposition, and could be examined simultaneously. This instrument, which was attached to a 6¼-inch equatorial, was used especially to note the changes in the appearance of the 1474 line on the preceding and following limbs of the sun as the eclipse progressed. At the beginning of totality the 1474 line extended to a height of about 12′ on the eastern limb of the sun, while on the western limb it was faint, and not more than 4′ in height. As the eclipse progressed, the lines changed relatively, becoming sensibly equal at mid-eclipse, and the conditions at the close of totality being the reverse of those at the beginning. This change was many times greater than any change due to the moon's motion, and is regarded by Dr. Hastings as conclusive proof that the outer corona is mainly due to diffraction. The dark *D* lines were seen in the corona, and the bright hydrogen and magnesium lines by several observers. The relative height and brightness of the coronal rings seen in an integrating spectroscope were estimated.

The duration of totality was five minutes twenty-five seconds. The corona was bright, and characterized by five well-defined streamers, a careful sketch of which was made by Dr. Dixon. The azimuths of the shadow-fringes at the beginning and end of totality were obtained, and their distances from each other estimated. The meteorological observations made by Mr. Upton showed a slight but well-defined rise in barometric pressure, a rise in humidity, and a fall in temperature. The temperature reached the values given at night, while the radiation thermometers indicated that the receipt of heat by the earth was almost wholly checked. The direction and velocity of the wind were unchanged during the time of the eclipse.

The photographs obtained by Messrs. Lawrence and Woods, the English members of the party, who were assisted by Mr. Qualtrough, of the Hartford, include a series of negatives of the corona to its outer limits, and also of the coronal spectrum. The latter contains a few bright lines, but not as many as were obtained by the same observers in Egypt a year ago. The phenomenon of reversal of the Frauenhofer lines was also successfully photographed.

The "Hartford" returned to Caroline Island on the 8th of May, and on the 9th sailed for Honolulu, which was reached on the 30th; a stop of four days having been made at Hilo, Hawaii, to allow a visit to the volcano of Kilauea. The party reached the United States June 11.

Mr. J. Janssen, the leader of the French expedition which visited Caroline Island to observe the solar eclipse of May 6, has made a report to the French Academy of Sciences, which is published in full in the *Bulletin hebdomadaire de l'Association scientifique*, No. 181. It contains, first, an interesting account of the voyage to Caroline Island, and a brief description of the island, with the difficulties encountered in landing the instruments; then follows a statement of the instrumental outfit and the plan of observations. The search for intra-mercurial planets was assigned to Messrs. Palisa and Trouvelot. The former used an equatorial of 0.16 m. aperture, having a short focus and a large field; the latter was provided with an equatorial of the same size, which had a finder of 0.08 m. aperture, thus giving the observer two telescopes. The finder had a field of 4°.5, and was used in examining the region in the vicinity of the sun, while the larger instrument was intended to give the position of any strange object that might be noted by means of its position-circles. In order to avoid the necessity of reading the circles, an attachment was made to both right ascension and declination circles, by which fine marks could be made upon the circles and verniers by the observer's assistants, and the corresponding readings determined at leisure. The finder was also furnished with a reticule containing cross-threads, and a position-circle for use in noting the appearance of the corona, to the drawing of which Mr. Trouvelot gave a portion of the time of the local phase.

The search for intra-mercurial planets was also conducted by the aid of photographic apparatus, which Mr. Janssen thus describes:

"At my order, Mr. Gauthier had prepared an equatorial mounting with an hour-axis two meters long, carrying a strong and large platform, upon which were fastened the following photographic apparatus: a large camera having a lens of eight inches (0.21 m.), made by Darlot, giving a field of 20° of 25° (plate of 0.40 m. by 0.50 m.), and designed for photographing the corona and the region about the sun with reference to the stars there found. A second camera, with a Darlot lens of six inches (0.16 m.) giving a field of 26° to 35° (plate of 0.30 m. by 0.40 m.), for the same purpose; and a very fine apparatus by Steinheil for studying the corona. A second mounting carried several cameras with lenses of four inches (0.10 m.), giving a great amount of light, and designed to determine by very sensitive plates what are the limits of the corona—an apparatus of great light-power, the exposure lasting during the whole of totality."

For spectrum analysis the following apparatus was employed: "A [reflecting] telescope of 0.50 m. aperture, having a very short focus (1.60 m.), and supplied with a direct-vision spectroscope of ten prisms; the slit of the spectroscope could be placed at different position-angles, and rapidly opened or closed at the pleasure of the observer. An excellent finder, supplied with a reticule, was placed near the spectroscope, and distant from it by such an amount that, when one eye had fixed upon some point of the corona in the finder, the other could obtain the spectroscopic analysis of this point." There were also attached to this telescope a bi-quartz polariscope by Prazmowski, and a spectroscope for showing Respighi's rings. A spare mirror of 0.40 m. diameter was carried as a reserve, but was not brought into use, as by great care the first was kept uninjured, in spite of the frequent rains and the moist climate.

Mr. Janssen gives the following condensed report of his own observations, drawn up immediately after the observations, in accordance with the plan by which all the observers of the party were governed:

"My observations were of two classes—optical and photographic. The optical observations were principally designed to determine whether the coronal spectrum consists of a continuous spectrum as a background with bright lines, or if the Frauenhofer lines exist there generally (an investigation made especially with regard to the question of ultra-solar cosmic substances). In 1871 I had announced that, besides the hydrogen lines, I had established in the spectrum of the corona the presence of the *D* line and of several others.

"In the present eclipse I proposed especially to solve this question. By means of the optical arrangements above described, I have been able to determine that the basis of the coronal spectrum is composed of the complete Frauenhofer spectrum. The principal lines of the solar spectrum, especially *D*, *b*, *E*, etc., were detected so surely that there can be no possible doubt of this fact. I recognized, perhaps, a hundred lines.

"I recognized this composition of the spectrum, particularly in the lower or most brilliant portions of the corona, but not to an equal degree at the same distance from the moon's limb. The details of this will be given and discussed at a future time.

"I studied also the rings of Respighi. The rings did not appear uniform about the moon's limb, but presented peculiarities of structure, which will be especially discussed in their relation to the question of the Frauenhofer lines.

"I studied also polarization, but devoted to it only a few moments, using the excellent biquartz polariscope of Prazmowski. The polarization was very well defined, and possessed characteristics already recognized.

"Before the observations, I made a preliminary examination of the corona with the naked eye, and with an excellent telescope by Prazmowski. This examination was for the purpose of guiding me in the subsequent observations.

"All these studies—study of shape, spectrum analyses, Respighi's rings, polarization—were combined with a view of solving the question of extra-solar cosmic substances. We think that the discovery of the complete Frauenhofer spectrum in that of the corona considerably advances this question.

"*Photography.*—Two great instruments, containing eight cameras, had been prepared for studying the question of intra-mercurial planets, and that of the shape and extension of the corona. With regard to heavenly bodies in the vicinity of the sun, these photographs will require a minute examination; but with respect to the corona, it can be said that the great power of several of the lenses used—that of eight inches (0.21 m.) and that of six inches (0.16 m.)—and also the length of exposure, permitted us to prove that the corona has an extension very much greater than that shown by optical examination, either with the naked eye or in my telescope.

"Several of our large photographs of the corona have great distinctness. They show important details of structure which ought to be discussed. The shape of the corona was absolutely constant during the whole duration of totality."

The reports of Messrs. Tacchini, Palisa, and Trouvelot are not given, but are alluded to in the discussions of the results of the observations which next follow. Mr. Janssen regards it quite improbable that any intra-mercurial planets exist, on account of the negative testimony given by Mr. Palisa, combined with that of Professor Holden of the American party. Mr. Trouvelot's conclusion is less decisive, but the observer wished to re examine the region of the sky before coming to a final conclusion.*

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*Mr. Trouvelot observed, near the close of totality, a star which he describes as "bright, and of a pronounced red color;" but, by some misunderstanding, its true position was not recorded by the special attachments to the circles above described. Its position, therefore, cannot be determined, nor the question of its identification be positively settled. The observer announces (*Comptes rendus,* September 17) that he has re-examined the region, and finds no star of the corresponding magnitude and color

The author adds, "When we consider that the bodies discovered by Professor Watson in 1878 can be identified, within the limits of error to which the method employed by that astronomer is liable, with two stars in Cancer,* we arrive at the conclusion that it is to-day extremely improbable that there exists one or more planetary bodies of any importance between Mercury and the sun. Our photographs, although not yet completely examined, seem to lead to the same conclusion."

The duration of totality was found by Mr. Trouvelot to be $5^m\ 24^s.1$, by Mr. Tacchini to be $5^m\ 23^s$.

On the subject of the corona, Mr. Janssen thus writes:

"*The corona.*—Mr. Tacchini's report shows that this skillful astronomer made remarkable observations at Caroline Island, especially with regard to the analogy between the composition of the spectrum of certain parts of the corona and the spectrum of comets. It was part of my plan to examine this correspondence, as is shown by a note drawn up by me long before the eclipse, and which I read to my colleagues when we compared our respective reports. It is a matter which ought to be verified with the greatest care in future eclipses. However, I leave to Mr. Tacchini the task of developing his observations.

"It will be seen from my report that the principal object of my observations was to decide one point of the composition of the spectrum of the corona which has always seemed to me very important, viz, whether the light of the corona contains an important proportion of solar light. The result surpassed my expectation in this matter. The Frauenhofer spectrum, so complete as I witnessed it at Caroline Island, proves that, without denying that a certain part is due to diffraction, there exists in the corona, and especially in certain parts of the corona, an enormous quantity of refracted light; and as we know, besides, that the coronal atmosphere is very thin, it must be that in these regions cosmic matter exists in the condition of solid corpuscles, in order to explain this abundance of reflected solar light.

"The more we advance, the more we perceive the complex nature of the regions in the immediate vicinity of the sun; and it is only by persistent and very varied observations and an exhaustive discussion of these observations that we can arrive at an exact knowledge of these regions. The great eclipse of 1883 has allowed us to take a step forward.

"*Photography of the corona.*—The result of the studies of the photo-

in the vicinity of the approximate position which he was able to assign to it; "although," he adds, "the absence of a red star as bright as that which I observed in the eclipse seems quite naturally to lead to the conclusion that the body in question is no other than an intra-mercurial planet; yet, as the most necessary elements, such as the position and a disk or a sensible phase, are wanting in my observation, I think I ought to suspend, for the present, my conclusions upon the probable nature of the body."

* First pointed out by Dr. C. H. F. Peters, *Ast. Nach.*, 2253 and 2254.

graphs will be given later; for they require a thorough examination since they record many most interesting phenomena. I will simply say, at present, that these photographs show a corona more extended than that given by telescopic examination, and that the phenomena appeared well defined and steady during the duration of totality.

"*Luminous intensity of the corona.*—I had prepared a photometric measure by photography of the luminous intensity of the corona. This experiment showed that at Caroline Island the illumination given by the corona was greater than that of the full moon. The exact numbers will be given later. It should be noted that this is the first time that an exact measure of the luminous intensity of this phenomenon has been made."

The remainder of the report gives an account of the return journey of the members of the expedition. They visited the volcano of Kilanea, on the island of Hawaii, and passed a night in the crater on the edge of the lava lake. Mr. Janssen made some experiments, which, he states, "shows some curious coincidences between these volcanic phenomena and those of the solar surface. I was able, also, to obtain the spectrum of the flames which issue from the lava, and to establish in them the presence of sodium, hydrogen, and carbureted compounds." —(Professor W. Upton in *Science*, November 2.)

The total solar eclipse of August 28, 29, 1886.—This great eclipse is a return of that of August 17, 18, 1868, which was extensively observed in the Bombay and Madras Presidencies and in other parts of its track from Aden to Torres Straits. In 1886 the track of the central line will be mainly over the Atlantic Ocean, and at that portion of it where the duration of totality is longest it will not be observable on land. It is therefore of interest to examine the possible conditions of observation. In deducing the results which follow, the places of the sun and moon have been taken from the *Nautical Almanac*, where Newcomb's corrections to Hansen's Lunar Tables are introduced. As will be seen from the Ephemeris, the central eclipse commences in longitude 79° 46′ west of Greenwich, and latitude 9° 48′ north, off Colon, in the Isthmus of Panama, thence running in the direction of the Windward Islands across the northern parts of New Granada and Venezuela; passing over the island of Granada, it traverses the Atlantic, and meets the coast of Africa in the Portuguese possessions, not far from St. Philip de Benguela, and crossing South Africa to Sofala, it ends on the east coast of Madagascar. At Cartagena the duration of totality is $3^m. 2^s$, with the sun at an altitude of 5°; at Maracaibo the duration is $2^m. 57^s$, with the sun 9° above the horizon. The southern extremity of the island of Grenaada will have the most advantageous conditions for observation, having regard to length of totality and accessibility. The total eclipse begins there at $7^h\ 11^m, 0^s$ A. M. on August 29, and continues $3^m\ 42^s$, the sun being at an altitude of 20°; at the northern extremity of the island the length of total eclipse is about five seconds less. In Carriacou, the principal island in the Grenadines, the duration of totality is $3^m\ 21^s$; at the northern point of Tobago it is $1^m\ 51^s$.—(*Nature.*)

Photographing the corona without an eclipse.—In a paper read before the British Association, Dr. Huggins gives an account of his more recent experiments in coronal photography. The photographs referred to in his first paper read before the Royal Society, 1882, December 21, were obtained with a Newtonian reflector by Short. Since then Miss Lassell has lent Dr. Huggins a seven-foot Newtonian telescope made by the late Mr. Lassell. No secondary reflector is used, nor is the mirror tilted, but the open end of the tube is fitted with a mahogany cover in which are two circular holes three and a quarter inches in diameter. Through one of these the light is admitted, and the framework for carrying the sensitive plates is fitted over the other. The performance of the apparatus is very satisfactory. The photographs show the sun's image sharply defined, but it is only when the sky becomes clear and blue in color that any coronal appearances present themselves.

In Dr. Huggins's earlier work he employed absorbing media in order to limit the light used to the violet rays. But much difficulty was experienced from the rapid manner in which the colored solutions (potassic permanganate, or iodine in carbon disulphide) decomposed under the influence of sunlight. Dr. Huggins therefore tried chloride-of-silver plates, which are strongly sensitive to light between *H* and *h*, but hardly at all beyond *H*, and has been able to secure photographs of the corona with them, without the use of any absorbing medium at all. The developer employed has been a solution of ferrous citro-oxalate, and all the plates have been backed with a solution of asphaltum in benzole. For the purpose of screening the sensitive surface from the intensely bright image of the sun, small circular disks of thin brass, slightly larger in diameter than the sun's image, were held close before the sensitive plate. Less advantage was, however, found from the use of the disk than had been anticipated. No photographs could be secured on May 6, the day of the total solar eclipse. One of the English observers of the eclipse, however, having made a careful comparison of the short-exposure photographs taken at Caroline Island, with Dr. Huggins's photographs, expresses his opinion that Dr. Huggins's photographs of the corona are certainly genuine up to 8′ from the sun's limb.—(*The Observatory*, November, 1883.)

A private letter from Dr. Huggins, dated December 22, 1883, states that "the solar photographs are now strengthened by a new process which makes the fainter details more visible. A selection of plates has has been sent to Mr. Wesley to draw from, and his drawings have been compared with the negatives by Captain Abney. Of one of the plates taken May 31, 1883 (about one solar rotation period after the eclipse of May 6), Mr. Wesley and Captain Abney independently made drawings.

These drawings agree, and both of them correspond *unmistakably with the eclipse photograph.* I think I may venture to say that there can no longer remain any doubt as to the true solar origin of the main details of the *photographs* taken of the eclipse up to 8′ to 10′ from the limb. Arrangements are in progress for experiments at a good elevation."

On the conservation of solar energy: a collection of papers and discussions. By C. William Siemens. London, 1883.—This is a collection of the original paper read before the Royal Society by Siemens, and the criticisms from Fitzgerald, Faye, Hirn, Archibald, and others, together with the replies of Siemens.

The theory, well summed up on p. 22, supposes that space is filled with aqueous vapor and carbon compounds; that these, at low pressures, are dissociated by the radiant energy of the sun; that the dissociated elements are drawn into the sun at its poles, unite, and generate heat sufficient to give a temperature of about 2,800° C.; and that the aqueous vapor and carbon compounds formed are again thrown off by centrifugal force at the sun's equator.

As evidence of the presence of carbon vapors in space, Siemens refers to the analyses of meteors, which in some cases have proved that hydrocarbons were a component of the meteoric mass, and again to the work of Abney and Langley on the absorption of the radiant energy of the sun.

The dissociation of vapors at low tensions is a point which seems to be well established. One of the earliest proofs is given in Prof. J. Willard Gibbs's paper on the equilibrium of heterogeneous substances.

Some two or three years ago Prof. Ogden Rood succeeded in getting experimental evidence of dissociation in rarefied gases at ordinary temperatures, but has never published his results.

Dr. Siemens gives, on p. 13, what evidence he early obtained of dissociation of gases in vacuum tubes under the influence of sunlight. What he has done since may be found from an account of his recent lecture at the Royal Institution (*Nature*, May 3). Objections to the theory are well put by Fitzgerald when he asks (p. 41) "how the interplanetary gases near the sun acquire a sufficient radial velocity to prevent their becoming a dense atmosphere round him; why enormous atmospheres have not long ago become attached to the planets, notably to the moon; why the earth has not long ago been deluged when a constant stream of aqueous vapor, that would produce a rain of more than 30 inches per annum all over the earth, must annually pass out past the earth in order to supply fuel to be dissociated by the heat that annually passes the earth; and why we can see the stars, although most of the solar radiations are absorbed within some reasonable distance of the sun."

Faye objects that the presence of such a resisting medium in space as the vapor is not to be accepted, with our present knowledge, and that the centrifugal force at the sun's equator is far too small for the action required.

Hirn, starting with the supposition that the sun's temperature is 20,000° C., writes, that, although the dissociated gases might unite in the chromosphere, they would, on passing down through the sun's atmosphere, be again dissociated, and absorb as much heat as they had given out on combining.—(*Science.*)

THE SOLAR PARALLAX.

Transit of Venus, 1769.—Professor Newcomb has lately taken advantage of a visit to the Imperial Observatory of Vienna to make, with the consent and support of its director, Prof. E. Weiss, an examination of Father Hell's manuscript record, with reference to deciding on the alleged falsification of these observations by Hell himself. The result of his examination was so different from that generally accepted, that Professor Newcomb prepared and presented to the Royal Astronomical Society a statement of the evidence and his conclusions. The story of Hell's supposed tampering with his observations of the transit, made at Wardhus in 1769, is, in substance, that he delayed publishing them so long as to give rise to the suspicion of intending to alter them; that he showed them to no one until after he had received the observations made at other stations; that a cloud was thus thrown over their genuineness; that the suspicions thus excited were confirmed in 1835 through the discovery and publication by Littrow of Hell's original manuscript journal, which its author had neglected to destroy; and that the examination of this journal showed numerous cases of alteration and erasure of the original observed figures, including the seconds of first interior contact, which had been completely erased, and replaced by new numbers inserted with different ink at some subsequent time. And the reason for all this was supposed to be, that Hell desired to publish, not his true observations, but results which should be in the best possible accordance with the observations of others.

In his discussion, Professor Newcomb makes but slight allusion to the absence of many circumstances which might be expected to accompany manufactured observations; but he has presented all the positive evidence within reach so fully as to enable every one to draw his own independent conclusions. His own conclusions are—

First. The belief that there was any suspicious delay in the publication of Hell's observations, or anything in his course to give reasonable ground for a suspicion that he intended to tamper with his observations, is a pure myth.

Second. Excepting the time of formation of the thread of light at ingress; excepting, also, a discrepancy of one second in the time of internal contact, and a change of two seconds in one of Sajnovics's times—it is proved, not only negatively and presumptively, but by positive evidence and beyond serious doubt, that all the essential numbers of observation given by Hell, whether relating to the transit, time, or longitude, are printed as concluded upon and written in his journal at

Wardhus, before there was any possibility of communication with other observers.

Third. The addition of the time of the formation of the thread of light was suggested by the accounts of other observers; but the time itself is Hell's own, obtained possibly from estimation and memory, but more probably from a memorandum made at the time of observation, which he neglected to insert in his journal.

Fourth. The alteration in Sajnovics's time of second internal contact were probably made, because Sajnovics himself afterward concluded that his recorded time was too late; but it may be assumed, that, in reaching this conclusion, he was influenced by Hell's observations.

Professor Newcomb adds, respecting his own proceedings in investigating this subject, that, in commencing the examination of Hell's journal, he had no hope of doing more than deciding whether it was or was not safe to use Hell's numbers as actual results of observations, and no thought of doubting the commonly received view of the case. He soon became perplexed to find himself differing entirely from the conclusions of Littrow. Before the latter had found the manuscript, suspicion had rested upon Hell's truthfulness; so that when he looked into the manuscript, and saw such extensive alterations, the indictment seemed so clearly proven that Littrow's only duty was to make the facts which proved it known to the world. He thus unconsciously assumed the tone of a public prosecutor, and saw all the circumstances from an accuser's point of view.—(*Science.*)

Transits of Venus, 1874 *and* 1882.—The United States Transit of Venus Commission, under whose direction all the operations undertaken by our Government in connection with the transits of 1874 and 1882 were carried out, has lately communicated a statement with regard to the conduct of its affairs and the reduction of the observations. The number of parties organized for the observation of the transit of 1882 was eight, four of which were sent to the southern hemisphere, the other four remaining in the United States. The foreign stations were, with their chief astronomers, as follows: Wellington, South Africa, Prof. Simon Newcomb; Santa Cruz, Patagonia, Lieut. Samuel W. Very; Santiago de Chile, Prof. Lewis Boss; Auckland, New Zealand, Mr. Edwin Smith. The home stations were Washington, D. C., Prof. William Harkness; Cedar Keys, Florida, Prof. John R. Eastman; San Antonio, Tex., Prof. Asaph Hall; Cerro Roblero, N. Mex., Prof. George Davidson. In addition to these parties, there were two others, equipped wholly or in part at private expense, but whose operations were conducted in such a way as to insure the strict comparability of their work with that of the Government parties. One of these was stationed at Princeton, N. J., in charge of Prof. Charles A. Young, and the other at the Lick Observatory, Mount Hamilton, Cal., in charge of Prof. David P. Todd. The photographic results will be derived from the labors of these two parties in the same way as from the Government photographs, and the final report will contain the work of all ten parties on a uniform plan. The Commission's report states that, on the day of the last transit, the sky was perfectly clear at about half the stations, while at the remainder clouds impeded the work more or less, but nowhere to the extent of producing failure. The number of photographic plates obtained at all the stations, and which will be available for measurement, are in the aggregate nearly fourteen hundred, of which about eight hundred were obtained in the northern hemisphere and six hundred in the southern. They are distributed with a fair evenness among the ten stations, except that Auckland and Washington were unfortunate in obtaining very few. The reductions of all these photographic observations are now going on, four computers being employed in the work. The photographs obtained at three of the stations have already been measured, and some progress has been made in the reductions based upon these measurements. It is believed that the sun's distance derivable from the transit of Venus in 1874 and 1882 must depend chiefly upon the photographs; and when it is remembered that the conditions of weather on the former occasion were so unfavorable as to allow only between two and three hundred available negatives to be made in both hemispheres, the remarkable success of the operations during the transit of December, 1882, will be apparent. If no unforeseen delay occurs, probably the definitive result from the photographs of both these transits of Venus can be arrived at in about four years.

Transit of Venus, 1882.—A list of the photographic plates of the Transit of Venus of 1882 in the hands of the Transit of Venus Commission for discussion is given below, together with a list of contact observations:

Stations.	Photographic plates.		Contacts observed.			
	Exposed.	Can be measured.	First.	Second.	Third.	Fourth.
Washington, D. C	53	49				
Prof. William Harkness				1	1	
Com. W. T. Sampson			1	1	1	1
Prof. E. Frisby			1	1	1	1
Ensign S. J. Brown					1	1
Mr. Joseph A. Rogers				1	1	1
Cedar Keys, Fla	176	167				
Prof. J. R. Eastman				1	1	1
San Antonio, Tex	204	121				
Prof. A. Hall					1	1
Rev. Dr. Richardson					1	1
Capt. W. R. Livermore					1	
Cerro Roblero, N. Mex	216	216				
Prof. George Davidson			1	1	1	1
Mr. J. S. Lawson			1	1		
Mr. J. F. Pratt					1	1
Princeton, N. J	190	127				
Lick Observatory, California	123	115				
Total for northern hemisphere	961	795	4	7	11	9

Stations.	Photographic plates.		Contacts observed.			
	Exposed.	Can be measured.	First.	Second.	Third.	Fourth.
Wellington, South Africa	236	200	......	......	......	......
Prof. S. Newcomb	....	....	1	1	......	......
Lieut. T. L. Casey	....	....	1	1	......	......
Ensign J. H. L. Holcombe	....	....	1	1	......	......
Miss M. E. Cummings	....	....	1	1	......	......
Miss A. P. Ferguson	....	....	1	1	......	......
Miss J. N. Brown	....	....	1	1	......	......
Santa Cruz, Patagonia	224	204	......	......	......	......
Lieut. S. W. Very	....	....	1	1	1	1
Mr. O. B. Wheeler	....	....	1	1	1	1
Santiago de Chile	204	152	......	......	......	......
Prof. Lewis Boss	....	....	1	1	1	1
Mr. Miles Rock	....	....	1	1	1	1
Auckland, New Zealand	74	31	......	......	......	......
Mr. Edwin Smith	....	....	......	......	......	1
Prof. H. S. Pritchett	....	....	......	......	1	1
Mr. John J. Stevesou	....	....	......	......	1	1
Total for southern hemisphere	738	587	10	10	6	7
Total for both hemispheres	1,700	1,382	14	17	17	17

From this it will appear that over a thousand plates are regarded as suitable for measurement.

The Transit of Venus of 1882.—The *Comptes Rendus* of the Paris Academy of Sciences for August, 1883, is almost wholly occupied by the preliminary reports from the various expeditions sent by the French commission for the observation of this phenomenon, and one or two expeditions acting in co-operation with the commission. The observations of contacts, etc., appear in these reports. The stations included are Petionville, Hayti; Puebla, Mexico; Fort Tartenon, Martinique; Saint Augustine, Fla.; Santa Cruz, Patagonia; Cerro Negro, near San Bernardo, Chili; Chubut, Patagonia; Rio Negro (4^h 21^m 20^s W. of Paris and 40° 47′ 51″ S.); Hoste Island, Orange Bay, Terra del Fuego; and Bragado, Buenos Ayres. It is gratifying to note the general success which attended these expeditions, even at the most southern station in Orange Bay, the latitude of which was 55° 31′ 28″.

VULCAN. (?)

The editor of the *Astronomische Nachrichten* (Professor Krüger) remarks in No. 2547, with regard to the red star seen momentarily by M. Trouvelot near the sun during the total eclipse on the 6th of May, that, according to a communication he has had for some time in his hands from Professor Holden, there can be no doubt that the star in question was in fact *α* Arietis. No intra-mercurial planet, therefore, was seen during the eclipse.—(*Athenæum.*)

The conclusion above given receives additional confirmation from the report of M. Palisa, which has since been published. In fact the identification named is due to M. Palisa alone, and it was made in an ingenious manner.

THE EARTH.

The Geodetic Congress.—The most generally interesting part of the proceedings of the geodetic conference which met at Rome in 1883 is that connected with the selection of a common first meridian.

The report of the permanent committee of the International Geodetic Association recommends to the conference the general acceptance of the meridian of Greenwich; it was referred to a special committee composed of one representative for each of the following: England, the United States, Germany, Italy, France, and Hamburg. The report concludes thus:

"We terminate our report by proposing to the assembly the following resolutions:

"The seventh general conference of the International Geodetic Association, held at Rome, and in which representatives of Great Britain, together with directors of the principal astronomical and nautical almanacs, and a delegate from the Coast and Geodetic Survey of the United States, have taken part, after having discussed the questions of unification of longitude by the adoption of an initial meridian, and the unification of time by the adoption of a universal hour, have come to the following conclusions:

"Firstly, that the unification of longitudes and hours is equally desirable in the interests of science as in those of navigation, commerce, and international communication. The scientific and practical utility of this reform considerably outweighs the sacrifices and the trouble of arrangement to which it will put the minority of civilized nations. It should, therefore, be recommended to the governments of all the states interested, that it may be arranged and confirmed by an international convention, so that henceforth one and the same system of longitudes may be employed in all the astronomical and nautical almanacs in all the geodetic and topographical bureaus and institutes, and in all geographical and hydrographical charts.

"Secondly, that the conference propose to the Governments to choose for the initial meridian that of Greenwich, inasmuch as that meridian fulfills, as a point of departure of longitudes, all the conditions required by science; and that being already actually and most extensively used of all, it presents the greater probability of being generally accepted.

"Thirdly, that the longitudes should be reckoned from the meridian of Greenwich in the sole direction of from east to west and from zero to 360°, or from zero to 24 hours. The meridians on the charts and the longitudes in the registers should be indicated everywhere in hours and minutes of time, with liberty of adding the indication of the corresponding degrees.

"Fourthly, that the conference recognizes for certain scientific needs and for the service for the great administrations of the means of communication, such as railways, steamship lines, telegraphs, and posts, the utility of adopting a universal hour, side by side with the local or national hours, which will necessarily continue to be employed in civil life.

"Fifthly, that the conference recommends, as the point of departure of the universal hour and of cosmopolitan dates, the mean noon of Greenwich, which coincides with the instant of midnight, or with the beginning of the civil day, situated at the twelfth hour or at 180° from Greenwich. It follows that the universal time will correspond everywhere with the mean local time reckoned from midnight, less twelve hours and the longitude of the place, and that the dates change at the antipodes of Greenwich.

"Sixthly, that it is desirable that those states which, in order to adhere to the unification of longitudes and of hours, will have to change their meridians, should adopt the new system of longitudes as quickly as possible in their observations and official almanacs, in their geodetical, topographical, and hydrographical works, and in their new charts. As a means of transition it would be well that in new editions of old charts, on which it would be difficult to change the squares, the indications according to the new system should at least be inscribed alongside the enumeration of the old meridians.

"Seventhly, that these resolutions should be laid before the Governments and recommended to their friendly consideration, with the expression of the hope that an international convention confirming the unification of longitudes and of hours may be concluded as quickly as possible by a special conference."

The report of the special committee on the above resolutions was read on the 22d before the general meeting of the conference, and accepted after a very animated debate.

Referring to the resolutions, it is only requisite to state briefly that, according to the *Times's* report, as sent back to the conference by the special committee, they now stand as follows: Numbers 1, 2, 4, 6, and 7 were adopted by the committee without alteration; the other two were modified, or rather abbreviated, and now read thus:

"Thirdly, that the longitude should be reckoned from the meridian of Greenwich in the sole direction of from west to east."

"Fifthly, that the conference recommends, as the point of departure of the universal hour and of cosmopolitan dates, the mean noon of Greenwich, which coincides with the instant of midnight, or with the beginning of the civil day, under the meridian situated at 12 hours or 180° from Greenwich; the universal hour to be counted from zero to 24."

To these seven resolutions the special committee have added two others.

The first, inserted between numbers 1 and 2 of those referred to, reads thus:

"That notwithstanding the great advantages which the general introduction of the decimal division of the quadrant for geographic and geodetic co-ordination and the corresponding expressions for time is destined to realize scientifically and practically, reasons eminently sound appear to justify the passing by the consideration thereof in the great measure of unification proposed in the first resolution. Meanwhile, to satisfy at the same time important scientific considerations, the conference recommends on this occasion the extension, in multiplying and perfecting the necessary tables, of the application of the decimal divisions of the quadrant, at least for the great numerical calculations for which it presents incontestable advantages, even if it be desired to preserve the old sexagesimal division for observations, maps, navigation, etc."

The other, inserted between numbers 6 and 7, is as follows:

"The conference hopes that if the whole world is agreed upon the unification of longitudes and hours in accepting the Greenwich meridian as the point of departure, Great Britain will find in this fact an additional motive to take on her side new steps in favor of the unification of weights and measures by joining the metrical convention of May 20, 1875."

The resolution as to the choice of the initial meridian was carried by 22 votes to 4; while Mr. Christie, supported by the French delegates, moved the substitution of Greenwich midnight for noon as the point of departure. This amendment was negatived by 20 votes to 8.—(*Nature*, October 25, 1883.)

Telegraphic longitudes.—The Report of the United States Coast and Geodetic Survey for 1882 contains a very interesting sketch-map, which gives graphically the index to 105 determinations of telegraphic longitudes by the officers of the Coast Survey between 1846 and 1882.

It would add to the interest of this map if the telegraphic longitudes determined by various observatories (as the Naval Observatory, Cambridge, Clinton, Princeton, Albany, &c.), were to be separately indicated.

Telegraphic determinations of longitude in Asia.—The work of Lieutenant-Commanders Green and Davis and Lieutenant Norris, U. S. N., in determining telegraphic longitude has been previously noticed here. In 1877, 1878, and 1879 a chain of longitudes (telegraphic) was carried from Key West through the Windward Islands and to Panama, as well as from England to Lisbon, Cape de Verde, Rio, and Montevideo. The last station has been connected overland with Santiago de Chile, and Panama is now being connected with Santiago down the west coast. During 1881 and 1882 this important work was extended to the China seas, and the positions of Madras, Shanghai, Hong-Kong, Singapore, Nagasaki, Vladivostok, etc., were fixed. The prime importance of the work is for hydrographic purposes; but it is almost equally valuable astronomically. It is interesting to note that Captain Green's longitude of Vladivostok is $8^h\ 47^m\ 30^s.92$, while the direct (overland) longitude is $8^h\ 47^m\ 31^s.32$. The small discrepancy of $0^s.4$ is a testimony to the accuracy of the work.

Telegraphic longitudes in South America.—The following is an extract of a letter from Dr. Copeland, dated Lima, January, 1883: "At Chorillos, near this, are staying M. Barnaud, lieutenant de vaisseau, and M. Favreau, ensigne de vaisseau, members of the French Venus Expedition to Chili. Chorillos is the landing point of the cable from Valparaiso and Panama. The French astronomers, in conjunction with two colleagues now at Valparaiso, are determining the difference of longitude; they have 2-inch transit instruments, with chronographs and chronometers, and the cable is led directly into the observatory. The instruments are similar at both stations; the observers do not interchange stations, but the personal equation has been determined for wire transits and signals transmitted by Thompson's galvanometer. The strength of current is adjusted by a rheostat to a constant strength. A triangulation will connect Chorillos, Callao, and Lima, distant some 6 or 7 miles from each other. The connection of Valparaiso with Buenos Ayres on the one hand, and with Callao and Panama on the other, will complete the circuit of the greater part of South America, the chain from Greenwich to Buenos Ayres, through Lisbon, Madeira, St. Vincent, Pernambuco, Bahia, Rio Janeiro, and Montevideo, having been finished by Lieutenant-Commander Green, U. S. N., in 1879. It is deeply to be regretted that a spirit of undue economy prevents the British Government from taking part in these important operations, which are so closely connected with navigation and geography on a large scale."—(*Copernicus*, November 28, 1883.)

Chronometric longitudes.—The *Comptes Rendus* for January 8, 1883, contains an interesting note by M. de Magnac upon the accuracy of longitudes determined by chronometers. A comparison is made with the values determined in 1871–1873 of the longitudes of Bahia, Montevideo, and Rio de Janeiro with the telegraphic values more recently obtained by officers of the United States Navy. The differences are as follows:

Chronometric — Telegraphic.	
Bahia,	$-1^s.3$.
Bahia,	$+1^s.0$
Montevideo,	$-0^s.5$
Rio de Janeiro,	$-1^s.1$

This surprising accuracy, for expeditions of over forty days, is due to the method adopted, that of M. Villarceau, in which the rate observed on the land before departure and after the return are made the basis of a calculation giving the rate from day to day as a function of the time and temperature.

The United States Lake Survey.—There has just been issued by the Chief of Engineers, in a quarto of 920 pages, with thirty plates, a detailed report of the operations in the prosecution of the survey of the Great Lakes. This important work is now finished, and the report presents in a comprehensive manner the methods used and results obtained. The report starts with a historical account of the survey, from its inception in 1841 to its completion; gives a synopsis of the work accomplished under the various officers who from time to time have had charge of the survey; gives an account of the standards of length upon which the surveys depend, of the measuring-bars used and methods of using them, and of the results obtained both in the measurement of the base lines and in the results of their connection by triangulation, and of the geodetic and astronomical work. The part devoted to the discussion of the base apparatus will be found of special interest to geodeticians. Full account is given of the determination of the constants of the apparatus used, and of the coefficients of expansion. Also, there is a discussion of the "set" of a zinc bar when heated. A portion of the book is devoted to the consideration of the mean levels of the Great Lakes, and the methods by which the results were obtained. The question of tides in the lakes had been previously considered (Report of Chief of Engineers, 1872). The tides are perceptible, but of scientific rather than practical importance, the maximum being less than 2 inches.—(Professional Papers, Corps of Engineers, No. 24.)—(*Science.*)

General movements of the soil.—Dr. Hirsch, director of the Neuchâtel Observatory, has published an account of the motions of the pillars whch support his transit instrument, during the years 1860–1882. The whole series is analyzed and leads to the following conclusions:

1st. The hill on which the observatory is situated oscillates each year about the vertical. On the average it moves 39″.8 each summer from left to right, and 38″.2 each winter from right to left. Thus there is a progressive twist, beside the periodic ones.

2d. The hill changes its level progressively 24″ yearly, and always in the same direction. Thus since 1859 the change of level (towards the west) has been 550″. Dr. Hirsch compares the changes with the number of spots on the sun, and finds a connection between the two phenomena.

Mr. Faye, in reviewing this paper of Dr. Hirsch's, points out that the phenomena can be explained by the geological structure of the strata below the Jura. They are calcareous and clay beds which can slip the one over the other. Water does not penetrate the layers of clay, but it lubricates their surfaces and facilitates the sliding of one layer relative to another. The layers of limestone are moreover filled with holes and fissures running in various directions, and therefore excellent reservoirs for subterranean water. Mr. Faye explains the phenomena in question by supposing a stratum of limestone which is turning periodically over a lower layer of clay, under the influence of the change of seasons; while at the same time a progressive slipping of one layer on the other will account for the changes of level. In this connection, we may refer to diurnal movements of the soil derived from astronomical observations by Dr. Gould (U. S. Coast Survey Report, 1862–'64, and Cordoba Observations, vol. II, p. lii), and by Mr. Fergola (R. Ac. Sci. Napoli, 1871), as well as to the special physical studies by D'Abbadie in France, G. Darwin in England, and others.

THE MOON.

*Semi-diameter of the moon.**—Prof. H. M. Paul, formerly assistant at the United States Naval Observatory, Washington, gives in Appendix II of the Washington Observations for 1879 the results of two occultations of the Pleiades group by the moon, observed by himself to determine the occultation semi-diameter of the moon, and also the corrections to the right ascension, declination, and parallax of the moon. these being necessarily involved with the semi-diameter. The occultations occurred on July 6, 1877, and September 6, 1879, and were observed with the 9.6-inch equatorial of the Washington Observatory. The relative positions adopted for the stars were those of Wolf, with proper motions from comparison with Bessel, and the general proper motion of the group as given by Newcomb. The observations of 1877 were poorly placed for a determination of the correction to the semi-diameter; but those of 1879 give a much more reliable result. From the later (fourteen in all) the resulting correction to Hansen's mean semi-diameter ($15' 33''.47$) is $-1''.69 \pm 0''.12$; and the resulting value, is therefore, semi-diameter $=15' 31''.78 \pm 0''.12$. He gives also the results of Airy's determination from 296 scattered observations from 1833 to 1860. From the immersions and emersions at the dark limb the resulting values are larger by $0''.9$ and $0''.5$ than those given by Professor Paul, and from immersions and emersions at the bright limb Airy's results are larger by $2''.3$ and $4''.4$. Professor Paul concludes that the best way to observe the actual occultation at the bright limb is to use as high a magnifying power as possible, so as to obtain a decided difference of color between the star and the moon's limb. Neither set of occultations observed by Professor Paul gives any evidence of deviation of the moon's limb from a perfect circle.—(*The Observatory*, October, 1883.)

The moon's heat.—The *Sidereal Messenger* for August, 1883, contains an extract from a private letter of Professor Langley's giving some results of unpublished observations on the lunar heat:

"We are measuring the heat of the moon by the bolometer, and the light in its spectrum by other methods, in order to ascertain the temperature of the lunar surface. Our preliminary measures already warrant us in announcing a different conclusion from that reached by Lord Rosse, who, from the fact that a certain specimen of glass absorbed more

* *Science*, vol. I, No. 20.

of lunar than of solar heat, drew (as is well known) the inference that the lunar surface in sunshine was nearly of the temperature of boiling water. We find no evidence whatever of this, but are led by other experiments to believe that the fact (which we do not question) that most kinds of glass absorb more lunar than solar heat has no such explanation as Lord Rosse assigned to it, but is due to selective absorption of the solar rays by the lunar surface. We find no evidence of any but reflected heat there, and so far as our experiments go, no indication that the absolute temperature of the lunar surface, under full sunshine, is high enough to give any indication whatever of its existence to the most sensitive apparatus we have."

Virtual change of the astronomical unit of time.—Mr. E. J. Stone has recently communicated to the Royal Society a paper on a virtual change of the astronomical unit of time, which has taken place in consequence of the difference between Bessel's expression for the moon's mean longitude and the corresponding formulæ of Hansen and Leverrier. The investigation was primarily undertaken for the purpose of finding an explanation of the rapidly increasing discordance between the moon's place and that indicated by Hansen's lunar tables; and, after a careful examination of a number of other hypotheses, Mr. Stone thinks he has found the cause as indicated above.

Up to 1863, Hansen's lunar tables were satisfactory; since then the error of the moon's longitude has increased from $+0''.121$ to $+10''.265$.

Mr. Stone thinks this will also clear up some perplexing discrepancies in results as to the moon's secular acceleration. He points out that Hansen's tables "cannot safely be used in the discussion of ancient eclipses until the effects of this confusion of units of time have been cleared."

This paper has been replied to by various astronomers, notably Professors Adams and Cayley, who have shown that Mr. Stone is here in error.

MINOR PLANETS.

The part of the *Berliner Astronomisches Jahrbuch* for 1885 containing ephemerides of the minor planets for 1883 has been issued to the various observatories in advance of the publication of the annual volume. It contains approximate places for every twentieth day of 224 of these bodies, the latest being No. 225, with accurately calculated opposition ephemerides of 43, each extending over about five weeks. This division of the *Jahrbuch* occupies upwards of one hundred pages.

There are six cases during the year where the planets approach the earth about opposition, within her mean distance from the sun. On June 22 Phocea is at a distance of 0.93, declination $+16°$; on July 12 the distance of Clio is 0.96, declination $-35\frac{1}{2}°$; on August 1 that of Isis is 0.90, declination $-28°$; on October 1 that of Polyhymnia is 0.98, declination $+8\frac{1}{2}$; on October 20 that of Virginia is 0.98, declination $+13°$, and on December 11 Flora in perigee is at a distance of 0.97, with declination +18°. Galle's method of determining the solar parallax, so strongly advocated and ably applied by Mr. Gill, is not likely to fail for want of opportunities of applying it. As regards the magnitude near opposition we have in the case of Phocea 9.0; Clio, 10.2; Isis, 8.8; Polyhymnia, 9.7; Virginia, 9.9; and Flora, 8.2.

During the year 1883 four of these planets descend below 14^m, from coming into opposition not far from aphelion.—(*Nature.*)

New minor planets.—The following minor planets were discovered in the year 1883:

No.	Name.	Discovered.	Discoverer.
232	Russia	January 31	Palisa.
233		May 11	Borelly.
234	Barbara	August 12	Peters.
235	Carolina	November 28	Palisa.

JUPITER.

Mass of Jupiter.—Dr. Kempf has reduced a number of observations of difference of R. A. between Jupiter and the satellites III and IV, which were made by Dr. Vogel in 1868–1870. He has also re-reduced Airy's similar measures of IV (1832–36).

The mass of the planet by various methods is thus summarized:

I.—*From satellite-observations.*

Heliometer observations:		
Bessel (Schur)	1,048.629 ±	0.134
Schur	1,047.232	0.246
Transit observations:		
Airy (Kempf)	1,047.641	0.488
Vogel (Kempf)	1,047.767	0.310

II.—*From perturbations.*

Hansen—Egeria	1,051.12	0.81
Becker—Amphitrite	1,047.37	1.31
Möller—Faye's comet	1,047.788	1.185
Krueger—Themis	1,047.538	0.192
v. Asten—Encke's comet (1865–71)	1,047.611	0.171
Dubiago—Diana	1,045.25	0.46

The great red spot upon Jupiter's disk.—Prof. A. Riccò, of the observatory at Palermo, in a communication to the *Memorie della Società degli Spettroscopisti Italiani*, gives interesting details of his observations on the features of Jupiter's disk during the last opposition. The red spot had become very faint, indeed barely distinguishable, in April and May, and was invisible at the commencement of June, 1883.

Professor Hough also continues his work upon this interesting phenomenon with the Chicago 18-inch refractor.

SATURN.

Mass of Saturn.—In the years 1875, 1876, and 1877 Professor Hall observed the difference of R. A. of *Japetus* and (both limbs of) *Saturn* by means of the chronograph, measuring the difference of declination also. From 128 sets of observations (20 to 25 transits in a set) the mean distance of the satellite is deduced from each year separately. The probable accidental error of a single year's determination of a is slightly over $0''.05$ or $\frac{1}{10000}$ part.

The resulting mean is therefore probably nearly free from accidental error and is adopted by Professor Hall. It is $515''.522$ at Saturn's distance 9.53885.

The periodic time of *Japetus* has been deduced by a comparison with one of Sir W. Herschel's observations, those of Sir John and Washington observations. It is sidereal revolution = 79.3310152 days. Neglecting the action of the rings and satellites the mass of *Saturn* is $\frac{1}{3482.2}$.

The Cassini division of Saturn's ring.—At the January (1883) meeting of the Royal Astronomical Society, Prof. J. C. Adams made a very interesting communication on William Ball's observations of Saturn, upon which much confusion and misapprehension have existed. Attention has been directed to the subject lately by several astronomical contemporaries, mainly with the view to show that William Ball was not, as he has been considered, the discoverer of the chief division of Saturn's ring. Professor Adams has carefully examined letters from Ball preserved in the *Archives* of the Royal Society, Huyghen's *Opera Varia*, etc., and remarks: "I find no evidence that Ball, any more than Huyghens, had noticed any indication of a division in the ring." This statement may be accepted as conclusive that the impression of several English writers as to Ball's claim to the discovery of a double ring is a mistaken one, and the credit of the discovery rests with Cassini. The announcement of it made by the French astronomer of the Academy of Sciences is in the following terms: "Après la sortie de Saturne hors des rayons du soleil l'an 1675 dans le crépuscule du matin, le globe de cette planète paraît avec une bande obscure semblable à celle de Jupiter, étendue selon la longueur de l'anneau d'orient en occident, comme elle se voit presque toujours par la lunette de 34 pieds, et la largeur de l'anneau étoit divisée par une ligne obscure en deux parties égales, dont l'intérieur et plus proche du globe étoit fort claire, et l'intérieur un peu obscur. Il y avoit entre les couleurs de ces deux parties, à-peu-près la même différence qui est entre l'argent mat et l'argent bruni (ce qui n'avoit jamois été observé auparavant), et ce qui s'est depuis vu toujours par la même lunette, mais plus clairement dans la crépuscuel et à la clarté de la lune que dans une nuit plus obscure. Cette apparence donna une idée comme d'un anneau double, dont l'inférieur plus large et plus obscur fût chargé d'un plus étroit et plus clair." In two figures attached to this announcement the ring is shown with the outer half shaded and the inner half white, and there is a central band across the globe.—(*Nature.*)

Rings of Saturn.—Mr. William B. Taylor recalls attention to the announcement made by Otto Struve in 1851, that the observations of two hundred years showed the rings of Saturn to be widening, and the inner edge of the inner bright ring to be approaching the body of the planet.

"Accepting the only tenable theory of the rings, that they are composed of discrete particles, each revolving in its own orbit, we may, by Kepler's law, compute the period of rotation of any part of the ring. Assuming the period of the inner satellite (Mimas) to be 22h. 37½m., the computed period of the outer edge of the ring is 14h. 30m ; of the dividing stripe, 11h. 20m.; of the inner edge of the bright ring, 7h. 12m.; of the inner edge of the dusky ring, 5h. 45m.; and of the ring as a whole (supposed solid), about 10h. 50m. The period of the planet is 10h. 14m.

"With the complex perturbations induced by the exterior satellites, it is evident that no particle of the ring can revolve in a circular orbit; and it follows that, in a space so crowded with particles as to give a continuous light, there must be much interference. Whether the collisions at intercepting orbits result in heat or in disintegration, they necessarily tend to a degradation of motion, and hence to a shortening mean radius-vector and a diminishing period.

"It thus appears that Struve's conclusions have a rational theoretic basis. The rings are falling toward the planet and will eventually be absorbed. Indeed, on the generally received meteoric theory of their constitution, it is impossible to regard their present condition otherwise than as an evanescent phase of a progressive evolution."

Mr. Taylor points out that the relation between the rotation periods of the planet and the ring, and the relation between the rotation periods of Mars and its satellites, not only fail to impeach the nebular hypothesis, as some have supposed, but even fail to be anomalous.

If the planet had a velocity of rotation equal to that of a satellite revolving at its surface, it could not approach the spherical shape. And, the form having once been assumed, the rate of rotation must necessarily and continuously diminish through the influence of solar tides, until eventually the planetary day and year are identical.—(*Phil. Soc. Washington;* meeting October 13, 1883.)

*The divisions in Saturn's rings.**—Professor Kirkwood showed some

* *Astron. Nachr.*, No. 2527.

twenty years ago that Jupiter exercised a peculiar influence over the minor planets, tending to produce well-marked gaps amongst them at certain well-defined distances. For if the period of any minor planet were commensurable with that of Jupiter, the latter would exercise a perturbing influence upon it which would eventually result in a complete change of orbit. Later on, in 1868, Professor Kirkwood employed the same principles to account for the great division (Cassini's) in Saturn's rings. Maxwell had shown that the rings must be formed of separate particles moving round the planet to a certain extent as independent satellites. But a body moving round Saturn at the distance of Cassini's division would have a period that was very closely commensurable with those of each of the six inner satellites, and it would therefore be especially exposed to perturbation. Dr. W. Meyer, of Geneva, has carried the principle yet further and has investigated every possible combination of the commensurabilities of the revolution periods of the satellites, and he finds that, including the division of Cassini, there are seven places where the satellites would unite to exercise a perturbing influence on the members of the ring system. The first position is where the period would be one-fourth of that of Mimas, and marks the inner boundary of the dark ring. Particles moving at almost precisely the same distances would have their times commensurable with each of the other five inner satellites; thus for a period of one-quarter of that of Mimas we have a distance of 10″.56 from the center of Saturn, for one-sixth of that of Enceladus 10″.43, and for one-eighth of that of Tethys 10″.66. Dr. Meyer sees a consequence of this close agreement in the well-defined character of the inner edge of the dark ring. Next comes Struve's division in the dark ring. One-fifth the period of Enceladus corresponds to a distance af 11″.79; one-seventh that of Tethys 11″.66; the three next satellites give a closely similar result. The position of Struve's division is not very exactly known, and Dr. Meyer adopts 11″.79* as its distance, being the mean between the positions of the inner boundaries of rings C and B. One-third of the period of Mimas introduces a new series of commensurabilities in which all the six satellites take a part, but the agreement is by no means so close as in the first two cases, and Dr. Meyer regards the indistinct character of the inner boundary of the bright ring B, which would about correspond to the mean of the distances indicated, as connected with this less perfect coincidence. The period of Enceladus is four times, that of Tethys six times, that belonging to a particle at this distance. Cassini's division corresponds, as already stated, to a period commensurable with each of the six inner satellites, the period of Mimas being twice as long, Enceladus three times, Tethys four, Dione six, Rhea nine, Titan thirty-three. The commensurabilities in the case of the four nearest satellites are of the simplest possible character, and we find that the inner edge

* There is a misprint here in Dr. Meyer's paper; the observed and calculated distances have been interchanged.

of Cassini's division, which is situated at the distance thus indicated, is especially distinctly marked. The outer edge is very indistinct, the influence of Rhea and Titan being much feebler on account of their greater distance.

One-fifth the period of Dione corresponds to about the distance of Encke's division. One-eighth of Rhea's period and one-half of Titan's approximate roughly to the same distance. The division is faint and ill-defined. One-third the period of Tethys, the simplest relation now remaining, indicates the outer boundary of the ring system, and one-seventh that of Rhea and one twenty-sixth that of Titan correspond to distances of nearly the same amount.

The only simple relation omitted is that of one-fifth the period of Tethys, and thus closely corresponds to integral parts of the periods of the three next outer planets. There should, therefore, be another division at about 14″.7. Dr. Meyer does not seem aware of the fact, but several observers of Saturn have noticed that ring B begins to shade off a little nearer Saturn than the center of the ring, which would correspond to a distance of about 14″.7 or 14″.8. Professor Holden speaks of the point where this shading-off begins as "a definite point." The correspondence between calculation and observation as to the divisions of Saturn's rings would therefore seem to be complete.—(*The Observatory, September*, 1833.)

The satellites of Saturn.—Dr. W. Meyer has published (in the *Astr. nachr.*) corrected elements of the satellites *Enceladus, Tethys, Dione, Rhea, Titan*, and *Japetus*, chiefly founded upon his observations at the Observatory of Geneva in 1881, the mean motions, however, being determined from a comparison of the Geneva observations with the elements assigned by Jacob from measures of the satellites made at Madras during the years 1856–'58. The mean distances and periods resulting from Dr. Meyer's investigations are as follows:

	Mean distance.	Period.			
	Radii of Sat.	*d.*	*h.*	*m.*	*s.*
Enceladus	3.8661	1	8	53	6.92
Tethys	4.8116	1	21	18	25.62
Dione	6.1629	2	17	41	9.29
Rhea	8.6082	4	12	25	11.57
Titan	19.9111	15	22	41	23.16
Japetus	57.9303	79	7	49	24.84

(*Nature*, Aug. 16, 1883, vol. XXVIII, p. 377.)

URANUS.

Signor Schiaparelli, the director of the Royal Observatory at Milan, gives in *Astronomische Nachrichten*, No. 2526, the results of a series of observations of the figure of the planet Uranus, which has been exceptionally favorably situated for that purpose. His results (as to the amount of oblateness), by two separate methods, are $\frac{1}{10.98 \pm 0.93}$ and $\frac{1}{10.94 \pm 0.67}$, agreeing very well with that obtained in 1842 and 1843 (the last time when the planet's position was equally favorable) by the late Professor Mädler from his observations at Dorpat, and indicating that Uranus is the most elliptical of all the planets excepting Saturn. A similar result has been reached by Professor Young with the Princeton refractor.

Mass of a planet from observation of two satellites.—M. Struve recommends measurement of the position angle and distance of a satellite from another satellite, and not from the primary planet. A series of such measurements on satellites of Jupiter has been begun at Pulkova. The observations occupy one-third the time, and are considered to be two or three times as accurate as those by direct reference to the center of the planet. They are free, moreover, from the unknown constant errors inseparable from the latter—an advantage which Prof. A. Hall, in this paper, considers cheaply purchased at the price of greater difficulties in computation. He shows that while the solution of 6 normal equations requires 77 auxiliary quantities, that of 12 (the elements of both orbits being involved by the new method) requires 442, and therefore nearly six times the labor. But these 12 equations give the period and mean distance of each satellite, and hence two values of the planet's mass. (*Phil. Soc. Wash., math. sect. ;* meeting April 26.)—(*Science.*)

COMETS.

The Comet of 1771.—The comet discovered by Messier at Paris on April 1, 1771, and last observed by St. Jacques de Silvabelle at Marseilles on July 17, has long been mentioned in our treatises on astronomy as undoubtedly moving in a hyperbolic orbit. This inference was first drawn by Burckhardt, who considered that of all the comets calculated up to the time he wrote (Mémoires présentés par Savans étrangers, 1805) that of 1771 was the only one of which it could be stated with some degree of certainty that the orbit was hyperbolic. Encke reduced anew the six observations employed by Burckhardt, and found that the most probable elements were hyperbolic with eccentricity = 1.00937, which is almost identical with Burckhardt's value (1.00944). Nevertheless he did not regard the decided superiority of the hyperbola in the representation of the six places as an indubitable proof of the necessity of admitting motion in that curve; the positions used were not normal positions, but the results of single and isolated observations, and as such, the errors exhibited by a parabolic orbit had not so great a preponderance in his opinion as to enforce such necessity. He concluded that the subject still required examination by a combination of all the observations, and especially if the originals of those at Marseilles could be found.

Lately the orbit of the comet of 1771 has formed the subject of two memoirs, the first by Mr. W. Beebe, in the Transactions of the Connecticut Academy of Arts and Sciences, Vol. V; the second by Dr. H. Kreutz, published in the Proceedings of the Vienna Academy. Mr. Beebe gives also a hyperbolic orbit, accompanied by the most probable parabola for comparison. Dr. Kreutz is led to a parabolic orbit for the closest representation of the comet's path, and though the original observations at Marseilles had again been sought for unsuccessfully he does not think their recovery would affect the conclusion at which he has arrived. The elements of the definitive parabola are as follows:

Perihelion passage, 1771, *April* 19.14144 *M. T. at Paris.*

	°	′	″	
Longitude of perihelion	104	1	21.7	M. Eq. 1771.0.
Longitude of ascending node............	27	53	11.7	
Inclination	11	15	53.1	

Logarithm of perihelion distance, 9.955127.

—(*Nature.*)

Theory of Encke's Comet.—*Nature*, December 13, 1883, contains an abstract of the recent results of Dr. Backlund, whose paper has not yet reached this country.

Dr. v. Asten, in August, 1878, showed that an acceleration of 0″.104 in the mean motion would satisfy all the successive revolutions of the comet between 1819 and 1858. The probable error of a normal position was 9″ in each co-ordinate. The appearance of 1871 presented a striking exception to others, in that the acceleration had a quite different value, and Dr. v. Asten was led to the belief that some one of the asteroids had produced the retardation in question. In 1881 a similar retardation was indicated, and Dr. Backlund, employing v. Asten's methods, was able to fix on the time and place where the retardation occurred, which was again in the region of the small planets.

A complete revision of the formulæ by Dr. Backlund has led to the detection of a material error in the computations, which, being rectified, enables the whole of the observations of all the appearances, 1868–1881, to be well represented. The probable error of each co-ordinate of a normal position, 1868–1881, is now not above 4″.1. By introducing Schur's reduction of Bessel's mass of *Jupiter*, this error is finally reduced to 2″.8, and the resulting acceleration for each revolution, 1868–1881, is 0″.054. The precision with which the normal places are satisfied is truly remarkable.

The theory for the years 1819–1868 will next be examined, and the difference between the values of the acceleration for the two periods is to be examined.

The great comet of 1882.—Mr. Winlock, of the Naval Observatory, has recently printed as an appendix to the Washington Astronomical Observations a valuable summary of the Washington observations of this comet. The paper includes interesting drawings of the comet at various dates, and also special diagrams of the head.

The meridian observations of the comet are illustrated by a series of diagrams showing the particular part of the head which was observed; and this will be found to be a valuable addition for the use of computers, whose chief difficulty will be found in utilizing observations by different observers whose data refer to different parts of the nucleus.

Dr. Gould has communicated to No. 2538 of the *Astronomische Nachrichten* a long series of observations of the great comet (*b*, 1882) made at Cordoba, where it was observed by Mr. Thome, assistant at the ob-observatory there, until the 1st of June, a later date by twenty-six days than that at which it was seen at any other observatory.

The comets of 1883 have been, *a*, that discovered by Mr. Brooks on February 23, and the Pons comet of 1812, rediscovered by Mr. Brooks September 1, 1883. The variations in light of the latter comet have been noteworthy.

REPORTS OF OBSERVATORIES, ETC.

Reports of observatories for 1882.—The *Vierteljahrsschrift* of the German Astronomical Society for 1883 (part 2) contains a series of reports from various observatories, mostly European, of which we give the following abstract: It should be especially noted that a very large number of the European observatories are now engaged in remodeling their buildings or their instruments or both, and we may judge from their experience about how long it will be before a similar work will have to be done in America.

Athens: The *personnel* of the observatory consists of the director, Dr. Schmidt, and an assistant, Dr. Wurlisch. The Sun has been observed on 356 days for spots. The chart of the Moon published in 1875 gave the results of observations for the years 1840–1874; the measures are still continued, and with even greater assiduity as may be judged from the fact that more measures have been made since the publication of the chart than were made for its construction. Three hundred and seventy drawings of Jupiter made in the years 1841–1879 have been deposited in Potsdam; since 1880, 350 drawings have been made. The other planets are often examined but seldom drawn. Seventy-four variable stars have been observed, over 46,000 comparisons having been made. The Zodiacal Light and the Twilight Arch are observed at favorable opportunities.

Basle: This observatory is devoted chiefly to meteorology and its results are published in the Swiss Reports of Meteorology, annually.

Berlin: The 9-inch equatorial has been remounted by Bamberg, of

Berlin. The zone +20° to +25° is practically finished; the reductions are now in progress. The equatorial has been used by Dr. Knorre, for observations of comets and asteroids. The *Berliner Jahrbuch*, with its two series of circulars, has been published as usual.

Bonn: The zone +40° to +50° is still in progress, 1,020 observations of zone stars having been made; the observer, Dr. Deichmuller, took part in the Transit of Venus expedition to Hartford, Conn. The reductions are well up to the observations. The *Southern Durchmusterung* now counts 357,490 star positions. The final positions of 78,317 stars are now prepared for printing. It should be noted that all the work of the *Southern Durchmusterung* is done by Dr. Schönfeld.

Breslau: The report for 1882 differs from that of 1881 in no important particular.

Dresden (private observatory of Baron v. Engelhardt): Thirty-five observations of 3 comets and 110 observations of 37 planets have been made and published, and some important changes have been made in the instruments.*

Dusseldorff: In 1882 57 observations of 18 asteroids were made, and since 1847 1,102 observations of 141 planets.

Hamburg: The zone +80° to +81° has been completed, and the observatory has begun the zone between −15° and −16°. The divided circle of the meridian circle has been replaced by a new one, made by the Repsolds.

Hereny (Hungary): In 1882 the spectra of 147 fixed stars and 2 comets were observed, besides miscellaneous observations. The stellar-spectrum observations are classified in a table giving the types to which the stars belong.

Kalocsa (Hungary): Regular drawings of the Sun (22 centimeters in diameter) have been made during the year, and also a determination of the latitude and the (telegraphic) longitude from Vienna.

Karlsruhe: The instruments have been removed from Mannheim to a provisional observatory in Karlsruhe. With the 6-inch equatorial a series of measures of star-clusters is kept up. The Reichenbach circle (made in 1811) has received thorough repairs and is employed in a determination of the places of stars south of the equator; the objective is only 3 inches, and the stars selected are therefore 8 magnitude or brighter. Each star is to be observed six times, and Dr. Valentiner hopes to determine the places to $0^s.01$ and $0''.15$.

Kiel: The equatorial has received a thorough repairing by the Repsolds and has been used by Dr. Lamp in a series of Victoria and Sappho observations for Dr. Gill. Dr. Krueger gives in a paragraph some criticisms of the programme prepared by Dr. Gill, which deserve attention. Dr. Pape's observations for the determination of the equinox, 1860, are printed. The printing of the zone +55° to +65° has been be-

*A very interesting illustrated account of Baron v. Engelhardt's observatory is given in *Sirius* for November, 1883.

gun. Kiel will be in the future the central office for international scientific telegrams.

Leipzig: The buildings and instruments have received a thorough revision, in particular the meridian circle and the electric system. Small planets and comets have been observed on the equatorial, and since July, 1882, the sun-spot observations have been continued. The first part of the publications of the observatory is prepared for publication.

Leipzig (Dr. Engelmann's private observatory): The principal instrument is an 8-inch refractor by Alvan Clark, which has been used for measures of difficult double stars.

Milan: The 8-inch refractor has been used in observing double stars, of which 426 measures have been made. The topography of Saturn, Mars, and Mercury has been studied, and Professor Schiaparelli says that the spots on Mercury are not so difficult to recognize as is generally supposed. The meridian circle has made 1,600 observations on the doubles discovered by Mr. Burnham; this work will be soon completed. The observations of Dembowski are not yet ready for publication; the 18-inch refractor is in the hands of the Repsolds for mounting and will not be ready for work before the end of 1884.

Moscow: The work of this observatory is given in vol. ix, part I, of its Annals, which is just published.

Munich: Besides smaller instruments the observatory has a Merz refractor of 10½ inches, and a meridian circle of 4½ inches aperture. The buildings are being rebuilt and these instruments will be remodeled. The meridian circle is in the hands of Ertel for this purpose; the hourly magnetic and meteorological observations are discontinued, but will probably be resumed elsewhere. A series at longer intervals is kept up to connect the new series with the old; the Munich zones are being reduced; Dr. Seeliger is now director of the observatory.

Naples: A list of the publications of the observatory and of its observers is given.

O'Gyalla (Hungary): Besides miscellaneous observations 618 micrometric measures of 182 sun-spots on 151 days have been made.

Padua: The longitudes Rome-Padua, Rome-Florence, Padua-Florence were telegraphically determined. The 7-inch equatorial of Dembowski has been acquired by the observatory and will replace the 4-inch equatorial made by Stark.

Palermo: The sun-spots were drawn (scale of 0.51 meter to the solar diameter) on 315 days; the chromosphere and protuberances were drawn on 156 days. Observations of the reversal of the Frauenhofer lines, especially of 1474 K and b on 124 days. Drawings of Jupiter on 24 days. Observations of three comets on 78 days. Observations of 22 minor planets and of comets. A list of the publications of the observatory is given.

Potsdam: A spectroscopic examination of the stars from -1° to $+20^\circ$

has been completed, and the results are nearly ready for printing; it will contain 4,051 numbers. Two hundred and fifty groups of sun-spots have been observed. The observations of Secchi on the amounts of heat given out by different parts of the Sun's limb from equator to pole, have been repeated by Dr. Spoerer, who, however, finds no such difference as was reported by Secchi. Photographs of the Sun have been made on 195 days. The photometric observations (Zollner's photometer) will shortly be published in three parts: Part I will contain a description of the instrument and an investigation of the extinction of light; Part II will contain the observations of planets, and Part III the observations of variable stars. The comet Wells was photometrically observed on 21 nights; the result of these observations showed the comet to shine partly by its own light. Variable stars have also been repeatedly observed.

Prague: Professor Safarik gives an account of his observations of the Moon, Venus, Mars, and comets, and of 677 observations of variable stars, besides miscellaneous observations which cannot be summarized here.

Stockholm: Dr. Gylden has devoted his time to the continuation of his theoretical work on the motions of the major planets; the numerical computations require much time, and it is probable that the Reichstag will furnish computers to aid in the work. The observations on stellar parallax are not fully reduced, but appear to lead to the conclusion that the mean parallax of the first magnitude stars is rather less than 0″.1. Victoria and Sappho were observed in conjunction with Dr. Gill.

Upsala: Victoria and Sappho were observed with the refractor for the solar parallax. The observatory is undergoing repairs.

Zurich: The results of the observations of sun-spots are given in No. 59 of the *Mittheilungen*, and the contents of that publication are summarized. Besides this the miscellaneous observations of the observatory are given.

The Greenwich Observatory.—Among the leading points referred to in the report of the astronomer royal, W. H. M. Christie, F. R. S., to the Board of Visitors of the Royal Observatory, Greenwich, read at the annual visitation on June 2, 1883, are the following:

Besides the regular subjects of observation with the transit circle, the sun, moon, planets, and fundamental stars, a new working list of 2,600 stars, comprising all those down to the sixth magnitude inclusive, and not observed since 1860, has been prepared, and was brought into use at the beginning of March. The entire number of transits observed with this instrument during the year was 4,488; determinations of collimation error, 354; determinations of level error, 323; number of circle observations, 4,485; determinations of nadir point, 298; reflection observations of stars, 484.

Comet *a* 1882 was observed seven times on the meridian, and comet *b* 1882, three. The routine reductions of all the observations with this instrument are reported in an extraordinary state of forwardness. From the beginning of this year, a correction of $-0''.39$, has been applied to the results of the nadir observations to make them agree in the mean with the results of the reflection observations of stars. This discordance was insignificant in 1878, and is on the increase; its source has not yet been traced. Three determinations of flexure have been made during the year. The correction for *R—D*, the error of assumed co-latitude, and the position of the ecliptic, have been investigated for 1882. The value for the co-latitude, from the observations of 1882, is $38° 31' 21''.93$. The correction to the tabular obliquity of the ecliptic is $+0''.44$. The mean error of the tabular right ascension of the moon, from observations with the transit circle, is $+0^s.82$.

The observations of the moon with the alt-azimuth have been restricted to the semi-lunation between last quarter and first quarter. The moon's diameter has been measured thirty-three times, counting measures in both co-ordinates with the transit circle and the alt-azimuth.

A very valuable addition has been made to the instruments of the Royal Observatory by the gift of the Lassell 2-foot reflecting equatorial, generously presented by the Misses Lassell. This is the instrument with which the Saturnian satellite Hyperion was discovered in 1848. It was removed from Maidenhead early in March, and has been suitably mounted in the grounds of the Royal Observatory. The telescope has two large mirrors available for use; and the astronomer royal contemplates attaching one of them to the tube of the "southeast equatorial," which has a firm mounting and a perfect clock-work, and employing it for spectroscopic and photographic work. The Lassell telescope itself is well suited for the observation of faint satellites and comets which are beyond the present instrumental means of the observatory.

Spectroscopic observations of motion of stars in the line of sight have been made as follows: A hundred and forty-two measures of the displacement of the F line in the spectra of twenty-three stars, and twenty-six measures of the line b_1 in nine stars. The observations of Sirius during the past winter tend, on the whole, to confirm the impression that the rate of recession of this star had diminished progressively since 1877, and that its motion is now on the point of being converted into one of approach.

The spectrum of comet *a* 1882 was examined on three nights; that of the great comet *b* 1882, also on three nights; and that of comet *a* 1883, on one night. The spectrum of the first-named object showed the yellow sodium lines with great brilliancy just before perihelion passage. The spectrum of the aurora was also examined in 1882, November 17. The spectroscopic observations of all kinds are completely reduced to 1883, May 20.

During the year ending at this time, photographs of the sun were taken on 200 days, and 339 plates have been selected for preservation. The sun's disk was free from spots on seven days; and, since the extraordinary outburst of last November, the sun has been comparatively quiescent. The astronomer royal proposes soon to employ a modified photo-heliograph for this work, so as to obtain photographs of the sun 8 inches in diameter instead of 4. The measurement of a large number of Indian and other photographs of the sun, required to fill gaps in the Greenwich series, has been completed, these photographs having been received from the Solar physics committee.

The course of the magnetic observations has remained the same as in former years. Improvements have been made in the methods of photographic registration. There has been considerable magnetic activity during the year. The disturbances of November last are to be detailed graphically in the "Greenwich magnetic results for 1882." Particulars of magnetic disturbances are regularly communicated to the *Colliery Guardians* newspaper, for the information of mining surveyors.

The mean temperature of 1882 was 49°.6 or 0°.1 lower than the average. The highest air temperature was 81°.0, on August 6, and the lowest, 22°.2, on December 11. The mean daily motion of the air was 306 miles, 27 miles greater than the average. The greatest daily motion was 758 miles, on November 4, and the least, 30 miles, on December 11. The greatest hourly velocity was 64 miles, October 24. The number of hours of bright sunshine, as recorded by Campbell's sunshine instrument, was 1,245; that is, forty hours above the average of the five preceding years. The rain-fall of 1882 was 25.2 inches, slightly above the average.

Examination of sextant glasses, &c., at Kew.—In the *Proc. Roy. Soc.* for 1867, Prof. Balfour Stewart described an apparatus designed and constructed by Mr. T. Cooke for the determination of the errors of graduation of sextants. This instrument has from that date been constantly in use at the Kew Observatory, and since the introduction of certain unimportant improvements has been found to work very well.

No provision was made, however, for its employment in the determination of the errors of the dark shades used to screen the observer's eyes when the sextant is directed to the sun or moon, and it has been found that errors may exist in the shape of want of parallelism in these glasses sufficiently large to seriously affect an observation accurate in other respects.

It has also been found that sextant makers are desirous of having the shades examined before proceeding to fit them into their metal mountings, and also to have the surfaces of the mirrors tested for distortion before making the instruments up. With a view to the accomplishment of these ends, for some time past the Kew committee have undertaken to examine both dark glasses and mirrors, and to mark them with a hall-mark when they are found to answer the requirements necessary for exactitude.

For these purposes the following apparatus has been devised and brought into use at the observatory:

A telescope of $3\frac{1}{2}$ inches aperture and 48 inches focal length, a pair of collimeters of $1\frac{1}{4}$ inches aperture and 10 inches focal length, and a heliostat are firmly fixed to a stout plank, so that their axes may be in the same horizontal plane. The eye-piece of the telescope carries a parallel wire micrometer.

In order to adjust the instrument the telescope is directed to the Sun, a shade being fitted to the eye-piece and then placed in its Y's focused for parallel rays. The collimators are then fixed on their table with their object-glasses opposed to that of the telescope, the eye-pieces and wires having first been removed and a metal plate with a sharply cut hole in its center fitted to their diaphragms.

Light is next reflected down the collimator by the heliostat, and the aperture in the diaphragm being viewed through the telescope is carefully focused by moving the object-glass of the collimator to and fro by means of its rack and pinion.

The diaphragm aperture is next collimated by rotating the collimator in its bearings.

Both collimators being thus adjusted, they are placed side by side, so that their illuminated sight can be viewed simultaneously in the telescope, appearing as superimposed bright disks 12′ in diameter. They are next separated so that the disks remain merely in contact at the extremity of their horizontal diameters.

The instrument is now ready for use and the examination of the shades is performed in the following manner:

The glass to be tested is fixed in a rotating frame in front of the object-glass of one collimator, a corresponding shade being placed between the heliostat and diaphragm of the other collimator. The Sun is now directed on to the diaphragms. The colored disks are viewed through the telescope, when, if the sides of the shade placed between the collimator and the object-glass of the telescope are perfectly parallel, the relative position of the disks is unchanged; if, however, the shade is not ground true, the disks will appear either separated or to overlap. In the first case the amount of separation is measured by the micrometer, and serves to indicate the quality of the glass. In the case of overlapping images the shade is rotated through 180°, and separation produced which can be measured. A second examination is then made, the shade having been turned through 90°.

If in no position a separation of images is found to exist to the extent of 20″ the glass is etched K. O. 1; if more than 20″ but less than 40″, the mark is K. O. 2; with greater distortion than this, the shade is rejected and not marked.

To examine the quality of the mirrors, a small table, on leveling screws, is put in front of the object-glass of the telescope. The mirror to be tested is placed on its edge on this table, and turned until a distant well-defined object is reflected down the tube of the telescope. The object-glass of the telescope having previously been stopped down to an aperture corresponding to the size of the mirror the reflected image is contrasted with that seen directly, and if the definition is unchanged the mirror is marked K. O. with a writing diamond and returned to the maker; if the object appears distorted its unfitness for use is similarly notified. A small fee is charged for the examination.

Royal Observatory, Cape of Good Hope.—In the report for 1882, Dr. Gill states that the observations for the difference of longitude between the observatory and Aden are completed. The great comet was observed on every clear night from September 7, and photographs were obtained on six nights. The heliometer measures for the parallax of certain southern stars are nearly concluded. In connection with observations in the northern hemisphere, Victoria and Sappho have been observed for determining the solar parallax by Galle's method. Time of contact at the Transit of Venus was noted by six observers, and heliometer measures were made during the transit.—(*Monthly not.*, March, 1883.)

The Observatory at Melbourne.—The seventeenth annual report of the board of visitors of this establishment, together with the report of the Government astronomer, Mr. Ellery, for the year ending June 30, 1882, has been received. The meridian work with the transit-circle was for the most part limited to observations of standard stars, for the ordinary purposes of an observatory, and the determination of places of stars used for positions of comets. The 8-inch equatorial had been arranged for the observation of the small planets Victoria and Sappho during the last autumn, according to a programme agreed upon with several European and American and other southern observatories, with the view to another determination of the solar parallax. The large reflector was employed on celestial photography, for sketching a number of Sir John Herschel's smaller nebulæ, for drawings of comet 1881, IV, &c. The nebulæ about η Argus was examined on three evenings, and was found to agree very closely with the drawing made in 1875. The majority of the smaller nebulæ were found to accord well with Herschel's descriptions. Nos. 57 and 1423, however, were much fainter than Herschel indicated, and Nos. 1655 and 2181 differed considerably from his description. Two hundred and seventeen photographs of the Sun were taken. A new transit circle has been ordered from Troughton and Simms.—*Nature.*

The Sydney Observatory.—An octavo pamphlet of 16 pages has been distributed by the Sydney Observatory which gives the history and progress of astronomy in New South Wales from 1786 to 1883. The first permanent observatory was Sir Thomas Brisbane's, erected in 1821 and dismantled in 1847.

The Sydney Observatory dates from 1858, and though at first poorly supplied with instruments, it is now excellently equipped. A list of the publications of the various directors, Rev. W. Scott, G. R. Smalley, and H. C. Russell, is annexed to the pamphlet.

Paris Observatory.—Admiral Mouchez has issued his report on the work of the Paris Observatory during the year 1882–'83. He refers to the exceptionally bad state of the sky during the second half of 1882, and also to the derangements produced in the regular course of proceedings by the preparations for the Transit of Venus, as well as by the temporary absence of no less than five members of the *personnel* of the observatory for the purpose of taking part in it. Nevertheless the year will rank, he thinks, as one of importance in the history of the observatory on account of the installation of the new "*equatorial coudeé*," and the nearly completed arrangements for the more extended study of magnetism and terrestrial physics generally, with a view to which six subterranean chambers have been built under the best possible conditions of isolation and stability, so as to obtain observations in a constant temperature. With regard to astronomical work, the bodies of the solar system (including the small planets) appear to have been observed at Paris as regularly as heretofore, and steady progress has been made with the reobservation of the stars of Lalande's catalogue; during the last four years no less than 110,000 meridian observations have been made as part of the results to be incorporated in the new catalogue, the printing of which is now being commenced. The construction of the great refractor, of 16 meters focal length, is in an advanced state, the object-glass being finished; a dome 20 meters in diameter (equal in size to that of the Pantheon, and the largest movable dome ever made) is to be built to contain it, for which the ground has now been prepared, and special arrangements will be made to secure the building from any ill effects arising from displacement of the soil, particularly necessary from the circumstance that the ground below the observatory was mined for the catacombs. Admiral Mouchez is giving his attention also to the establishment of an astronomical observatory at the summit of the Pic du Midi, 2,859 meters high, where a meteorological observatory already exists, founded by General Nausouty. The advantages of this position for astronomical purposes, owing to the great clearness and transparency of the air, have been sufficiently manifested, and the admiral remarks that a telescope of comparatively very moderate power, if established there, might have led to the discovery of the satellites of Mars long before they were actually discovered at Washington. The intention is that any astronomer wishing to engage in special researches may take advantage of the contemplated new observatory.

American observatories.—(Albany, Clinton, Rochester, Toronto, Montreal, Cambridge, New Haven, Princeton, Washington.)

American astromomers will be much interested in a very intelligent account of a scientific journey made by Dr. Ralph Copeland in 1883, which is printed in *Copernicus* No. 32. The observatories named above were seen, and their chief points of interest are briefly and pleasantly mentioned. Dr. Copeland seems to have been most pleased with glass reticles, the American form of chronograph, Clark's present manner of separating the lenses of objectives and their color correction; while the chief fault found is with the too light mountings of Clark's equatorials compared with Grubb's, for example, and to a less extent their too great simplicity, as compared with Repsold's. In regard to the first question it may be asked whether the steadiness of position of the Washington 26-inch is not all sufficient; and as to the second it appears sufficient to mention that the *mounting* of the Milan refractor is to cost as much as the telescope itself, which seems extravagant to Americans.

The United States Naval Observatory.—The report of Admiral Shufeldt, under date of October 22, 1883, covers the work of the observatory for the past year.

The *personnel* of the observatory is as follows:

Rear-Admiral R. W. Shufeldt, superintendent; Commander W. T. Sampson, assistant to superintendent; lieutenants, Pendleton, Moore, Bowman, Garvin, Wilson, Harris, Sewell; ensigns, Brown,* Allen, Taylor, Hoogewerff; professors, Hall, Harkness, Eastman, Frisby; assistant astronomers, Skinner, Winlock, Paul; clerk, Thomas Harrison; computer, W. M. Brown, jr.; computers (Transit of Venus), Woodward, Flint, Wiessner, A. Hall, jr.; instrument-maker, W. F. Gardner; also three watchmen and nine laborers.

The report, which is not yet published, contains a brief account of the work accomplished with the principal instruments of the observatory—the 26-inch and 9.6-inch equatorials, the transit circle, prime vertical and meridian transit—and the progress in the chronometer department, the department of nautical instruments, the library, and also in the reductions of Gilliss's Zones of 1850, 1851, 1852.

The 26-inch equatorial.—This instrument has been in charge of Prof. A. Hall, with Prof. E. Frisby as assistant. Mr. George Anderson is employed as an assistant in the dome. This equatorial has been employed, as in preceding years, for the observation of double stars, satellites, and comets. The satellites of Saturn, Uranus, and Neptune have been observed; and we have now collected a large number of observations of these satellites. The ring of Saturn has been observed, but no remarkable changes have been noticed. In fact, many of the strange phenomena frequently described in connection with this unique

*Appointed professor of mathematics United States Navy October 13, 1883.

ring, the observers here fail to see on the best nights. During the greatest opening of the ring, which is near at hand, it is intended to make a set of micrometric measures of the dimensions of the ring. Some observations for stellar parallax have been undertaken; but as the observer resides at some distance from the observatory, such work is very laborious, and it seems better to defer it until more convenient arrangements are made. At the present time the pressing need on this instrument is, that the observations of satellites already made should be discussed for the purpose of correcting the orbits of these satellites and of determining the masses of the planets. This discussion has been begun, and the numerical calculations are being made by Ensigns W. H. Allen and J. A. Hoogewerff.

The transit circle.—This instrument, in charge of Prof. J. R. Eastman, was employed in the same class of work as in 1881–'82. The observers were Professor Eastman and Assistant Astronomers A. N. Skinner, Miles Rock,* and W. C. Winlock. The whole number of observations made with the transit circle from October 18, 1882, to October 18, 1883, is 3,880.

The meteorological observations have been continued, as in former years, by the watchmen.

The 9.6-inch equatorial.—This instrument has been in charge of Commander W. T. Sampson, assisted part of the time by Lieut. W. E. Sewell, and part of the time by Lieut. John Garvin. It has been used, as in former years, in observations of the phenomena of Jupiter's satellites, occultations by the moon, places of comets, and for obtaining corrections to the ephemeris places of minor planets.

Prime vertical instrument.—This instrument is in charge of Lieut. C. G. Bowman, assisted by Ensign H. Taylor. Observations with it were recommenced November 14, 1882. Continuous observations have been restricted to about forty stars, in no case exceeding 2° zenith distance when on the meridian; and these, with one exception, have been closely confined to the time of the two maxima of aberration. The one exception referred to was in the case of alpha Lyrae, which has been regularly observed throughout the twenty-four hours, having in view the possibility of a determination of its absolute parallax. Up to this time about 580 observations have been secured. In the reductions, Struve's formulæ have been used, and the labor has been greatly lessened by the use of his auxiliary tables for the prime vertical transit.

Meridian transit instrument.—This instrument has been in charge of Lieut. U. R. Harris, and Lieut. E. C. Pendleton has assisted. The meridian transit instrument has been used for the observations of stars of the *American ephemeris* for clock and azimuth corrections, and the determinations of the right ascensions of the sun, moon, and major planets. The total number of observations of the character mentioned is 1,408.

* Succeeded November 1, 1883, by Prof. H. M. Paul.

Observations have been taken as often as practicable, to obtain each day the correction of the standard mean-time clock for setting to correct time the transmitting clock, which is used in sending out the time signals from the chronometer room and in rating the chronometers.

Harvard College Observatory.—The annual report of the director of Harvard College Observatory, for 1883, was submitted on the occasion of the annual inspection by the visiting committee. It is a document of considerable length, and reviews in detail the doings of the year. The report begins with a statement that the annual donation or subscription of $5,000, which has continued for a term of five years, has now ceased. An attempt has been made to supply its place by a permanent fund. For this $50,000 have been subscribed, and it is hoped that this will be increased to $100,000, so that the activity of the observatory may be maintained. The working force of the institution now consists of the director and sixteen assistants of various grades, six of whom are women and ten men. The photometric determinations of the times of eclipse of Jupiter's satellites have been continued. The eclipses thus observed since October, 1882, have been 55, and from the beginning 240. Experimental observations of occultations and transits of the satellites have also been made with a double-image micrometer. A part of the zone observations made under Professor Bond's directions has been revised for the purpose of detecting cases of proper motion among small stars, for which this early work of the observatory furnishes valuable data. The present revision also includes photometric determinations with a wedge of tinted glass.

The construction of charts of small stars near certain selected bright stars, in accordance with a plan adopted some years ago by a committee of the Association for the Advancement of Science, has been begun. Similar charts of the neighborhood of variable stars have also been undertaken. Reference is made to successful distribution of early cometary intelligence through the observatory. By this arrangement, the first accurate observations of the two comets discovered this year were made at this observatory, and the positions obtained were extensively used in the computation of orbits. Experimental work has been done in anticipation of a systematic investigation of the spectra and color of the stars. Between February 8 and November 1 Professor Rogers made 2,640 observations of fundamental stars with the meridian circle, including 136 of Polaris and 121 of the sun. Mention is made of the determination during the year through observations at Cambridge of the longitude of McGill Observatory, in Montreal. In order to complete the series of zone observations which formed an important part of the work of the meridian circle from 1870 to 1879, it became necessary to reobserve a large number of stars, and to observe others which were found to have escaped notice previously. The faintness of many of these required a different system of illumination, which was successfully arranged by Mr. George B. Clark, and at present the transit of stars of the tenth, and even of the eleventh, magnitude can be observed.

The successful working of the meridian photometer is remarked upon, and it is stated that since November 1, 1882, there have been made 133 series of observations of this kind, which required about 20,000 settings. The most important investigation made with the instrument relates to the magnitudes of the brighter telescopic stars in the northern hemisphere. This will result in reducing to a single system the estimates of brightness made at thirteen observatories for ten or fifteen years, during the recent co-operative zone observations. It appears from the work of the meridian photometer that systematic errors in previous estimates of magnitude have occurred, owing to the presence of the Milky Way and of groups of bright stars, especially those in Orion. The equatorial of the west dome has been actively employed by Mr. Chandler especially in the study of the variable stars. About one hundred and forty variables of long period are definitely known to exist, and each of these objects is observed twice a month, according to the present plan of work, and still more frequently during its brighter phases. About three hundred observations of the color of variable stars have also been made, and telescopic stars suspected of variability are likewise examined. Important experiments in astronomical photography have been made. It is thought that photographic methods will furnish very delicate tests of the color of stars, and a photographic map of the whole heavens is to be formed.

A congratulatory reference is made to the adoption of the new standard time, in respect to which it is remarked that the policy of the observatory has been to avoid forcing the matter in anticipation of the public wishes. The Boston time-ball was dropped during the year at noon by telegraph on 321 days, and by hand on 40 days. On 4 days it failed to fall at noon, but was dropped five minutes later. The transfer of the Smithsonian Institution to the observatory of the responsibility of collecting and distributing intelligence of new discoveries is noted as one of the important events of the year. Among other matters the successful observations of the transit of Venus last December are mentioned. The report closes as follows:

"The director visited Europe during the summer, and, among other scientific results of his trip, obtained copies of valuable unpublished manuscripts of Sir William Herschel and of Argelander. The Herschel manuscripts complete the estimate of the light of all stars in Flamsteed's Catalogue, and are of great importance in connection with the work of the meridian photometer. Thirty-one publications relating to science have been made during the year by the observatory or its officers individually." (*Boston Advertiser.*)

From the last annual report of Harvard College Observatory we learn that the search for new planetary nebulæ (by the spectroscopic method) has resulted in the discovery of seven such objects. Most of them are so minute that they cannot be distinguished from stars by the ordinary eye-piece. Photometric work on the satellites of Mars confirms that of 1877 and 1879, except that the brightness of Deimos, when preceding and when following Mars, does not seem to change, as formerly noticed. The determination of the brightness of various points on the Moon to aid the work of the Selenographical Society is now completed. From this investigation it appears that the scale of brightness, in use by common observers of the Moon, is closely expressed in terms of stellar magnitudes, each degree in the scale answering to the ratio of light equivalent to six-tenths of a magnitude. The wedge photometer has been used to measure the light of faint stars in zones. It is so placed in the instrument that the diurnal motion of the stars carries them from its thin to its thick portion, and the time of their disappearance is noted to determine their brightness. The careful study of Sawyer's variable star, D. M. + 1°, No. 3408, proves it to be a very interesting object. Its period of variability is 20h. 7m. 4s., 1.6 being the shortest known belonging to the Algol class. Its variation is from 6.0 to 6.8.

The telegraphic system devised by those in charge of the *Science Observer* for the speedy transmission of comet news has been improved, extended, and will probably soon come into general use. Progress has been made in the reductions of the meridian circle work from 1870 to 1879. These observations will make about 1,200 printed pages, and will fill three volumes of the Annals. Volume I will contain an introduction with discussion of instrumental constants, &c.; II will contain all the zone observations in journal form, and III, observations of secondary polar stars made in 1872–'73, a list of stars for United States Coast Survey in 1878, and other similar work in 1879. This important work is already well advanced, under the direction of Prof. W. A. Rogers. The Coast Survey Catalogue is now ready for publication.

The work of the meridian photometer has been considerable. Over ninety thousand measures were made last summer on about 4,000 stars, visible to the unaided eye. This work involves the discussion of several problems of general interest in connection with the light of the stars, among which may be mentioned atmospheric absorption. The discussion of about fifteen thousand observations shows this curious result: That we may assume the absorption at any altitude exceeding 15° to be equal in stellar magnitude to one-quarter of the secant of the zenith distance, which agrees very closely with the empirical law deduced by Seidel.

Though some have claimed that the Pole Star is variable, its constancy is established by the photometer.

Other valuable matter in this report pertains to variable star work, equatorial observations, scientific papers published, and plans for the future. (*Sidereal Messenger.*)

It is desired to form, at the Harvard College Observatory, a collection of all photographs of the heavenly bodies and of their spectra which can be obtained for the purpose, and Professor Pickering requests that both European and American astronomers will contribute specimens to this collection. Original negatives would be particularly valuable. It may happen that some such negatives, having slight imperfections which would limit their value for purposes of engraving, could be spared for a collection, and would be as important (considered as astronomical observations) as others photographically more perfect. In some cases astronomers may be willing to deposit negatives taken for a special purpose, and no longer required for study, in a collection where they would retain a permanent value as parts of a historical series. Where photography is regularly employed in a continuous series of observations it is obvious that specimen negatives only can be spared for a collection. But in such cases it is hoped that some duplicates may be available, and that occasional negatives may hereafter be taken for the purpose of being added to the collection, to exhibit recent improvements or striking phenomena.

When negatives cannot be furnished, glass positives, taken if possible by direct printing, would be very useful. If these also are not procurable, photographic prints or engravings would be desirable.

In connection with photographs themselves, copies of memoirs or communications relating to the specimens sent, or to the general subject of astronomical photography, would form an interesting supplement to the collection.

Field Memorial Observatory of Williams College.—The following brief description of this new observatory is based on a photographic view by Pach Bros., 841 Broadway, New York. The building is situated some three-fourths of a mile from the Hopkins Observatory, on the college grounds. It consists of a large meridian room, a hall, a bed-room, and a large computing room. The building is of iron, on a stone foundation. The meridian instrument is a circle by Repsolds of 4½ French inches aperture. The room is designed so as to give the best field for this beautiful instrument. The slit is 40 inches wide, covered by three hinged shutters. Windows allow ventilation, and a novelty in such construction is a tower or ventilating shaft. The wall shutters are arranged as doors. The whole aspect of the building is very pleasing to the eye and the situation is excellent. Professor Safford is engaged in a highly important work on polar stars, the first part of which is about to be printed.

Litchfield Observatory.—Dr. Peters, in his annual report, says: "The work in the observatory was continued upon the same plan and directed to the same objects as in the years preceding. The number of stars observed since my last report, in zones, is 12,069—considerably more than in any former year, since the mapping of the skies approaching the Milky Way requires a greater number of fundamental positions. A new glass scale, which we owe to the kindness of Prof. W. A. Rogers, of Cambridge, as it is ruled so that one scale division in the focus of our refractor exactly equals 10 seconds of arc, has saved much time in the reduction. In all, we have now 87,982 zone star observations, which should be arranged in a catalogue. Twenty of the celestial charts, for which the zone stars form the skeleton, have been published during the year (at my private expense), and distributed gratuitously from the Litchfield Observatory to other observatories, learned societies, and private individuals to reciprocate favors received by our institution.

"At the request of Mr. Gill, royal astronomer at the Cape of Good Hope, a number of observatories in the northern and in the southern hemispheres united to make corresponding observations upon two of the minor planets, in order to determine by this method the solar parallax. The Litchfield Observatory was the only one co-operating in the United States, and I have been successful in obtaining some good sets of observations upon Victoria, but none upon Sappho, the opposition of which fell into the later part of autumn, when the sky was unfavorable, as usual, while a complete set, as demanded by the programme, each time required an uninterrupted clear sky of about four hours. Of the remarkable naked eye comet that showed itself last September and in the following months some positions have been determined which have peculiar value, as I believe, because the real, very small nucleus was discovered, for which most of the observers measured by mistake what was only an agglomeration of light in the narrow and very long bright jet. The hope of observing the Transit of Venus of last 6th of December from this place made me decline the offer to go with one of the expeditions sent out by the Navy Department. But inexorable clouds brought sad disappointment here at home. Positions of minor planets have been determined only in cases where either the orbit seemed to need considerable correction or where the apparent smallness of the planetoid might be an obstacle to its being observed elsewhere. The variables here detected have been followed up at intervals in order to ascertain their periods. Meridian transit of stars have been taken as often as it seemed necessary to keep the rates of clocks and chronometers under control.

"The instruments, on the whole, are in good condition, but I must report what I have said in former years, that it is desirable to have the object-glass of the Spencer refractor repolished, and perhaps even refigured. I have mentioned, also, before the deteriorated state of the filar micrometer which, as is natural after so many thousands of measurements, is sensibly wearing out, so that soon it will be almost impossible to get creditable results by it. Meanwhile the filar micrometer is one of the most essential apparatus for utilizing the great refractor.

"The observatory building has stood now about thirty years. An examination in the basement has revealed the unpleasant fact that the sills and posts of the trusses, especially at the corners of the central square, are rotten, so as not longer to sustain the overlying weight. I call the earnest attention of the trustees to this. The ruthless destruction (in October last) of the plantation of young trees that, cultivated with love and labor for fifteen years, with time were to give shelter against the predominant rough western winds, will seriously impair the work of the observatory in the future, when my place will be filled by an astronomer of less iron constitution than mine. The destruction was unwarrantable and without the knowledge of the curators of the grounds. I recommend the immediate replanting of forest trees on the plot."

The 30-inch Clark objective for the Pulkova Observatory.—This objective was finished early in 1883, and Director Otto v. Struve made a special visit to the United States to test it. Dr. Struve first visited Washington and observed various difficult or peculiar objects with the 26-inch telescope. Among these were *Jupiter*, *Sirius*, *Procyon*, the *Orion* nebula, Σ 3121 (distance $0''.4$), 42 *Comæ*, η *Geminorum*, etc. The same objects were then viewed at Cambridge with the 30-inch objective in a temporary mounting, and Dr. Struve was entirely satisfied with the performance of the objective. This was then carefully packed and sent to Hamburg to be mounted by Messrs. Repsold.

The 36-inch objective of the Lick Observatory.—From articles in San Francisco papers it appears that M. Feil, of Paris, the glass founder, expects to send the crown disk in the rough to the makers, Alvan Clark & Sons, in December, 1883. The flint disk has been for a long time on hand.

Private observatory of Mr. Robert McKim, Madison, Ind.—"Mr. McKim has built the first observatory in Indiana at Madison. The building is situated on the grounds west of his residence in this city, and consists of a brick equatorial tower 12 feet square and 35 feet high. The tower is surmounted by a revolving hemispherical dome, which gives a clear view of the heavens in every direction. The instruments provided are a portable equatorial telescope mounted on a tripod stand; aperture of objective 4 inches; magnifying powers, 44 to 400; also a fixed equatorial telescope mounted in the dome; aperture of objective, 6 inches; magnifying powers ranging from 35 to 500. Both of these telescopes were made by Messrs. Alvan Clark & Sons, of Cambridgeport, Mass. The mounting of the fixed equatorial was made by Messrs. Fauth & Co., of Washington, D. C., who have done first-class work, and furnished all the accessories required for a complete equatorial. An improved position micrometer is also provided, an excellent piece of workmanship of Messrs. Fauth & Co. Other needed apparatus will be provided to make the observatory complete and to contribute something to science."

MISCELLANEOUS.

Notes on some recent astronomical experiments at high elevations on the Andes, by Ralph Copeland.—These experiments were made during the first half of the present year (1883) at the cost of the Earl of Crawford. At La Paz, in Bolivia, 12,000 feet, with the full Moon in the sky, ten stars were seen in the Pleiades with the naked eye, and also two stars in the head of the Bull that are not in Argelander's *Uranometria Nova*. The rainy season lasted roughly until the end of March, after which there was a large proportion of fine sky. At Puno, on Lake Titicaca, 12,600 feet, with a 6-inch telescope mounted on a lathe headstock, a number of small planetary nebulæ and some stars with very remarkable spectra were found by sweeping the southern part of the Milky Way with a prism on Professor Pickering's plan. The most remarkable stars had spectra reduced almost to two lines, one near D and the other beyond F, with a wave-length of 467 millimeters, and apparently identical with a line in *some* only of the northern nebulæ as observed by Mr. Lohse and Mr. Copeland. A few close double stars were also found, amongst them β Muscæ.

At Vincocaya, 14,360 feet, the solar spectrum was examined with a somewhat damaged instrument. The chief fact noted was the relative brightness of the violet end of the spectrum. With a small spectroscope several lines were seen beyond H and H_2. The prominences were visible with almost equal facility in C, D_3, F, and H_8. Attempts to see the corona proved futile, nor were the prominences seen otherwise than in the spectroscope, the only difference being that the slit could be opened far wider than down at the sea level. A most careful examination of the zodiacal light failed to show even the slightest suspicion of a line in its spectrum, which was continuous, although short. Both at Puno and Vincocaya the air was very dry; the relative humidity there and at Arequipa, 7,700 feet, being as low as 20 per cent. At Vincocaya the black bulb at one time stood above the local boiling point, while the wet bulb was coated with ice. The author was of opinion that an observatory might be maintained without discomfort up to 12,000 feet, or even a little higher—the night temperature falling only slightly below the freezing point. At greater elevations the thermometer falls 1° for every 150 feet of height, the barometer sinking about 0.1 inch for the same change. At 15,000 feet it will thus be seen that arduous winter conditions are reached without any very material gain in the transparency of the atmosphere. From information received it seems possible to maintain a station for a short time in the early summer as high as 18,500 feet; later on the rains set in and render traveling very difficult. Railway and steamboat communication enable instruments of any size and weight to be carried as high as 14,660 feet, and as far as the Titicaca shore of Bolivia. (*Nature*, October 18, 1883.)

The English Nautical Almanac.—The volume of this ephemeris for 1887, was published in November, 1883, the contents being generally the same as in previous years. The track of the total solar eclipse of August 19 is given in detail for the greater part of the course, and the maximum duration of totality is found to be 3m. 50s., the central eclipse with the sun on the meridian falling in longitude 102° 0′ E. and latitude 53° 47′ N. The Greenwich list includes four occultations of *Aldebaran* during the year and one of *Regulus.*

The average annual sale of the *Nautical Almanac* during the last five years has exceeded 15,500, though many maritime nations have now their nautical ephemeris. (*Nature.*)

It is stated in *Nature* No. 741 that in the French budget the sum of $200,000 is annually given by the Department of Public Instruction as a subsidy to astronomy and meteorology. This is exclusive of subsidies voted by the municipalities of Marseilles, Toulouse, Bordeaux, and Lyons for their astronomical observatories, as well as of the grants (by cities) which partly support the meteorological observatories of Besançon, Puy de Dôme, Montsouris, and Pic du Midi.

New standard railway time.—The convention which met at the Grand Pacific Hotel in Chicago, in the autumn of 1883, to fix upon a general standard of railway time, was presided over by P. P. Wright, general superintendent of the Lake Shore and Michigan Southern Railroad, and W. F. Allen, editor of *The Official Railway Guide*, New York, acted as secretary. About sixty representatives of the principal railways of the United States were present. Secretary Allen, who has taken the lead in this very important arrangement, announced to the convention that he had succeeded in getting companies representing 78,000 miles of road to favor the adoption of a uniform standard time, and that the proposed system was already in use upon 10,000 miles of track in the Eastern States. The representatives of twenty-nine roads, representing 27,181 miles of road, voted in favor of the change, and the representatives of two roads, representing 1,714 miles of road, voted in the negative. The plan is to divide the territory traversed by the railways into four sections, between which there will be exactly one hour's difference in the time, and all the lines within each division are to be run upon uniform time. The division lines of these sections are to be the 75th, the 90th, the 105th, and the 120th meridians, and the following, as adopted by the convention, will show the territory comprised in each section:

"1. That all roads now using Boston, New York, Philadelphia, Baltimore, Toronto, Hamilton, or Washington time as a standard, based upon meridians east of these points or adjacent thereto, shall be governed by the 75th meridian or Eastern time (four minutes slower than New York time). This includes roads run by Portland, Providence, New London, Montreal, Albany, Richmond, and Charleston time, in addition to those specially named above.

"2. That all roads now using Columbus, Savannah, Atlanta, Cincinnati, Louisville, Indianapolis, Chicago, Jefferson City, Saint Paul, or Kansas City time, or standards based upon meridians adjacent thereto, shall be run by the 90th meridian time, to be called central time, one hour slower than Eastern time, and nine minutes slower than Chicago time. This includes roads run by Macon, Rome, Nashville, Salem, Mobile, Saint Louis, Vicksburg, Dubuque, Minneapolis, Saint Joseph, Galveston, Houston, and Omaha time, in addition to those named above; also, the Union Pacific to North Platte and Wallace, the Burlington and Missouri River to McCook, the Atchison, Topeka and Santa Fé Railway to Coolidge, the Texas Pacific to Toyah, and the Galveston, Harrisburg and San Antonio to Sanderson.

"3. That west of the above-named section the roads shall be run by the 105th and 120th meridian times respectively, two and three hours slower than Eastern time.

"4. That all changes from one hour standard to another shall be made at the termini of roads or at the ends of divisions."

No general arrangement of the running of railway trains has ever before been attempted of equal importance to the public with this new movement, and it can readily be seen that it cannot but very greatly simplify and systematize the present complex and almost infinite variety of running schedules upon our railroad lines. The matter has been from the first in the hands of practical men who know their business, and the universal adoption of the system proposed on November 18, 1883, was a remarkable witness to the widespread intelligence and to the common sense of our people.

A subject-index to scientific papers.—One of the most important works for the student of science is the "Royal Society's Catalogue of Scientific Papers," a list of the articles on every branch of science published in periodicals and transactions of learned societies between 1800 and 1872. In these volumes the various articles are catalogued by authors, the arrangement being alphabetical. In answer to an inquiry, the secretary of the Royal Society recently informed Dr. H. Carrington Bolton that the society had abandoned the project of publishing a subject index to their "Catalogue of Scientific Papers." This is greatly to be regretted, for the utility of that monumental work is reduced one-half owing to the want of an index of topics. The chief reasons for this decision on the part of the Royal Society are the enormous expenses, and the difficulty of arranging the material in a systematic manner acceptable to all. The expense would be greater than mere clerical hire, for it is conceded that superior talent would be necessary to do this work in a satisfactory manner.

Copernicus.—With the publication of volume III (1883), this valuable astronomical journal will come to an end. It has not had a sufficient number of subscribers to make it self-supporting. It is a matter of regret to astronomers that a journal which fills so excellent a place is to be discontinued, and for such a reason. It has been from the first admirably edited, and it contains so many excellent papers that a set of the three volumes of *Copernicus* is a necessary part of an astronomical library. At any rate, the editors may congratulate themselves that they and their friends have left nothing undone to found a first-class journal of astronomy in Great Britain. It appears from this failure that the

Astronomische Nachrichten (which covers a different field from *Copernicus*), together with the proceedings and transactions of learned societies suffice for the present wants of the science.

Astronomical telegrams.—The Secretary of the Smithsonian Institution notifies that arrangements have been completed with the director of the Harvard College Observatory for conducting the system of telegraphic announcements of astronomical discoveries which was established by the Institution in 1873, and that henceforward the American center of reception and distribution of telegrams will be "The Harvard College Observatory, Cambridge, Mass.," to which all astronomical telegrams should in future be sent.

American Astronomical Society.—A society with this title has been formed in New York and vicinity. It has as yet published no transactions, although it is intended to do this.

ASTRONOMICAL BIBLIOGRAPHY, 1883.

Following is given a list of the principal books of the year, including those memoirs which have been reprinted from the publications of observatories, scientific societies, etc. It is largely compiled from the excellent *Naturæ Novitates* of R. Friedlander, of Berlin. The prices are added in German marks, 4 marks equal to $1 very nearly:

Anales del Instituto y Observatorio de Marina de San Fernando. Seccion II: Observaciones meteorológicas, a. 1879–'81. 2 vol. San Fernando, 1880–'82. fol.

Anales del Instituto y Observatorio de Marina de San Fernando. Seccion II: Observaciones meteorólogicas. Año 1882. San Fernando, 1883. fol.

Annales du Bureau des Longitudes et de l'Observatoire astronomique de Montsouris. Tome 2. Paris, 1883. 4to. 18

—— Les mêmes. Tome 3. Paris, 1883. 4to. 18

Annales de l'Observatoire de Moscou. Publiées par Th. Bredichin. Vol. IX, livraison 1. Moscou, 1883. 4to.

—— Vol. IX, livraison 2. Moscou, 1883. 4to. 117 pg. av. 6 plchs. 8
Cont.: Belopolsky, Observat. héliograph.—Bredichin et Belopolsky, Observ. spectr. du Soleil en 1881.—Bredichin, Rech. s. la gr. Comète de 1882, II. Observ. de Jupiter, 1881–'82. Observ. de qlqs. Comètes.—Ceraski, Photometr. Beobacht.

Annales de l'Observatoire de Paris, publ. sous la dir. de Mouchez. Observations, 1879 et 1880. Chaque vol. M. 36. Mémoires, vol. XVII, M. 26. 3 vols. Paris, 1883. gr. 4to.

Annales de l'Observatoire de Paris, publiées sous la direction de Mouchez. Mémoires. Tome XVI. Paris, 1883. 4to. 405 pg. 24

Annuaire de l'Observatoire de Montsouris pour 1883. Météorologie appliquée à l'agriculture et à l'hygiène. Année 12. Paris, 1883. 12mo. 450 pg., fig. 2

Annuaire du bureau des longitudes p. l'an 1883. Paris, 1883. 12mo. 864 pg., fig.

Cont.: Faye, s. la figure d. comètes.—Janssen, les méthodes en astronomie. La prochaine Éclipse de Soleil. 6 Mai, 1883, etc. 1.50

Anton, F. Bestimmung der Bahn des Planeten (114) Cassandra. (Wien), 1883. 8vo. 138 pg. 2

Arbeiten, Astronomische, f. die europäische Gradmessung im Königr. Sachsen. Abth. 3. Die astronom. Arbeiten. Ausgeführt unter Leitung v. C. Bruhns, nach dessen Tode bearb. v. Th. Albrecht. Heft 1. Berlin, 1883. 4to. 10

Astronomical papers prepared for the use of the American Ephemeris and Nautical Almanac, under the direction of S. Newcomb. Vol. I. Washington, 1882. 4to. bd. 16

Cont.: Newcomb, Recurrence of solar eclipses.—Newcomb and Meier, Transformation of Hansen's lunar theory.—Michelson, Experiment. determinat. of the velocity of light.—Newcomb, Catalogue of 1,098 standard clock and zodiacal stars.—Hill, On Gauss's method of computing secular perturbations, w. an. applicat. to the action of Venus on Mercury.—Newcomb, Discussion of observed transits of Mercury 1677–1881.

Astronomical, and Magnetical, and Meteorological Observations made at the Royal Observatory, Greenwich, in 1881. London, 1883. roy. 4to.

Astronomische Beobachtungen auf der k. Universitäts-Sternwarte zu Königsberg. Herausg. v. E. Luther. Abth. 37, Thl. I. Königsb., 1882. fol.

Astronomische Nachrichten, begründet v. H. C. Schumacher. Unter Mitwirkung der astronomischen Gesellschaft herausg. v. A. Krueger. Bd. 104, 105, 106. (24 Nrn. each.)
Kiel. 1883. gr. 4to. 15

Astronomischer Kalender für 1884. Nach dem Muster des k. v. Littrow'schen Kalenders hersg. v. d. k. k. Sternwarte. Neue Folge. Jahrgang 3. Wien, 1883. 8vo. 150 pg. 1.20

L'Astronomie. Revue mensuelle d'astronomie populaire, de météorologie et de physique du Globe, publiée p. C. Flammarion. Paris. gr. 8vo. av. nombr. figures. Année II, 1883. 12 nrs. 12

Auwers, A. Neue Reduction d. Bradley'schen Beobachtungen aus d. Jahren 1750–1762. Bd. II.
Petersburg, 1882. 4to.

Backeljau, F. Le calcul par les logarithmes et nouvelles tables du logarithme 3 des nombres.
Gand, 1883. 12mo. 49 pg. 1.50

Becker, E. Die Sonne und die Planeten. Leipzig, 1883. 8vo. 296 pg., m. 68 Abbildgn. Lwd. 1

Beckett, E. Astronomy without mathematics. 7 edit. London, 1883. 8vo. 4.20

Beobachtungen angestellt am astrophysikalischen Observatorium 	k. O'Gyalla hersg. v. N. v. Konkoly. Bd. V, enthaltend Beobachtungen v. Jahre 1882. Halle, 1883. gr. 4to. 96 pg., m. 1 Kpfrt. 10

Bremiker, C. Logar.-trig. Tafeln mit 6 Decimalstellen. 9. Aufl. Berlin, 1883. gr. 8vo. 4.20

Bremiker's Logar.-trigon. Tafeln mit 6 Decimalstellen. Neu bearb. v. Th. Albrecht. 10. Stereotyp-Ausg. (Enth. auch die Tafel der Logarithmen der Sinus und Tangenten der Winkel bis zu 5 Grad von Secunde zu Secunde.) Berlin, 1883. gr. 8vo. 18 u. 598 pg. 4.20

Bredichin, Th. Sur la comète de 1825, IV. (Roma. Mem. d. Soc. d. spettroscop. ital.) 1882. gr. 4to. 10 pg. av. 1 plche. 2

——— Sur la comète de 1882, I (Wells). (Moscou), 1883. 4to. 15 pg. av. 4 plchs. 2.50

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NECROLOGY OF ASTRONOMERS, 1883.

ALEX. NIC. SAWITSCH, director of the Observatory at Cronstadt, d. —, 1883, at St. Petersburg, æt, 73.

VICTOR PUISEAUX, member of the Paris Academy of Sciences, d. —, 1883, at Paris.

ARTHUR ROCHE, professor of astronomy at Montpelier, d. April 18, æt, 63.

Sir EDWARD SABINE, whose pendulum observations are so well known, d. June 26, 1883, at London.

Professor LISTING at Konigsberg, d. —, 1883.

Prof. W. A. NORTON, of Yale College, d. September 21, 1883, æt, 73.

Sir CHARLES W. SIEMENS, d. November 18, at London.

YVON VILLARCEAU, member of the Paris Academy of Sciences, d. December 23, 1883, æt, 70.

GEOLOGY.

By T. Sterry Hunt, LL. D., F. R. S.

EOZOIC ROCKS.

The question of the Eozoic or Primary rocks, details regarding which were given in the report of last year, continues to occupy a prominent place in geological literature. Giekie, the director of the geological survey of Great Britain, has, in a late communication to the Geological Society of London, attempted to set aside the conclusions arrived at by the later British geologists, and to maintain that the great groups of crystalline rocks which these observers have recognized as more or less distinct pre-Cambrian series are either altered Cambrian strata or erupted rocks of still later date. This conclusion, and the facts alleged in support of his view are denied alike by Hicks, Hughes, Bonney, and others, and we are promised an extended discussion and re-examination of the subject, which, it may be predicted, will lead to the final refutation of the ideas of the old school, now defended only by the official geologists, and the correlation of these crystalline rocks with those of North America and of the Alps, now shown to be of pre-Cambrian age.

In this connection it may be mentioned that the familiar doctrine of the igneous and eruptive origin of the undoubtedly Eozoic, or pre-Cambrian rocks has been of late resuscitated by C. W. Hitchcock and by Marr, among others. The latter, in an elaborate essay in the *Geological Magazine* (June, 1883), insists upon the supposed permanence of ocean-basins, and the growth of continents from their borders, as now maintained by some geologists. Such a view presents great difficulties to those who maintain the marine origin of Eozoic rocks, and Marr proposes to regard them as of igneous and terrestrial origin; or, in other words, as derived from materials ejected from volcanic vents, either in liquid or in solid form, which by subsequent changes have given rise to the granitoid gneisses and succeeding crystalline schists. This view, which is by no means new, fails to account for the intercalation with these stratified crystalline rocks of various special deposits, such as limestone, apatite, iron-oxyds, quartz, metallic sulphides, and silicates like olivine, serpentine, and pyroxene, all of which, in interstratified masses, form integral parts of the older crystalline series. These it is sought to explain as the result of local metasomatism. The hypothesis which supposes them to have originated in an alteration of sediments like those of later times is equally untenable without invoking metasomatism, and we are led to look to a modified Neptunian view as a solution of the problem.

The origin of continents and the supposed stability of sea-basins is ably discussed in the *Geological Magazine* for June, 1883, by W. O. Crosby, and reasons are there given for calling in question the doctrine lately maintained by Dana and others in opposition to the older and generally received view of the alternations of sea and land. The derived origin of vast continental areas made up of great thicknesses of Paleozoic and more recent sediments, in great part of mechanical origin, necessarily involves the destruction and the disintegration by chemical and mechanical processes of not less considerable masses constituting previous continents.

In this connection Hunt has discussed the question of the sub-aërial decay of rocks. (*Amer. Jour. Science*, September, 1883.) This process consists in a more or less complete chemical decomposition of most of the silicates of the crystalline rocks, the feldspars being converted into clay by the loss of their protoxide-bases and a large part of their silica, all of which are removed in solution in water. The silicates of protoxide-bases, such as hornblende, are in like manner decomposed, with the solution of the lime and magnesia, and most of the silica, the iron remaining as peroxide; while certain silicates, such as garnet and tourmaline resist, like quartz and magnetite, the process of decay. These transformations being effected under the influence of the atmosphere, the bases are dissolved as carbonates. Thus the decay of crystalline rocks is "a necessary preliminary to glacial action and erosion, which removed previously softened materials." The points insisted upon by the author are thus resumed:

1. The evidence afforded by recent geological studies in North America and elsewhere shows the universality and the antiquity of the sub-aërial decay both of silicated crystalline rocks and of calcareous rocks, and its great extent in pre-Cambrian times.

2. The fact that the materials resulting from this decay are preserved *in situ* in regions where they have been protected from denudation by overlying strata alike of Cambrian and more recent periods, or, in the absence of these coverings, by the position of the decayed materials with reference to denuding agents, as in driftless regions or in places sheltered from erosion, as in the Appalachian and St. Lawrence valleys.

3. That this process of decay, though continuous through later geological ages, has, under ordinary conditions, been insignificant in amount since the glacial period, for the reason that the time which has since elapsed is short, and also, perhaps, on account of changed atmospheric conditions in later ages.

4. That this process of decay has furnished the materials, not only for the clays, sands, and iron oxides, from the beginning of Paleozoic time to the present, but also for many corresponding rocks of Eozoic time. The bases thus separated from crystalline silicated rocks have been the source, directly and indirectly, of all limestones and carbon-

ated rocks, and have, moreover, caused profound secular changes in the constitution of the ocean's waters. The decay of sulphuretted ores in the Eozoic rocks has given rise to oxidized iron ores, and also to deposits of rich copper ores at various geological horizons.

5. That the rounded masses of crystalline rock left in the process of decay constitute not only the bowlders of the drift, but, judging from analogy, the similar masses in conglomerates of various ages, going back to Eozoic time, and that not only the form of these detached masses, but the outlines of eroded regions of crystalline rocks, were determined by the preceding process of subaërial decay of these rocks.

As regards the rocks of the Scottish Highlands noticed in the report of last year, and especially of the so-called younger gneiss, Callaway has continued his studies in that region, and has considered its relation to the Paleozoic series. This gneiss, the Grampian series of Hicks, is called Caledonian by Callaway, and, as we have previously said, is apparently identical with the series already named Montalban in North America, and includes in its lower part, in Scotland, the granulites of Nicoll. Some of its rocks have a certain resemblance to the older Hebridian (Lewisian or Laurentian) gneiss, which is often porphyritic and has been by some observers described as an igneous rock.

The accompanying Paleozoic (Cambrian) strata are named by Callaway the Assynt group, and consist at the base of what has been called the Torridon sandstone, followed by a quartzite, sometimes with annelids, flagstones or grits with *Salterella*, and a mass of dolomite. The Caledonian gneiss appears in some cases to overlie directly this Assynt group, this relation according to Callaway being due to a dislocation of the strata, with a great thrust from the east which has squeezed together both series of strata into a succession of folds overturned to the west, giving to the whole series a general easterly dip. The Caledonian gneiss is seen in Glen Coul to overlie immediately the Hebridian gneiss, while elsewhere this same older gneiss is directly overlaid by the Cambrian quartzite, which again is seen resting in outliers upon the younger gneiss. This latter is penetrated by numerous granitic veins, which never penetrate the Assynt group. Callaway notes between the Hebridian or Laurentian gneisses on the west and the Caledonian on the east (the Assynt group occupying the interval), several nearly parallel north and south faults, which increase in upthrow from the west to the east. Thus the first of these brings up the basal sandstone through the quartzite, then faults more to the eastward bring up the sandstone through the overlying dolomite, and finally the underlying Hebridian gneiss itself; the younger or Caledonian gneiss appearing in its proper place still farther to the east. This is very similar to the successive faults long since observed and described all along the western side of the Atlantic belt in North America, the general structure of which is repeated in the Scottish Highlands. Similar foldings have been pointed out by Brögger in Scandinavia, where lower Paleozoic rocks are closely folded in the Eozoic.

ALTERED OR METAMORPHIC ROCKS.

Brögger has also described the local changes of the Paleozoic strata near Christiania, where eruptive masses of granite and of syenite have caused the development of crystals of chiastolite in certain shales still retaining the marks of graptolites. Other beds are changed into a kind of hornstone, while in the limestones of the series the shells of *Orthis* are found associated with well-developed garnets. Similar facts to these are well known in other regions. These conditions are, however, very unlike those presented in disturbed regions where a process of folding and inversion having caused uncrystalline strata to pass below crystalline stratified rocks, these latter have been assumed, as in the Scottish Highlands, to have resulted from an alteration of still newer and originally superimposed uncrystalline sediments.

Uncrystalline rocks thus enfolded seem occasionally to have suffered local changes, due apparently to the action of thermal waters coming up through fractures along the folds and giving rise to crystalline minerals. Rénard has lately described an interesting example of the kind in a belt of graywacke and slates referred to the Devonian, and affected by a northeast and southwest plication. The change is very marked along the axis of this, but shades off on either side till the sediments are unaltered. Garnet, hornblende, mica, and titanite have here been developed in the schists, and are associated with anthracitic matter. These minerals are mixed with grains of clastic origin, and the whole of the phenomena would appear to be due to infiltrating waters. There is, however, a wide difference between these mixtures of clastic mate rials with crystalline silicates which have been formed and deposited in their midst, and the wholly crystalline feldspathic and hornblendic rocks of the Eozoic ages.

In this connection Bonney has lately studied the so-called metamorphic conglomerate of Valorsine in the Alps, and has submitted to careful microscopic examination the layers of so-called gneiss and mica-schist in this conglomerate of carboniferous age. He shows that the mica and other constituent silicates of these were derived from pre-existing crystalline rocks, and that the material has been subjected to immense pressure, by which the quartz has been broken and the feldspar crushed. From the latter, and from interposed earthy dust, minute scales of micaceous minerals have been formed by such micro-mineralogical changes as are always at work in similar rocks, and chalcedonic quartz has been deposited. He adds, however, that "of metamorphism, in the technical sense of the word, there is no trace."

Bonney further remarks that "a few years since it would have been heresy to assert that very clear proof would be necessary before we could accept a crystalline schist as the metamorphosed representative of a rock of Paleozoic age. Yet at the present time many who have made a special study of this branch of petrology would not hesitate to go this far, and some would even declare that we do not know of any completely metamorphic rock which is not of Archæan age. Certainly the stock-instances of metamorphism in Wales, and especially in Anglesea, in Cornwall, in Leicestershire, and in Worcestershire, have utterly broken down on careful study. Outside the English geological survey probably no person who can use a microscope believes that the schists of Anglesea are altered Cambrian, or that the slates of this age were melted down into the quartz-porphyry of Llyn-Padarn." He adds: "No inferences with regard to metamorphism can be accepted until they have been fully confirmed by the evidence of the microscope."

He concludes that his own and others' studies show that the crystalline schists and gneisses of the Alps existed in their present condition long before the carboniferous period, and insists upon the fact that throughout the various regions of the Alps we everywhere pass from comparatively unmetamorphosed rocks of known age to a highly metamorphosed rock, of which it can only be said that it is immensely older. In this latter series, moreover, he declares we "can trace a certain lithological and stratigraphical sequence leading upward through a series of groups - - - from the coarse granitoid gneisses and protogines to the topmost well-stratified but still truly metamorphic schists," and concludes that we have no evidence that any of these crystalline foliated rocks of the Alps are as young as the Cambrian period.

Bonney has also described further the Miocene conglomerates of the so-called *Nagelflue* of the Rigi, and refers to the frequent indenting and pitting of the included pebbles, a phenomenon often noted and described in this and other similar conglomerates, which he ascribes in part to direct pressure and in part to the action of water, localized and intensified by the pressure of adjoining pebbles. He objects to the notion that such mechanical changes depend upon high temperature, as some have suggested.

THE SCOTTISH HIGHLANDS.

A further contribution to the geology of the crystalline rocks of Scotland has been given by Lapworth in an extended memoir entitled "The Secret of the Highlands," in which he discusses the vexed question of the relations of the crystalline and the uncrystalline rocks, arriving at results similar to those of Callaway, already set forth. In the coast region of Durness and Eriboll, in Sutherlandshire, it has been asserted by previous observers that we have a distinct ascending succession from the basal Hebridian gneiss through fossiliferous Paleozoic limestones to the micaceous gneiss and schists of the central Highlands. According to Lapworth, we have at the base a great mass of coarse-grained massive gneiss, composed of feldspar and quartz, with hornblende, and more rarely with mica, the strata being nearly vertical, with a northwest and southeast strike. These rocks are the Hebridian, Lewisian or Laurentian gneiss of different observers. Resting unconformably upon this ancient gneiss is a second body of strata, gently inclined, with a general northeast and southwest strike, and consisting of two divisions, lithologically very distinct. The lower is made up of a quartzite with annelid-markings, flags, and limestones, the latter holding *Maclurea*, *Murchisonia*, *Orthoceras*, and other Lower Paleozoic forms. These uncrystalline rocks are described as the Durness or Eriboll series, and are surmounted, in apparent conformity, by the upper division. This consists of flaggy quartzose, micaceous and chloritic schists, with thick layers of hornblendic and micaceous flaggy gneiss, and includes bands of dioritic and syenitic rock, described by some writers as igneous. There is no doubt that the older gneisses are more ancient rocks underlying unconformably the fossiliferous group, the only question being as to the true relation of the latter to the younger schists and gneisses which, from their first appearance at their western outcrop, form an almost unbroken mass, extending south and east to the central Highlands, and covering an area of at least 15,000 square miles. This area includes the Caledonian and Grampian gneisses of other authors, and those who, following Murchison, maintain the reality of the apparent supra-position, are forced to regard the crystalline rocks of this area as altered Paleozoic strata newer than the Durness limestone. Various hypotheses have been put forth to explain the relation of these without admitting such a conclusion; while the British geological survey have accepted the visible sequence, as it stands, with all its consequences. Murchison noticed to the east of the fossiliferous limestone of Loch Eriboll what he regarded as an upper quartzite, but this, according to Nicoll, was but a repetition of that below the limestone, and was newer than the upper gneiss, which he believed to be a pre-Cambrian series brought up by a fault. Callaway, in like manner, maintained that there are two Eozoic gneissic series unconformable the one to the other, and that the fossiliferous group was laid down in discordance on both, and owes its apparent infra-position to the younger gneiss to dislocations. The unconformable supra-position of the fossiliferous strata to the lower gneiss is, according to Lapworth, very clear. The limestone of the Durness series, though apparently of great thickness, and with gentle dips, he finds to be made up of a few distinct lithological zones, repeated many times by a series of faults or of sigmoid flexures, and to be visibly overlaid at a low angle by wrinkled micaceous schists and flags, including zones of gneissic and hornblendic schists. Even where faulted against the limestone, this upper series appears to correspond in dip and strike with the limestone series below, thus seemingly confirming Murchison's view. All this is seen in the Durness area, but on proceeding to Loch Eriboll, which lies in a narrow valley a few miles to the south, we find on its western side the older gneiss which separates this from the valley of Durness, wherein are seen only the quartzites and limestones resting on this older or Hebridian gneiss. In the more eastern valley of Loch Eriboll, however, while the fossiliferous rocks of the Durness group overlie on its western side the older gneiss, they are seen on its eastern side clearly to overlie the newer gneiss of Murchison, upon which the quartzite rests unconformably, with a conglomerate at its base. The so-called upper quartzite is but a repetition of this.

ROCKS OF THE BLUE RIDGE.

As regards the crystalline rocks of the southern part of the Appalachian belt, J. B. Elliott has described several sections from the great valley along the border of Georgia, Tennessee, and the Carolinas. He adopts the notions advanced by Bradley and some others as to the Paleozoic age of these crystalline rocks. The Ocoee and the Knox groups of Safford, which include the Taconian and parts of the succeeding Cambrian, are supposed by Elliott to form, in a metamorphic condition, the great gneissic, micaceous, and hornblendic belt of the Blue Ridge. The view here resuscitated is not sustained by any new facts. The rocks of this region, as seen and described by the writer, in northwestern Georgia, are pre-Cambrian schists, chiefly of Montalban age, with overlying Taconian quartzites, slates, and marbles, the age and relation of which were long ago correctly pointed out by Lieber in South Carolina. The hypothesis of Bradley has no other argument in its support than that deduced from apparent stratigraphical succession, which is as valueless and misleading here as farther north along the same mountain-belt in the Alps, in Wales, or in the Scottish Highlands, in all of which regions the fallacy of the metamorphic hypothesis and the pre-Cambrian age of the crystalline schists is now established.

The recent studies of Fontaine in Virginia are important in this connection as showing the relation of the crystalline rocks of the Blue Ridge to the base of the Paleozoic series. In the interval of about sixty miles between Turk's Gap and Balcony Falls he finds three groups of rocks. The oldest, referred by him to the Laurentian, is described as consisting chiefly of coarse heavy-bedded granitoid gneisses, destitute of mica, and containing a small amount of hornblende, which is not well defined. Associated with and overlying these are massive bedded rocks, in which hornblende predominates, with a triclinic feldspar and some magnesian mica, doubtfully referred by him to the same series. The second group, called by him Huronian, includes chloritic, argillaceous, and hydro-micaceous schists, becoming epidotic, and passing into massive beds described as felsitic in character, often concretionary and amygdaloidal. This group abounds in copper, both native and in sulphuretted forms. The third group, recognized by Fontaine as the Primal series of Rogers, has here a thickness of about 2,400 feet, and consists essentially of shales, flags, sandstones, and conglomerates. In its upper fourth is found a great mass of quartzite, carrying the *Scolithus* typical of this series in Pennsylvania and elsewhere. Beneath it are intercalated quartzite beds, sometimes conglomerate, and holding pebbles of the ancient gneiss. The basal conglomerate, of unequal thickness, varies in composition with that of the adjacent Eozoic rock, of which it is chiefly composed; the pebbles being in some cases derived from the Laurentian gneisses and in others from the Huronian schists. These basal beds are infiltrated with quartz and chlorite, and in some cases are only distinguished from the underlying Huronian schists, from which they were derived, by the presence of large included fragments of these. The slates and flags of the Primal series are described by Fontaine as sometimes talcose, pearly, or nacreous in character, and as changing to kaolin by decay. They include large masses of limonite, and in some cases harder quartzose beds are charged with specular iron. The upper 500 feet of the series consists of shales, often kaolinized, containing both limonite and manganese-oxide, and graduating into the overlying magnesian limestones of the Auroral division of Rogers, which with the underlying Primal makes up the Taconian series. The great Appalachian belt of pre-Cambrian rocks, to which the Blue Ridge belongs, was overlaid in many other parts of its extent by strata of Paleozoic age, as is well known, and the relations of these give evidence that important movements of the region occurred at intervals until after the close of the Paleozoic period, and in many cases involved in folds portions of Paleozoic strata, thus giving a deceptive appearance of infra-position. The fractures which often accompany these folds still afford passage in many cases to thermal waters, and such waters, in past times, by their action upon the strata along their course have produced local changes by the development of crystalline minerals; a phenomenon alluded to above, which has been adduced as an evidence of the Paleozoic age of the true crystalline schists.

The organic forms from Bernardston, Mass., have lately been studied by Whitfield, who describes them as occurring in "metamorphic sandy shales," and also in an underlying bed of crystalline limestone. In the limestone he finds two species of *Favosites* not certainly identified, a form resembling *Syringopora*, and stems of crinoids of large size. The sandy shales called by Dana "laminated quartzites" have yielded to Whitfield species of *Strophomena*, *Spirifera*, and *Rhynchonella*, etc., besides a form of *Petraia*. From all these he concludes that the limestones are Silurian, probably of Niagara age, while the shales are of the age of the Chemung or Middle Devonian. It is remarkable that these two rocks, which at Bernardston immediately overlie each other, are separated by so wide an interval in time; a fact testifying to great stratigraphical irregularities in the region.

The fossiliferous limestones of Littleton, N. H., also intimately associated with crystalline schists, have in like manner been examined by Whitfield, who reaches the conclusion that these, including *Halysites catenulata*, *Favosites Niagarensis*, *Astrocerium venustum* Hall, and *Pentamerus nysius* are, like those of Bernardston, of Middle Silurian age, and probably belong to the Niagara.

NORTH AMERICAN CAMBRIAN.

In a late communication to the Boston Society of Natural History, Hunt proposes to consider the Cambrian rocks of the great North American basin as represented in four typical areas: (1) the Appalachian, (2) the Adirondack, (3) the Mississippi, and (4) the Cordillera area. To the first of these belongs the great thickness of much disturbed sediments along the whole eastern border of the basin, constituting the First Graywacke and the Sparry Lime-rock of Eaton; being the Upper Taconic of Emmons, and the Potsdam and Quebec groups of Logan. The Hudson-River group, as originally defined, included the whole of the Cambrian Appalachian, besides some of the underlying Taconian slates and portions of overlying Ordovician beds, of Loraine age, in consequence of which the name of Hudson-River group came to be regarded as the paleontological equivalent for the Loraine. The Adirondack area of the Cambrian includes the stable and little-disturbed area around the Adirondack Mountains, embracing the Champlain and Ottawa Basins, in which the series is represented only by the Potsdam and Calciferous divisions, corresponding apparently to but a small portion of Cambrian time. The physical conditions of the Mississippi area, as seen in the valley of the upper Mississippi, appear to have been similar to those of the Adirondack region. The region of the Cordilleras, in which great developments of Cambrian rocks are met with, presents conditions of deposition unlike the other. While in the Adirondack area there is a break, both paleontological and stratigraphical, between the Cambrian and the Ordovician, which begins in some places with the Chazy and in others with the Trenton, we have, according to the late studies of Walcott in Nevada, a gradual passage from the Cambrian to the Ordovician (Lower Silurian or second fauna of Barraude). "In this section," he remarks, "we have an illustration of the gradual extinction of an older fauna as a new one is introduced, the sedimentation continuing, and no physical disturbance occurring to change the conditions of animal life." The break between the Calciferous and the Chazy is here filled. It is to be remarked in this connection that the fossils of the Levis limestone of Canada (the Sparry Lime-rock of Eaton) were long since declared by Billings to occupy an intermediate position, and constitute a passage from the Calciferous to the Chazy. From the incomplete data which we now possess with regard to the lower Paleozoic rocks of the northwest side of Newfoundland, there is little doubt that further studies there will add to our knowledge of the relations of the first and second faunas, and help to illustrate the conception of an unbroken succession. The notion that breaks, unconformities, and sudden transitions should form the basis of classification in stratified rocks, is growing obsolete. (See further, for details of the Paleozoic rocks of the Cordillera region, the account of the Geology of the Eureka district in Nevada.)

In the Grand Cañon of the Colorado there is found immediately below the Devonian a series of Cambrian strata, known as the Tonto group, containing an abundant fauna like that of the Potsdam of the Mississippi area. This group rests unconformably upon a vast series of uncrystalline shales, sandstones, and limestones, measuring over 11,000 feet, and including 1,000 feet of interbedded igneous rocks, constituting the Grand Cañon and Chu-ar groups of Powell. These have afforded some few organic forms, as yet undescribed, which lead Walcott to regard this lower series, lying between the Tonto group and the crystalline rocks below, as also of Cambrian age, though they had previously been regarded by Powell as pre-Cambrian. These rocks, judging from the collections seen by the writer, are wholly uncrystalline sandstones and shales, unlike the Taconian in character, and it is suggested by Walcott that they may correspond to the Keweenian, which occupies a position between the Taconian and the Potsdam, being separated from this latter by a great unconformity and vast erosion. The Keweenian, moreover, as the writer has shown, presents evidences of organic forms. Until, however, these rocks of the Grand Cañon and of the Keweenian series shall have been found to include the representatives of the first fauna of Barrande it would be unphilosophical to include either of them in the Cambrian. Few thoughtful geologists now suppose this fauna to mark the dawn of organic life, and we may hope to find beneath its horizon a long series of organic forms stretching far backward through what have been aptly termed the Transition rocks to those of the Primitive time.

The great series of silicious and argillaceous rocks, with some included limestones and beds of crystalline iron ores, found to the northwest of Lake Superior, which were provisionally designated by the present writer as the Animikie series, have since been studied by N. H. Winchell, in Minnesota, and found to have a thickness of not less than 10,000 feet. These rocks, which underlie the Keweenian, are, in the absence of these, unconformably overlaid by the horizontal Cambrian sandstones of the Mississippi area, as is well seen on the Saint Louis River, in Minnesota, and have been by the writer referred to the Taconian. They have lately yielded him the remains of an organism believed to be a sponge. The Keweenian series itself in places rests upon these rocks, as elsewhere upon the Huronian, the Laurentian, and at Duluth, upon rocks which have been referred by the writer to the Norian series. He has suggested that, as long since claimed by Emmons and Houghton, some of the iron-ore-bearing rocks of northern Michigan belong to the Animikie or Taconian series, although hitherto confounded with the Huronian rocks of the region, with which both here and in the Atlantic belt they have certain resemblances.

The Cambrian rocks along the eastern side of the Atlantic belt, as seen in Newfoundland, New Brunswick, and Massachusetts, present an important field for comparative study. W. S. Dodge has lately reexamined these rocks, as seen in the latter region. The argillites and conglomerates of the Boston basin, as has long been known, afford at Braintree a Cambrian fauna, which has been referred to the Menevian horizon. It is there found abundantly in argillite beds, which dip with a high angle to the south, and have a maximum thickness of 500 feet. Their precise relation to the conglomerates of the region is left undetermined. These strata are traversed both by feldspathic and by pyroxenic eruptive rocks. Mr. Dodge there distinguishes an older (the Braintree) and a younger (the Quincy) syenite, the latter holding numerous fragments of a fine-grained black diabase, as well as fragments of a fine-grained syenite, but it is not clear that any of these are derived from the older syenite. The younger of these overlies the slates, and the older would also appear to be more recent than these, but the point is not clearly brought out. The slates in the vicinity of the intrusive masses are altered, and present large oval cavities partially filled with epidote, sometimes irregularly distributed and sometimes scattered along discolored bands parallel to the stratification. The writer has observed similar conditions elsewhere in the slates of the Boston basin in proximity to intrusive rocks.

SILURIAN, CAMBRIAN, AND TACONIAN.

I. C. White, of the second geological survey of Pennsylvania, has described the unconformable superposition of the Oneida sandstone, the base of the (true) Silurian, to the Hudson-River group, as well seen on the Erie railroad near Otisville, N. Y., the dip of the former being there 28° and that of the latter 43° to the north, while the lower series has an eroded surface, and has, moreover, furnished fragments to the overlying sandstone. Similar evidences are seen at the Lehigh Water-gap. This stratigraphical unconformity, though sometimes questioned, was long since pointed out by H. D. Rogers, and was confirmed by the present writer in 1878. In this connection, there arises an important question as to the geological position of the so-called Hudson-River slates. The evidence from the valleys of central Pennsylvania, as well as on the north shore of Lake Ontario, is that there is no unconformity nor stratigraphical break between the Oneida sandstone and the Loraine shales, which are often regarded as identical with the Hudson-River slates. As has, however, been pointed out by the present writer, the Hudson-River group, as at first proposed by Vanuxem, was by him made to include not less than three distinct groups of argillaceous strata, two of which he declared to be—in eastern Pennsylvania, at least—geographically distinct, namely, the fossiliferous Loraine shales of the central valleys, there lying conformably beneath the Oneida sandstones, and the non-fossiliferous argillites of the great Appalachian valley, which, as described above, are unconformably overlaid by this same Oneida sandstone. The Loraine shales, according to Hunt, are, so far as yet known, unrepresented in the great valley, where, however, besides the roofing-slates belonging to the Lower Taconic—the Transition Argillite of Eaton—there is in many places a great development of red sandstone, conglomerates, and argillites, the continuation in Pennsylvania of the First Graywacke of Eaton, which from southern New York is traced east of the Hudson, and thence to Quebec and beyond. This is the Cambrian of the Appalachian area, the Upper Taconic of Emmons, and the Potsdam and Quebec groups of Logan, which, from the valley of the Hudson to that of the Saint Lawrence, has been known as the Hudson-River group, with the inclusion, however, in parts of its distribution, as in Pennsylvania, of Lower Taconic slates, and elsewhere of overlying Loraine shales.

The appended table representing the nomenclature of Eaton, as proposed by him fifty years since, with the modern names given to his divisions, will serve to show the relations of the great groups mentioned to the Silurian rocks above and the older crystalline strata beneath, and may be read in connection with the classification of Eozoic and Paleozoic rocks given in the report for 1882. The Potsdam sandstone had not, in the time of Eaton, been recognized as distinct from the Calciferous sand-rocks. The student of American geology familiar with its history will note that the great stratigraphical error of Mather and his followers was in denying the distinctness of the First Graywacke of Eaton, and in asserting its identity with the Second Graywacke, or, in other words, in denying the existence of a Graywacke series beneath the horizon of the Trenton limestone. There are, in fact, two such lower series, for the great mass of sandstones and shales which make up the Primal of Rogers, and, as they occur in Virginia, have been described above by Fontaine, occupy a position below the granular lime-rock of Eaton, and constitute a Taconian Graywacke, not indicated in the table.

Eaton's Nomenclature (1832).			Later Names.	
III. Lower Secondary.	3. Corniferous Lime-rock		Upper Helderberg	Devonian.
	3. Geodiferous Lime-rock		Niagara	Silurian.
	2. Millstone-grit	Second Graywacke.	Oneida—Medina	Silurian.
	1. Graywacke-slate	Second Graywacke.	Utica—Loraine	Ordovician. (Upper Cambrian.)
II. Transition.	3. Metalliferous Lime-rock		Chazy—Trenton	Ordovician. (Upper Cambrian.)
	3. Sparry Lime-rock. Calciferous Sand-rock		Upper Taconic. (Quebec Group.)	Cambrian. (Middle and Lower Cambrian.)
	2. Millstone-grit	First Graywacke.	Upper Taconic. (Quebec Group.)	Cambrian. (Middle and Lower Cambrian.)
	2. Graywacke-slate	First Graywacke.	Upper Taconic. (Quebec Group.)	Cambrian. (Middle and Lower Cambrian.)
	1. Argillite		Lower Taconic. (Itacolumitic Group.)	Taconian.
I. Primitive.	3. Granular Lime-rock		Lower Taconic. (Itacolumitic Group.)	Taconian.
	2. Granular Quartz-rock		Lower Taconic. (Itacolumitic Group.)	Taconian.
	1. Gneiss and other Crystalline Rocks		Huronian. Montalban. Laurentian. Norian. Arvonian.	

The distinctness of the Taconian from the overlying Cambrian, at one time included with it under the name of Upper Taconic, being apparent, there is no longer any reason for calling the latter Taconic, or using this name as a synonym for Cambrian, as is done by Marcou; nor yet in arguing, from the Cambrian fauna found in the upper rocks, the Cambrian or Lower Silurian age of the Lower Taconic, as is done by Dana.

In the last year's report reference was made to the recognition by Crosby of a great series of rocks in Trinidad, the Caribbean group of Guppy, which are unconformably overlaid by fossiliferous Cambrian strata, and have moreover the lithological characters of the North American Taconian, the Lower Taconic of Emmons, and the Itacolumitic group of Lieber. Crosby has since noticed a great development in the mountains of eastern Cuba of a similar series, where they form a belt six or eight miles wide, and are highly inclined, with an east and west strike. They include great masses of white crystalline limestone, often micaceous and associated with hydro-micaceous and chloritic schists. These, with the similar rocks of Trinidad and the Spanish Main, he compares with the Lower Taconic rocks of western New England, and designates as Taconian. They are, according to him, entirely distinct from another great series of uncrystalline limestones with sandstones and fissile slates, with which they have been confounded, which, though they have as yet yielded no fossils, are supposed to be equivalent to the Mesozoic and Tertiary strata of San Domingo and Jamaica.

GEOLOGY OF SPAIN.

Barrois has lately published an important memoir on the ancient rocks of Galicia and the Asturias in Spain, some of the results of which throw light on American geology. The primitive rocks of the Cantabrian chain, granites, gneisses, and crystalline schists, are in these provinces overlaid by a great mass of strata including the whole Paleozoic succession from the base of the Cambrian to the top of the coal measures. In the province of Toledo the base of this series is a Scolithus sandstone, which, according to Cortazar, there rests directly upon the crystalline schists; but in the Asturias there are found beneath a similar sandstone a hundred meters or more of limestone and shales containing an abundant Cambrian fauna, including several species of *Paradoxides*, with *Conocephalites*, *Arionellus*, and a cystidean. Between these fossiliferous strata and the crystalline schists there intervenes in the region under notice a volume of not less than 3,000 meters of strata described as argillites and quartzites, with dolomites and limestones, sometimes saccharoidal and cipolin marbles, with beds of specular iron. This great series of unfossiliferous strata is included with the overlying fossiliferous beds by Barrois, under the common name of Cambrian, which he defines as including the first fauna of Barrande. To these succeed immediately, and without a stratigraphical break, the Scolithus beds that contain, besides, *Bilobites* and *Cruziana*, and are described as identical in character with the Armorican sandstone of Brittany. They are followed by a great concordant series, in which the forms of Barrande's second and third faunas are abundant. These strata, measuring in all about 600 meters, with the basal sandstone, have near the middle the roofing-slates of Luarca, which, like those of Angers in France, contain the forms of the second (or Ordovician) faunas, while higher in the series are slates and limestones with the third or true Silurian fauna. Barrois applies the name of Silurian to the rocks of both the second and third faunas, and includes therein, though not without hesitation, the Scolithus sandstone, which he admits should, in accordance with the views of British geologists, be included with the first fauna. The Scolithus of these sandstones would seem to be similar to that of the Potsdam of the Adirondack region (long since shown to be distinct from that of the Primal sandstone of Rogers), and is described by Barrois as exhibiting an internal tube, and as resembling *Verticillopora*, to which he compares it. The Scolithus found at Port Henry on Lake Champlain shows this internal tube.

The American geologist is here reminded of the typical Potsdam which rests on the crystalline rocks in the Adirondack region, while near by, in Vermont and New York, are found the slates and limestones of a still lower Cambrian horizon, the so-called Lower Potsdam, between which and the ancient crystalline rocks are interposed, along the Appalachians, several thousand feet of quartzites, slates, and limestones, constituting the Taconian, which may well be represented by the 3,000 meters of strata found by Barrois in Galicia between the primitive schists and the base of the fossiliferous Cambrian.

The Devonian, which overlies conformably the Silurian in this part of Spain, has a thickness of not less than 1,000 meters, and includes a great amount of limestones and an abundant fauna. It is succeeded by the carboniferous, having at its base a great limestone member, and above, 2,000 or 3,000 meters of coal measures, with more than eighty coal seams, many of them of value. The carboniferous limestone is in part dolomitic, and is remarkable for its great deposits of ores of zinc, lead, manganese, cobalt, and mercury, which are found in veins and fissures in these rocks, and according to Sullivan and O'Reilly are post-Eocene in age.

TRIAS OF EASTERN NORTH AMERICA.

Prof. George H. Cook has discussed the history of the Mesozoic areas of eastern North America, constituting the new red sandstone, which probably include both Jurassic and Triassic beds, and have already been considered in the report of last year. Cook regards those from South Carolina to Massachusetts, and probably also those of the British provinces, as having been at one time in some way connected, and supposes that a great extent of these sediments thus defined was after wards broken up into the present areas by a number of axes of elevation, or else by great faults.

Dana has since reviewed this subject at some length and takes a different view. He remarks that Cook's supposed area, 1,000 miles or more in length, of Mesozoic sandstones, now covering regions that are 1,000 feet or more above sea-level, must either have been marine or lacustrine, neither of which conclusions is in accordance with what we know of the rocks in question. Those of the Connecticut valley are apparently of fluvatile and estuary origin, and the same is probably true of other areas. The deposits of coarse and fine material, as long since pointed out by Edward Hitchcock, came from rocks bordering on the existing areas, and show that the basin could not have extended much beyond its present limits. The materials bear evidence, in the distribution of materials of varying coarseness, of alternate swift and slow currents. The coarser sediments are most common along the borders of the present areas, where, however, they occur interruptedly.

In all these respects their distribution corresponds to that of the latter valley-deposits of the Connecticut River. The elements of the sandstones are the result of mechanical disintegration of the crystalline rocks of the margin, including not only quartz but undecayed feldspar, suggesting, as remarked by Dana, a disintegration of the adjacent crystalline rocks. He notes in this connection, that "disintegration by the rusting of the mica (biotite) is now making (to the east of New Haven), just such granitic sand as constitutes the coarse (Triassic) sandstone of East Haven." Dana compares the material of the Trias of the Connecticut valley to the stratified drift of post-Pliocene age in the same valley, and conceives these Mesozoic sandstones and conglomerates to have accumulated in a great estuary in a glaciated region. The various Triassic areas are parallel to old lines of uplift, which in Pennsylvania correspond to the sigmoid form of the ancient topography. This great area was distinct from that of the Connecticut valley.

SERPENTINES AND RELATED ROCKS.

The question of the geological age and the origin of serpentines was discussed in the report for 1882. The present writer has since published an extended memoir on serpentines, repeating with detail many of the facts there noticed, and recalling the history of the serpentines as found at various geological horizons in the Laurentian, the Huronian, the Montalban, and the Taconian series, as well as the later development of it in the Silurian, in the remarkable bed of serpentine formerly exposed among the dolomitic strata of the Onondaga salt-group at Syracuse, N. Y. He has noticed the serpentine associated with limestone in the Laurentian series at New Rochelle, N. Y., where it occurs, both mingled with limestone, forming varieties of ophicalcite like those common elsewhere in the Laurentian, and also constituting great bedded masses, the whole interstratified with the gneisses of the series.

He has further described the remarkable locality of serpentine on Staten Island. This, which forms a bold ridge of some miles in length, was formerly described as eruptive, and correlated with the intrusive diabase belt of the Mesozoic, which extends parallel with it, a little to the west, on the same island. While the Triassic sandstone lies along the western base of the serpentine ridge, its southern and eastern bases are covered by nearly horizontal Cretaceous beds. Britton, who redescribed and mapped this region in 1880, regarded it as a protruding mass, belonging to the Eozoic rocks below, a view confirmed by the present writer, according to whom its prominent position is due to the fact that it was left exposed by the subaërial decay of the inclosing gneiss rocks—which became kaolinized, while the serpentine, though softer, resists to a greater extent chemical change—and was subsequently surrounded by Mesozoic strata, from the midst of which it now rises.

The similar occurrences of serpentine in New York City, at Hoboken, and again in Chester County, Pennsylvania, are also redescribed by the writer. The latter appear as protruding masses among gneisses and mica-schists referred to the younger or Montalban series; but it remains uncertain whether their stratigraphical place is in these or in the older Laurentian gneisses, which underlie them directly in these regions. The Laurentian of the high lands on Manhattan Island appears to be overlaid in parts by areas of younger gneisses and mica-schists, the remaining portions of a mantle of Montalban; a circumstance which makes it doubtful whether the serpentine masses are to be referred to the one or to the other series, though they are regarded as probably Laurentian.

The writer has also described in detail the mass of serpentine and euphotide which rises from the Tertiary rocks at Monteferrato, in Tuscany, and shows that it is not intrusive, but a protruding portion of the underlying Eozoic series, identical with the greenstone group of the Alps, and probably Huronian. He maintains the aqueous origin of serpentine, and its formation from sea-water through the intervention of solutions of silicate of lime or soda from subterranean sources. The relations of the serpentine to the limestones, with which they are often associated, are compared to those of bedded or concretionary flint or chert. While many geologists have concluded, from the results of microscopic study and the frequent association of olivine and enstatite with serpentine, that the latter has been formed by the hydration of the two silicates before named, several recent Italian observers, among them Issel, Mazzuoli, and Capacci, suppose the material of serpentine to have been ejected in a hydrated form from the earth's interior into the sea, as an aqueous magma, which consolidated into serpentine, and by dehydration gave rise to the olivine and enstatite often found with it. This hydroplutonic hypothesis, confessedly gratuitous, is a concession to the evidence in favor of the apparently aqueous deposition of serpentine rocks.

In this connection should be mentioned the recent conclusions with regard to the great deposits of olivine rock, once described as of igneous and eruptive origin, but, from recent observations in many parts of the globe, now coming to be regarded as a stratified indigenous rock. The recent studies of Törnebohm, Brögger, and others of the olivine rocks of Norway unite in showing it to be one of the stratified rocks of that region, where it is intercalated with other crystalline schists. A similar conclusion was announced by the present writer, in 1879, with regard to the bedded olivine rocks of North Carolina; while the recent studies in Greece, by Diller, show that the olivine rock of Mount Ida, in the Troad, passes into olivine-bearing talcose schists, and is associated with crystalline limestones and with other crystalline schists. Julien has recently discussed the olivine rocks of North Carolina, of which he recognizes the sedimentary character and their interstratification with hornblendic, talcose, and chalcedonic rocks, which he supposes to result from the alteration of the olivine; but he seeks for the origin of all this in beds of olivine sand, for which he imagines an igneous source. Varieties of olivine are known to be formed by igneous fusion, but its mode of occurrence in these and other crystalline schists, and in crystalline limestones, is incompatible with such an origin, and only explicable on the theory of its aqueous origin.

This question assumes a curious geological importance in connection with the hypothesis of the permanency of oceanic basins. The little reefs which make up the islands of St. Paul are situated nearly under the equator, in the mid-Atlantic, longitude 29° 2′ west, and rise abruptly from 400 or 500 fathoms of water, which are found within one and two miles of them. The rocks of which they consist have just been examined by Rénard and found to consist of a common variety of olivine rock, containing, besides this mineral, portions of actinolite, and a variety of pyroxene, with grains of chromite or picotite; the whole arrangement of these elements resembling greatly the so-called gneissic structure which characterizes certain crystalline schists. In a word, the rock of St. Paul's has the characters of an Eozoic crystalline schist rather than those of an eruptive rock. It has been suggested that these little islands are the remaining summit of a submerged continental area, a vanished Atlantis, the mountain peaks of which were of crystalline schists, a view to which Rénard inclines, and which co-incides with the conclusions now deduced from the study of similar rocks in Norway, in Greece, and in North America. The significance of the discovery in mid-ocean of stratiform crystalline rocks like those of our continental areas is obvious.

SILICIOUS DEPOSITS.

Sorby's microscopical observations in 1880 showed that in many sandstones there has been a deposit of silica in the form of quartz upon the detrital grains of this mineral composing the rock, in such a manner that there is perfect optical and crystalline continuity between these and the deposited layer, each fragment serving as a nucleus and having been changed into a definite crystal. This process, by infiltration, has served to consolidate the grains in many cases into a hard quartzite. The careful microscopic studies of Irving have furnished many illustrations of this process in the Potsdam and Saint Peter's sandstones in Wisconsin. The crystalline nature of many sandstones was long ago pointed out by Élie de Beaumont, and later by Daubrée. Brainard, of Ohio, in 1860, called attention to the crystalline character of certain sandstones in that State, which he then conceived to be due to chemical deposition from water. Young's later observations are to the same effect, and show that the deposited quartz is oriented with the inclosed grain. Irving notices that the tendency of silica to deposit itself upon a crystalline nucleus has been exerted on the surface of weathered sandstones, forming thereon a vitreous crust. A deposition of dissolved silica is also conspicuous in the Potsdam sandstone of Lake Champlain, as described by the writer, where certain beds are changed into hard quartzite and others are made up of grains agglutinated by a chalcedonic cement. From similar facts Hall long since concluded that the beds of Potsdam sandstone in Iowa had been in great part deposited from aqueous solution. It is probably in the absence of nuclei which determine the crystallization of dissolved silica that this substance often separates in a hydrated uncrystalline form as hyalite, opal, or silicious sinter.

THE ORIGIN OF IRON ORES.

The great deposits of magnetite and specular iron are generally held to be of aqueous origin, though some have maintained them to be eruptive. It is known that magnetite crystallizes out during the slow cooling from fusion of basic ferriferous silicates, and is common in many eruptive rocks. Julian has suggested that the separation of magnetite from these, and its concentration by the action of water, as seen in the washing of sands on a beach, may have given rise to the beds of magnetic iron ore found in crystalline stratified rocks. This view has been criticised by Newberry, who maintains the accepted theory, that they have been deposited from solution. He points out that these beds are often of great thickness, and are frequently directly inclosed in crystalline limestones, or in highly argillaceous schists, both of which rocks indicate a very different mode of deposition to that required for iron sands, which, as concentrated on our sea-shores, are also accompanied by layers of quartz sand.

PALEOZOIC ROCKS OF NEVADA.

Arnold Hague, in a preliminary report of the Geological Survey of the United States, has given us the results of a detailed study of the geology of the Eureka district in Nevada, with the help of Walcott in paleontology and Iddings in lithology. This district was selected both as a typical region for the study of the geology of the Great Basin, and also as one of economic importance from its mines of precious metals. From the great plateau, here about 6,000 feet above sea-level, the Eureka Mountains rise from 2,500 to 4.000 feet, and form an almost detached mass of Paleozoic strata, with eruptive rocks of Paleozoic and more recent dates. The Paleozoic sediments of the region have been broken up by an intricate system of faults, with flexures, into several great masses or blocks, from a comparative study of which it has been possible to reconstruct the geological succession, and with the aid of paleontology to give a more complete view than has yet been obtained of the Paleozoic series of the Great Basin. The stratigraphical column, from the lowest exposed beds of the Cambrian to the summit of the coal measures, has a thickness of not less than 30,000 feet, of which over 11,000 feet are limestones or dolomites, and 5,000 feet quartzite, and presents but a single break, which, marked by unconformity, appear in the midst of the second fauna. The name of Silurian is given by the author to the rocks holding the second and third faunas of Barrande, that of Cambrian being reserved for the first, but in the great conformable sequence here displayed the transitions between these three faunas are marked by such gradations that the dividing lines adopted for these divisions are confessedly arbitrary.

Of the 7,700 feet assigned to the Cambrian, the lowest member, the base of which is not displayed, is the Prospect Hill quartzite, 1,500 feet in thickness, to which succeeds the great mass of more or less magnesian limestone of 3,000 feet, known by the same local name. Between these two occur the first fossiliferous beds, known as the *Olenellus* shales, which have afforded a fauna closely related to that of the slates of Georgia, in Vermont, a portion of the old Hudson-River group, subsequently called Lower Potsdam by Billings. In the great mass of the Prospect Mountain limestone and its overlying Secret Cañon shales, with more or less limestone (2,000 feet), followed by the Hamburg limestone (1,200 feet), and the Hamburg shales with chert nodules and layers (500 feet), which is regarded as the summit of the Cambrian, we have at various horizons an abundant fauna, which is closely related to that of the Potsdam of the Upper Mississippi. We have thus in conformable succession in this region the divisions hitherto called Lower and Upper Potsdam, the two ranging through more than 6,000 feet of strata. To the Hamburg shales succeed the Pogonip group, consisting of 2,700 feet of limestones, with some argillaceous and arenaceous beds, overlaid by the Eureka quartzite, compact, vitreous, and 500 feet thick, without fossils.

The forms of the first fauna pass upwards from the Hamburg shales some distance into the Pogonip group, which higher up contains an abundant fauna, compared with that of the Chazy, with some forms characteristic of the Trenton. It is worthy of note that in this group but a single undetermined graptolite is as yet known. At the top of the Eureka quartzite is a marked stratigraphical break, above which occurs the Lone Mountain limestone 1,800 feet thick, containing Trenton fossils in its lower part, and corals, apparently of Niagara age, toward the top. Although this mass is assumed as the summit of the Silurian, it is said to graduate imperceptibly upward into the great Nevada limestone, which, with its interbedded shales and quartzites, has a thickness of 6,000 feet and is characterized throughout by a Devonian fauna, including representatives of Upper Helderberg, Hamilton, and Chemung. The 2,000 feet of the White Pine shales, above the Nevada limestone, containing some remains of land-plants, include an invertebrate fauna indicating a passage to the Carboniferous. This has as its lowest member the Diamond Peak quartzite, shaly at the base, but for the most part hard and vitreous, again becoming slaty near the summit, and including, about 500 feet from the base, a thin band of fossiliferous limestone. Above this comes the Lower Carboniferous limestone (3,800 feet), separated by the Weber conglomerate (2,000 feet) from the Upper Carboniferous, the summit of the Paleozoic column. Both of these limestones are highly fossiliferous. The Silurian and Devonian strata of the Lone Mountain and Nevada limestones are seen in places in the district to rest unconformably upon the Eureka quartzite, while elsewhere these Carboniferous limestones repose directly upon the Pogonip limestones, the whole intermediate series of 10,000 feet being absent.

The ancient crystalline rocks of this district are very few. A single small outcrop of granitic rock appears, and porphyroid granites and quartziferous porphyries are described as breaking through and locally altering the Pogonip limestone. The later eruptive rocks, Tertiary and post-Tertiary in age, are described as hornblende-andesite, augite-andesite, dacite, or quartziferous hornblende-andesite, and rhyolite or quartziferous trachyte, together with basalt. The dacite followed the hornblende-andesite, and the rhyolite the dacite, all of which in turn are cut by the basalts. The rocks described as basalt vary greatly in composition from the ordinary type of about 50 per cent. to over 60 per cent. of silica. These more silicious basalts are descirbed as destitute of olivine.

These igneous rocks do not appear to have come from central volcanic vents, but have been erupted along great meridional lines of faulting, and are often found bordering the uplifted blocks of Paleozoic sediments. The chief localities of these rocks are along the east and west sides of a great depressed block of Carboniferous strata, which is nearly surrounded by outflows of Tertiary lavas. Among these are noticed great numbers of local extrusions which are wholly independent at, the surface, from neighboring masses. The whole condition of things suggests forcibly that these great accumulations of Paleozoic strata are or were immediately underlaid by a floor of crystalline rocks in a state of plasticity.

THE COMSTOCK LODE.

G. F. Becker has given, in the reports of the United States Geological Survey, a preliminary account of a more extended study of the geology of the Washoe district and the Comstock lode, while for a detailed account of the lithology of the region we must await the final report. It is well known that this immense quartz lode, which has yielded over $315,000,000 of bullion in the last twenty-five years, is in great part included in erupted rocks of Tertiary age. The study of these, and of their changes under the influence of the heated waters, which have doubtless brought in the materials of the lode, is full of interest, and shows the frequent production of epidote and of chlorite by the transformation of the original mineral species. The hypothesis which has been advanced, that the high temperature of the mine-waters and their inclosing rocks is due to the chemical changes in these, connected with kaolinization of the feldspars, is discussed and rejected. The feldspars are not kaolinized, nor do the waters contain the large amount of dissolved silica and alkalies which would be derived from such a process. Furthermore, there is no reason for believing that such a transformation of the feldspars would generate heat. Analogy would suggest that heat should be rendered latent in such a process. It is suggested that the source of the abundant water of the mine is to be found in the precipitation on the high crests of the Sierras, to the west, and that it reaches the lode through deep-seated channels, in which it becomes heated. The mine-waters are charged with carbonic acid, and that encountered at a depth of 3,000 feet, having a temperature of 170° F., was found to be charged with hydrogen-sulphide. Such waters have probably been the efficient agents in filling the lode with quartz and precious metals. The well-known Steamboat Springs, at a lower level, a few miles distant, still discharge waters at a boiling heat, along a fissure parallel to the great lode, and near to the contact of ancient massive rocks and andesites. The waters of these springs, impregnated with hydrogen sulphide, still deposit silica and cinnabar on the walls of the fissures, all of which facts are recalled by Becker in this connection. It may here be mentioned that evidence collected by the present writer at the locality shows that the discharge of water and vapor at the Steamboat Springs has diminished considerably since the opening of the deep levels of the Comstock lode.

The theory that the filling of mineral veins, in many cases at least, comes from lateral secretion, is considered by Becker, and it is shown that the unchanged diabase of the Comstock lode contains, chiefly in the augite, a noteworthy amount of both gold and silver; and, moreover, that the diabase which has been modified by water has lost one-half of this amount. It is also shown that the total exposure of diabase is sufficient to account for far more bullion than has been extracted from the mines. It is in connection with this rock that the richest ore-bodies have been found, while those in contact with the ancient diorite are comparatively barren; all of which facts would seem to favor the hypothesis that the supply of the precious metals in the lode has been dissolved from the diabase. The present writer, twenty-five years since, called attention to the dissemination of small quantities of ores of copper and of nickel in the greenstones of the Huronian series, and also to the fact that, while the quartz lodes carrying copper (and sometimes nickel ores) pass from the greenstones into the adjacent quartzites, they become barren; a fact which was regarded as evidence that these veins were filled by lateral secretion.

GEOGRAPHY.

By Commander F. M. Green, U. S. N.

While the area of unexplored regions of the earth's surface does not seem to have been materially decreased during 1883, a large amount of knowledge has been derived from the labors of travelers, explorers, and surveyors during that time.

Among the problems affecting geography in general the one to which the most attention has been drawn during the last year is that of a common prime meridian or the selection of a point from which all nations shall agree to reckon longitude. Strange as it may appear, sentimental considerations seem to have had a large share in forming the opinions expressed on this subject, and no plan appears to have met with such general approval as that of drawing the prime meridian through some point in the ocean away from the capital of any country, so that no national susceptibilities need be offended. It would seem that a very few words should serve to dispel such an idea. As longitudes are now measured, the starting point must be either a portable or permanent observatory, connected with a telegraphic system of cables and shore lines, in order that the local times of various places may be telegraphically compared. These conditions would be impossible with a prime meridian in the middle of the Pacific or the Atlantic Ocean, while they are completely fulfilled at Greenwich, where by the tacit or expressed consent of nearly all nations the prime meridian is now placed.

At the seventh general conference of the International Geodetic Association, held at Rome, October 23, 1883, it was formally resolved to propose to the Governments interested to select for the initial meridian that of Greenwich, defined by a point midway between the two pillars of the transit circle of the Royal Observatory.

An international convention, called at the instance of the United States Government, will meet at Washington in the autumn of 1884 to endeavor to agree upon this or some other prime meridian.

Pendulum observations of the force of gravity as a factor in the investigations of the figure of the earth have been continued by officers of the United States Coast Survey. In the United States the principal stations at which pendulums have been oscillated are Albany, Hoboken, Baltimore, Washington, Saint Augustine, and San Francisco. The three invariable pendulums previously swung at Greenwich, Kew, London, and Washington having been left in charge of the Coast Survey, advantage was taken of the presence of observers skilled in pendulum work with the expeditions for the observation of the transit of Venus and of the total solar eclipse of May 6, 1883, to obtain results for gravity at widely separated stations. Observations were accordingly made at Auckland, New Zealand; Sydney, New South Wales; Singapore, Tokio, Caroline Island, Honolulu, (at a station in Maui occupied by De Freycinet in 1819,) and at San Francisco.

As indicating the widely spread interest in geographical study, reference may be made to a list of geographical societies and geographical magazines recently published in the ninth volume of the Geographischer Jahrbuch, the former numbering seventy-nine and the latter one hundred and nineteen.

HYDROGRAPHY.

The only original survey of foreign coasts prosecuted under the direction of the United States Hydrographic Office during the year has been the continuation of the survey of the Pacific coast of Central America by the officers of the United States steamer Ranger.

Lieut. Commander Z. L. Tanner, in the United States Fish Commission steamer Albatross, has performed a most valuable work in running lines of soundings during the last winter in the Atlantic Ocean and Caribbean Sea, and disproving the existence of alleged shoals and dangers which have for years disfigured the charts. The details of the work will properly be included in the summary for 1884.

The United States Coast Survey have continued the deep-sea explorations which have been prosecuted for several years past in the western part of the North Atlantic Ocean. During the winter of 1882–'83 a systematic examination of the ocean bed between Bermuda and the Bahamas was made, extending to the eastward as far as St. Thomas. Numerous deep-sea soundings and dredgings were made, with observations of surface, serial, and bottom temperature. One most noteworthy result of this cruise, which was performed by the steamer Blake, commanded by Lieut. Commander W. H. Brownson, U. S. N., was the finding of the great depth of 4,561 fathoms, or 5.2 statute miles, nearly, about 75 miles to the northward of Porto Rico. The bottom temperature was found to be 36¼° F., and the specimen-cup brought up brown ooze. This is believed to be the greatest depth from which bottom has been brought up. The sounding was made with one of Commander Sigsbee's piano-wire sounding machines.

The British Admiralty have employed nine vessels, with fifty-seven officers and four hundred and sixty-eight men, in surveying the shores of the United Kingdom, the China Sea, Korea, Borneo, islands in the Western Pacific Ocean, Australia, Newfoundland, the Bahama Islands, the Rio de la Plata, and the Straits of Magellan. A careful examination of the Straits of Sunda was also made to ascertain and lay down the changes caused by the Krakatoa volcanic eruption.

In June an expedition, organized by the French ministry of marine and under the superintendence of A. Milne-Edwards, sailed from Rochefort on the French government steamer Talisman for the exploration of that portion of the Atlantic Ocean off the western coast of Africa in the vicinity of the Cape de Verde, Canary, and Azores islands and the Sargasso Sea.

Very numerous soundings and dredgings were made, the latter resulting in the finding of very many new and interesting species. The greatest depth found seems to have beeen 3,427 fathoms, between the Cape de Verde islands and the Azores, about the 25th parallel of latitude. As the depths found indicate a contour of the ocean bottom largely differing from that shown in a recent German bathymetrical chart, it is evident that the locality needs further examination. The bed of the Sargasso Sea was found to consist of a thick layer of fine volcanic mud, with fragments of pumice and rock. A vast volcanic chain appears to stretch parallel with the African shore, the Cape de Verde islands, the Canary group, Madeira, and the Azores being the only parts of it not submerged. About the 1st of September the Talisman returned to Rochefort.

The physical survey of the Mediterranean Sea under the direction of the Italian Government, has been continued by Captain Magnaghi, of the Italian navy, in the Government steamer Washington. This undertaking has now been in progress for three years, under the patronage of the Accademia dei Lincei.

The official report of the Norwegian expedition for the exploration of the North Atlantic, in 1876–'77–'78, has been published. Volumes IV and V contain a historical account of the expedition, with the geographical, astronomical, magnetic, and natural history observations. The general objects of the expedition were the determination of the contour of the bottom by sounding, the investigation of the rate and direction of currents, and of the physical condition and chemical constituents of sea-water, as well as zoological, botanical, meteorological, and magnetic work. The region examined lies, generally speaking, between the west coast of Norway and a line drawn from Iceland to Spitzbergen. The greatest sea depth found was rather more than 2,000 fathoms, between Jan Mayen and Spitzbergen. Aside from the deep-sea work, the most interesting geographical results of this excellently managed expedition are derived from Dr. Mohn's examination of the island of Jan Mayen, an extinct volcano 6,400 feet high, and from his remarks on Bear Island and Spitzbergen. The volumes of this report are most liberally circulated by the Norwegian Government.

The preliminary report of the Superintendent of the United States Coast Survey states that the work of connecting points in the various States of the Union by triangulation has been carried on in Maine, New Hampshire, Vermont, New York, New Jersey, Pennsylvania, Delaware, Virginia, Maryland, District of Columbia, West Virginia, Ohio, Kentucky, Tennessee, Indiana, Illinois, Wisconsin, Nebraska, Arkansas, Missouri, Colorado, and Nevada. A special work of triangulation was done in connecting the survey of the Atlantic coast with that of the great Lakes. In addition the work of the Coast Survey proper has been industriously carried on by surveys for mapping the exact coast line and determining the depth of water in the various sounds, bays, and harbors. The line of transcontinental levels has been pushed from Mitchell, Ind., to Kansas City, Mo. Very many astronomical determinations of latitude and longitude have also been completed, and tidal observations have been carried on in numerous places along the coast. For the details of the invaluable labors of this admirably conducted branch of the public service, reference should be made to the annual detailed report.

The work of the Northern Transcontinental Survey, under the direction of Prof. R. Pumpelly, has unfortunately been suspended, owing to the necessity of a retrenchment of expenses by the Northern Pacific Railroad Company. During the year 1883 an approximate topographical survey was made of the country, roughly corresponding to the territory lying between the 46th and 48th parallels of latitude, and the 110th and 112th meridians, and also of the Flathead Basin in Western Montana, as well as the country lying between the Snake River and the southern boundary of Washington Territory, while in the central part of Washington Territory a survey has been made of nearly all the country south of the 48th parallel and between the Cascades and the Columbia, in all amounting to about 20,000 square miles. Besides this geographical work, careful geological sections were made of the Belt and Main ranges in Montana, and much work was done on the geology of the Cretaceous.

The plans for the geographical work of the United States Geological Survey for the season of 1883 contemplated the prosecution of work in nearly all the areas under survey during the previous year, viz, in Northern California, in Southern Montana, Northeastern Arizona and Western New Mexico, and in the region of the Southern Appalachians. In addition to these areas, work was commenced in the State of Massachusetts; a detailed survey of the Yellowstone Park, and of the Elk Mountains of Colorado was commenced; and, in connection with the geological investigations of the ancient lake basins of Western Nevada, considerable scattered topographic work was done.

The work in Northern California was, as during the previous year, in charge of Mr. Gilbert Thompson. His division, consisting of two parties, took the field early in July, and was continuously occupied until late in October. The work was greatly delayed by smoke and haze which prevailed during the greater part of the season, owing to immense fires in the Cascade Mountains, so that the output of the season, amounting to about 4,000 square miles, was not as great as it would have been under more favorable circumstances. The area surveyed comprises Mount Shasta and its foothills, and a considerable portion of the tangled mass of the Coast Range lying west of that peak. In the progress of his work Mr. Thompson succeeded in taking mules to the top of Mount Shasta, a feat never before accomplished.

The work of the Wingate division lay, mainly, in Northeastern Arizona, the balance being in Western New Mexico. The country, as is well known, consists almost entirely of plateaus, presenting but little relief, but deeply scored by cañons and almost devoid of water, making traveling very difficult. This division, which, under the charge of Prof. A. H. Thompson, was composed of one triangulation party and three topographic parties, was very successful. The season's work added in the neighborhood of 22,000 square miles to the mapped area of the country. This, with the work of the previous year, completed three atlas sheets, viz, the regions lying between longitudes 107° and 109° and latitudes 35° and 36°; between longitudes 109° and 111° and latitudes 35° and 36°; and between longitudes 109° and 111° and latitudes 36° and 37°.

In the progress of his work Mr. H. M. Wilson, in charge of one of the topographic parties, succeeded in penetrating into the hitherto unknown country in the neighborhood of the junction of the San Juan and the Colorado, and ascended Navajo Mountain, a peak rising at the junction of these two streams, and hitherto unvisited. This region is inhabited by a band of renegade Indians, who have heretofore made it extremely dangerous for white men to approach. Recently, however, the prevalence of a contagious disease among them, which has been attributed by them to their hostility to white men, has made them much more friendly, and they gave no trouble to this surveying party.

At the close of the season's work Professor Thompson determined the position of Fort Wingate by astronomical observations. The field work of this division, as well as that of the California division, has been upon a scale of 2 miles to an inch.

In connection with the study of the mining region of the Elk Mountains or "Gunnison country" a detailed survey, upon a scale of 2 inches to a mile, was made of the area drained by the upper waters of Slate River and Ohio and Anthracite Creeks, under the direction of Mr. Anton Karl. After completing about 1,000 square miles of this area, Mr. Karl was called away by the pressure of other duties, and work was suspended for the season. It was decided to make a resurvey upon a much more detailed scale than ever before attempted of the area of the Yellowstone Park. This work was assigned to Mr. J. H. Renshawe, who was, during the previous year, in charge of the work in Southern Montana. Commencing work in the northwestern part of the Park, he surveyed, on a scale of 2 inches to a mile, or about $\frac{1}{30000}$, an area of some 1,500 square miles, mainly with the plane table. Near the close of the season, after having been driven from the high country of the Park by the snows, he remeasured the Bozeman base, which was laid out and measured originally by one of the parties of Lieutenant Wheeler's Geographical Surveys West of the 100th Meridian.

In addition to a number of small sketch-maps upon a large scale in different parts of the basin region of Western Nevada, a considerable area, amounting to 1,500 square miles, was surveyed, upon a scale of 1 mile to an inch, in the high Sierra of Eastern California. This region is very interesting to the geologist on account of the glacial phenomena, both actual and recent, there exhibited. Besides containing the remains of enormous glaciers, there still remain in this area a number of small glaciers, which cover areas of from a fraction of a square mile to a number of square miles each.

In the Southern Appalachian country work was prosecuted vigorously, no fewer than five topographic parties and two parties for triangulation being in the field. The area surveyed in this section during the season amounted to fully 22,000 square miles. It comprises the western part of Maryland with the northern portion of West Virginia, the southern portion of the latter State lying between the Kanawha and Big Sandy Rivers, the southwestern corner of Virginia, the northern half of the valley of East Tennessee, and nearly all the mountain region of North Carolina. Maps of this region have been prepared upon a scale of 2 miles to an inch in approximate contours 200 feet apart vertically. Work in this part of the country is necessarily slow, compared with that in the West, owing to the larger proportion of bad weather and to the fact that the country is densely covered with forests, necessitating the employment of topographic methods which are slower and more expensive than those which can be used in the West.

The work in the State of Massachusetts was placed in charge of Mr. H. T. Walling, and was commenced in Berkshire County, in the western part of the State. Nearly all of the area of this county, with small adjacent portions of New York and Connecticut, was surveyed, amounting to 1,500 square miles. A map of this region has been prepared upon a scale of $\frac{1}{40000}$ in contours having a vertical interval of 50 feet. In the more level portions of the State the contours have necessarily smaller intervals.

The result of this season's work is to add between 50,000 and 55,000 square miles to the maps of this country.

Lieutenant Schwatka, of the United States Army, the celebrated Arctic explorer, has made a journey from the Pacific coast to the headwaters of the Yukon River and down that river to its mouth. Lieutenant Schwatka states, in a communication to *Science*, that the expedition arose from a desire of the commander of the military Department of the Columbia to gain some military knowledge of the Indian tribes in that district, and of the territory inhabited by them.

The part of the route from the coast to the Yukon River was almost unexplored, the maps and books relating to it being grossly incorrect and disagreeing in nearly every particular. Of the three or four passes known to exist over the mountain ranges which separate the headwaters of the Yukon from the Pacific coast, the best one is the Chilcoot trail, and was the one used by Lieutenant Schwatka's party, which consisted of two officers and five other white men and a number of Indians, varying from two to more than sixty. In order to monopolize the traffic with the Indians of the interior, the Chilcoot Indians, for whom this trail was named, formerly used every endeavor to prevent other tribes from using it, but lately Indians of several tribes have used it.

Leaving Chilcat Inlet on the Alaskan coast, in latitude 59°, on June 7, 1883, Lieutenant Schwatka's party proceeded by way of Dayay Inlet and the Dayay River flowing into it to the head of canoe navigation, 10 miles above the mouth of the Dayay River. From this point a journey of 26 miles was made over Perrier Pass through the glacier-clad mountain ranges. The pass was traversed at an altitude of 4,100 feet, and on June 12 Lake Lindemann was reached just below the extreme headwaters of the Yukon River.

On Lake Lindemann, in about latitude 59° 50′, the voyagers embarked on a raft, but had to make a portage round the rapids and cascades at the northern end of the lake, where they again embarked, passing through a chain of lakes, among which were two, named by Lieutenant Schwatka Lakes Bennett and Marsh, for J. G. Bennett, esq., and Professor Marsh, of Yale College. Glaciers were constantly seen along the mountain sides. On the 1st of July, just north of Lake Marsh, the great rapids were reached. They were found to be nearly 5 miles long, the first part being through a cañon lined with basaltic rocks which contract the river to about one-tenth of its width. After leaving the cañon there are about 4 miles of rapids 300 to 400 yards wide, broken by rocky bars and dams of timber, and ending in a cascade.

On the 5th of July the last of the chain of lakes was reached. Lieutenant Schwatka thinks that these lakes are all gradually being filled up with sediment deposited by the passing water, and found traces of many such lakes which have been filled up in the same way. At short distances to the northward of the chain of lakes the Yukon receives three important affluents from the east, called by Lieutenant Schwatka the Newberry, D'Abbadie, and Daly Rivers, and one from the west named the Nordenskiold. On the 12th of July, Miles Cañon and rapids were reached. This Lieutenant Schwatka considers the head of navigation for powerful and light-draught river steamboats, 1,866 miles from the Aphoon mouth of the Yukon. From here to old Fort Selkirk, of the Hudson's Bay Company, the journey was apparently uneventful. Lieutenant Schwatka settles definitely the heretofore doubtful point whether the Pelly or the Lewis River of the old traders should be considered the Yukon proper as being the larger confluent. He found the Lewis by far the larger in at least the proportions of five to three.

Lieutenant Schwatka states the length of the parts of his journey as follows:

	Miles.
From Chilcat to Lake Lindemann	52
Lake Lindemann to Fort Selkirk	486.8
Lake Lindemann to Nuklakayet	1,303.2
Total length of Yukon River	2,043.5

The map prepared by Lieutenant Schwatka's assistant will be of great service in correcting the very erroneous maps now in existence.

A new volcanic island has appeared in the Aleutian Archipelago very near the position of Bogosloff Island, which rose in the same way in May, 1796. The old island seems to have disappeared, the new one occupying a position about half a mile north-northwest of the old one. This island is said to be about 1,000 feet high, and is in a state of eruption still. It will be closely examined and reported upon during the present year.

SOUTH AMERICA.

In South American travel the subject of most interest has been the search for the remains of the ill-fated expedition, under Dr. Jules Crevaux, for the exploration of the Pilcomayo River. At a meeting of the French Geographical Society convened for the purpose, M. Émile-Arthur Thouar gave an account of his journey to inquire into the causes of the massacre of M. Crevaux and his party, and to rescue the survivors who were supposed to be prisoners in the hands of the Tobas Indians. Starting from Tacna in Peru in May, 1883, he hastily traversed the plateau between La Paz and Oruro, and descending the Pilcomayo from its source reached the place where the disaster took place in September, 1883. One survivor, a stupid boy, was found; but no relics could be recovered except a broken barometer, a letter of Crevaux, and a sketch map of the Pilcomayo. It was found that the attack by the Indians was made in revenge for some of their tribe having been killed by some white men from the garrison of Caiga, the Indians making no distinction between their assailants and the party of M. Crevaux. Two of the party escaped into the woods, but after four or five months of exposure and suffering they died.

M. Thouar gave some interesting details of the manners and customs of the Tobas Indians, showing that they were especially savage. His account of the journey down the Pilcomayo and across the Gran Chaco indicates that the Pilcomayo is navigable for nearly all its course, but the lower part of the river is obstructed by morasses. The gold medal of the French Geographical Society was awarded M. Thouar for his explorations, which it is thought may be the means of affording a much-needed outlet by way of the Pilcomayo and Paraguay Rivers for some of the products of Bolivia.

In the Proceedings of the Royal Geographical Society for June, 1883, is given a detailed account of the journey down the Beni River, by Dr.

E. R. Heath, reference to which is made in last year's summary. To this most valuable account is added a map of the journey, by Dr. Heath, who was acting as medical officer of the party engaged in investigating the capacities of the country under the direction of Mr. G. E. Church, who has made a comprehensive report to the United States Department of State on the general condtion of Ecuador, including a detailed description of its geography, with especial reference to its river systems and its productive resources (Senate Ex. Doc. No. 69, Forty-seventh Congress). Mr. Church states that no census has ever been accurately taken, but he estimates the population at about one million, of which one-tenth are of the white race, three-tenths of mixed whites, Indians, and negroes, and six-tenths pure-blooded Indians. A very graphic account is given of the topography and river systems. Mr. Church finds very little hope for the development of the country, in spite of its fine climate and great productiveness, on account of the indolent and dishonest character of the people generally and the oppressive and anarchical government.

In the Journal of the Royal Geographical Society for May, 1883, Mr. Robert Blake White gives an account of the physical features of those portions of the central provinces of Colombia of which no detailed account exists. Great interest has been manifested during the last few years in those countries, which it is supposed would be benefited by the completion of the Panama Canal, and their possible development. Of these countries none would be more favorably affected than Colombia, and the account of its topography and resources, accompanied as it is by a map corrected from Mr. White's own surveys, is of great interest, especially when it is remembered that the last European traveler in this region whose works have been at all read was Alexander von Humboldt, who only passed through the country from southeast to northwest, leaving on one side the large district described by Mr. White.

Dr. Paul Güssfeldt has been, during the past year, making interesting trigonometrical surveys in the Andes, and has attempted to ascend Mount Aconcagua in the Chilian Cordillera (22,750 feet high), but failed, owing to the intense cold.

The published account of the journeys of Lieutenant Bove, of the Italian navy, in and about Southern Patagonia, Tierra del Fuego, and the Falkland Islands, does not materially add to our knowledge of the physical features of those regions.

Lieutenant Bove now proposes a new expedition in order to investigate the present physical and economic condition of the Argentine Republic, with a view to establishing closer commercial relations between that country and Italy.

Under the command of Lieut. Commander C. H. Davis, U. S. N., a party of United States naval officers have been engaged in determining telegraphically differences of longitude on the west coast of South America. The cables recently laid between Panama and Valparaiso were utilized for this purpose, and the positions of Callao, Lima, Payta, Arica, and Valparaiso were carefully fixed, the latitude of each station being determined by the zenith telescope. Lieutenant-Commander Davis connected his chain of longitudes at the northern end with the station at Panama telegraphically determined in 1874 by Lieutenant-Commander Green, U. S. N., and at the southern end with the observatory at Cordoba, fixed in the same manner by Dr. B. A. Gould. This great work, which has been admirably executed, completes an enormous polygon or telegraphic chain of longitudes from Greenwich by way of Washington, Havana, Panama, Valparaiso, Cordoba, Buenos Ayres, Rio de Janeiro, Madeira, and Lisbon, back to Greenwich.

EUROPE.

A comprehensive idea of the work in progress by the Government surveys of the different countries in Europe is derived from the reports of the meetings of the International Geodetic Association. The proceedings at the annual meeting at The Hague in September, 1883, have recently been published, and are summarized by Mr. C. A. Schott in *Science* for November 16, 1883. The countries represented and from which reports of progress were received were Baden, Bavaria, Denmark, France, Hesse, Holland, Italy, Austria, Portugal, Prussia, Roumania, Russia, Saxony, Switzerland, Spain, Wurtemberg, Belgium, and Norway. Among the many interesting matters referred to in the reports of progress the most striking is the demonstration that the average level of the Mediterranean is lower than the Atlantic by about two feet and one inch (0.64 meter). This conclusion had been stated by M. Bourdalou, in 1864, in his work *Nivellements générale de la France*, but was not generally credited.

In levelling across from the Atlantic to the Mediterranean the following differences in average level have been found:

	Meter.
Between Santander and Alicante	0.662
Swinemunde and Marseilles by way of Switzerland	0.664
Swinemunde to Marseilles by way of Amsterdam	0.658
Amsterdam and Trieste	0.590

ASIA.

A very serious change has been effected in the eastern part of the island of Java and the neighboring islands by the volcanic upheaval of August, 1883. The small uninhabited island of Krakatoa, lying about the middle of the straits of Sunda, an important commercial passage between the islands of Java and Sumatra, was, at the time of the first obtainable accounts of it (A. D. 1681), in a state of eruption. The present eruption commenced on the 21st of May and continued with great activity for eight or nine weeks, until the evening of August 26 and the morning of August 27, when tremendous explosions followed in rapid succession, tearing away and throwing into the sea a large portion of Krakatoa island, causing immense waves, which, after retreating, rolled in on both sides of the straits, destroying towns and villages and drowning at least 100,000 people. Whole districts were covered with pumice and ashes, and the island of Krakatoa was reduced to a fraction of its original size—water a thousand feet deep being found where the greatest activity of the volcano was displayed. The channels of navigation were very much changed, and surveys have been carried on since the outburst to lay down the changed depths in the different passages. At the time of the great explosion two enormous waves were set in motion, and the same afternoon were registered on the tide gauges at Mauritius, the Seychelles in South Africa, and at some of the Pacific islands, and there is evidence that, proceeding onward, these waves crossed each other on the antipodes of Krakatoa, thus returning to the place of their origin no less than four times before the equilibrium of the sea was restored. Atmospheric waves were also sent round the globe by this terrific disturbance at very nearly the same velocity as that of sound, while such masses of dust and ashes were driven into the upper regions of the air as to cause unusually lurid skies and other remarkable atmospheric phenomena for some months all over the world. A committee of the Royal Society has been appointed to fully investigate all the physical phenomena connected with the subject, and their report will present an accurate account and examination of the effects of volcanic eruptions.

In the last report of the operations of the great Trigonometrical Survey of India, General J. T. Walker, R. E., the superintendent, states that the principal triangulation of all India on the lines originally marked out by Colonel Everest has now been completed. General Walker gives a brief review of the operations from 1800 to the present day. The details of the topographical surveys have been diligently carried on, and many maps have been published during the past year, but the chief geographical interest attaches to the trans-Himalayan explorations by native travelers. The regions explored as far as is made known were the water-shed of the Upper Oxus, and its chief tributaries, a large area in Great Tibet explored by a traveler known as A——K——, who has recently returned to Calcutta after an absence of four years, and who has been able to settle a vexed question as to the affluents of the Irawadi and the Brahmapootra. In addition to the reports of these and other native officers, the narratives of English officers included in this report contain a very large amount of information, especially regarding little known portions of British Burmah.

In an address to the Geographical Section of the British Association at Southport, in September, 1883, Lieutenant-Colonel Godwin-Austen gave a description of the general structure of the mountain ranges popularly known as the Himalayas, especially dwelling on the indications of glacial action as compared with similar markings in the Alps. Colonel Godwin-Austen indorsed Sir H. Strachey's conception of the general structure as the soundest and most scientific of those propounded, describing it as made up of a series of parallel ranges running in an oblique line to the general direction of the whole mass, the great peaks being on terminal butt-ends of the successive parallel ranges, the water-shed following the lowest parts of the ridges, and the drainage crossing the highest in deep gorges directly transverse to the main lines of elevation.

By order of the Russian governor of Turkistan an expedition was fitted out at Tashkend in the early part of 1883 for the thorough explorasion of the Pamir, or great central table land of Asia, its members being Captain Putiata, of the staff of the Russian army, Mr. Ivanoff, geologist, and M. Bendersky, topographer. By their labors the eastern half of the Pamir has been traversed in every direction, and on its southern border a connection has been made with the surveys and route maps of English travelers by careful astronomical observations at Tash-Kurgan and other points. Among the valuable results of this expedition are a five-verst map of the whole region, numerous measurements of heights and astronomical determinations of latitude and longitude, and large geological collections throwing light on the formation of the region.

Colonel Prjevalsky, the indefatigable Russian explorer, has commenced another journey through Tibet. Starting from Kiachta, near the southern end of Lake Baikal, in Siberia, he crossed the Gobi desert late in 1883, and on January 20, 1884, was at Alashan on his way to Koku-nor. From here Colonel Prjevalsky will attempt the exploration of Eastern Tibet during the present year, then following up the Brahmapootra to Ladak and Hast, and thence by way of Lob-nor and Aksu proceeding to Turkistan. This great expedition, fitted out at the expense of the Russian Government, will thus attempt to bring within the knowledge of the civilized world such portions of Tibet as at present are only known from the desultory travels of a few pundits and missionaries.

A Russian Government expedition having been engaged in exploring the former channel of the river Oxus, or Amu-Daria, has reported, after running a line of levels between the Caspian Sea and Khiva, that the only way of restoring the river to its old course would be by the construction of an artificial canal 125 miles long. Under these circumstances there seems no probability of the task being attempted.

A large amount of work is in progress by Russian geographers and surveyors; and at an exhibition in April, 1883, of geographical and astronomical works at St. Petersburg, many valuable maps of Russian territory in Asia were shown for the first time. A general description of these is contributed by M. Venukoff to the Bulletin of the French Geographical Society.

The military operations undertaken by the French in Cochin China will have the effect of adding much to our knowledge of the Indo-Chinese peninsula, which, indeed, has been the ground of French exploration from a very early day. The *Société Académique Indo-Chinoise* have recently published an account of all the scientific expeditions sent to this country by the French Government, commencing in 1680, and numbering seventy-seven up to 1881. These are in addition to the military expeditions and Government surveys. In spite of all this research there are large tracts of country and very many water-courses about which little or nothing is known.

Mr. Carl Bock, in a paper in the Geographische Mittheilungen for May, 1883, describes a journey undertaken by him from Bankok toward the Chinese frontier by way of the Menam River to Zimme and Kiangtsen on the borders of the Shan states. This account is chiefly important as indorsing and verifying Mr. Colquhoun's conclusions as to the practicability of a railroad from the sea to the southwestern frontier of China. Mr. Bock was prevented from traveling through the Shan states by native hostility.

The general census of Japan, taken on January 1, 1883, gives 36,700,110 as the population of the country, made up of 18,598,998 males and 18,101,112 females. The population of the larger towns is given as follows: Osaka, 1,772,333; Hiogo, 1,418,521; Nagasaki, 1,204,629; Tokio, 987,887; Kioto, 835,215. These figures do not represent the population of the towns named, but of the districts known as *fu* or *ken* bearing these names.

In the Japan Gazette have appeared during the last year a series of valuable letters relating to the island of Yezo, its geography, geology, fauna and flora, its mineral productions and ethnology, as well as the records of numerous journeys over the island. The author is Captain Blakiston, who has been for many years a resident at Hakodate, and who has thus amassed an enormous quantity of valuable material.

An admirable method of teaching physical geography has been devised and put in practice by the teachers at the school for the sons of Japanese nobles, at Tokio. A physical map of the country has been constructed between 300 and 400 feet long of turf and stone, showing every inlet, river, and mountain. The meridians and parallels are indicated by telegraph wire, and the positions of cities and towns are shown by tablets.

In the hopes of securing a well-directed scientific exploration of the interior of New Guinea the British Association at their annual meeting at Southport appointed a committee to confer with the council of the Royal Geographical Society as to the best means of attaining that object. The result of their deliberations has been to recommend an expedition now preparing by Mr. Wilfred Powell, whose plan is to ascend the Ambernoli River, which empties near Point d'Urville on the north coast, and when the river can be no farther ascended to cross the country toward the Finisterre Mountains, then, after renewing his provisions, to attempt to cross the island from Astrolabe bay to Port Moresby. The Melbourne *Argus* sent an expedition in July, 1883, under Captain Armit, with the intention of crossing the southeastern end of the island from

Port Moresby to Dyke Acland bay, a distance of 100 miles in a northeast direction; but after the death of Professor Denton, the naturalist of the expedition, from fever, the party returned without having crossed the island, only having penetrated to a distance of 40 miles from the coast without making any discoveries of importance. Shortly after the return of this expedition, another one, dispatched by another newspaper concern, the Melbourne *Age*, under the command of Mr. G. E. Morrison, started from Port Moresby with a similar object, viz, to cross the island to the northeastern coast, but near the foot of the Central range the party was attacked by natives, and, Mr. Morrison being severely wounded, a hurried retreat was made to Port Moresby. Mr. Chalmers, an English missionary residing in Southeastern New Guinea, has been examining a part of the delta of the Fly River, and finds it more extensive than had been supposed. He determined the fact of the cannibalism of the natives as concerns their enemies, but found them generous and hospitable. The interest excited in the exploration of this practically unknown island is so great that the labors of the present year will probably increase materially our knowledge regarding it, but its sickly climate and savage inhabitants make the task of exploration very difficult.

AFRICA.

Many explorers and travelers for geographical and commercial objects have, as for several years past, been engaged in journeys in Central Africa, but no specially striking discovery has been made, and the details of the numerous journeys are generally uninteresting and tedious, although, taking the aggregate of results, a large amount of detail has been added to the maps of Africa. English missionaries and consular officers have been prominent in furnishing valuable material of this kind.

The expedition in charge of Mr. Joseph Thompson, and fitted out by the Royal Geographical Society, left England in December, 1882, and proceeded to Zanzibar; then proceeding inland from Mombasa, a port about 140 miles to the northward of Zanzibar, reached Taveta, at the the foot of Mount Kilimanjaro, on the 31st of March. On attempting to penetrate farther inland he met with determined hostility on the part of the Masai tribe, and was forced to return to Taveta. Starting again in July with a larger force, he has (March, 1884) been unheard of for several months.

Among the numerous other travelers who have been exploring various parts of Central Africa during the past year are M. Revoil, who has been traveling in the Somali country; M. Giraud, who has undertaken to cross Africa from Zanzibar by way of Lake Bangweolo and the Congo, but who was turned back to Karema by the hostility of the natives; and Mr. O'Neill, Her Britannic Majesty's consul at Mozambique, who has made a journey to Lake Shirwa and back to the coast. Mr. R. Flegel has, under the auspices of the German African Society, been engaged in examining the course of the Binue River, an affluent of the Lower Niger, and has discovered its source, and also that of the Logué River, which discharges into Lake Chad. Dr. Fischer, whose quarrels with the natives while attempting to reach Lake Bahringo from the east coast through the Masai country, were the cause of Mr. J. Thompson's delays, has been obliged to return without accomplishing his object.

No region of Central Africa has been more thoroughly and systematically explored of late years than the banks and surroundings of the Congo River In a paper read before the Royal Geographical Society, and published in the Proceedings of that society for December, 1883, Mr. H. H. Johnston gives a very graphic account of that great river from its mouth to Bolobo, with a description of the physical aspect of the surrounding country. Another good description was given in an address in March last before the meeting of the German Geographical Society at Frankfort, by Herr Pechuel Loesche, who served as second in command with Mr. H. M. Stanley at Stanley Pool.

ARCTIC REGIONS.

The expeditions sent to occupy stations in the far north for the purpose of making meteorological observations under an international arrangement have all returned safely, with the exception of the party commanded by Lieut. A. W. Greely, U. S. A., which has occupied a station at Lady Franklin Bay since the spring of 1881. Two ineffectual attempts have been made to reach the party by relief ships, one ship being turned back in 1882 by heavy ice, and another, the Proteus, being sunk by the ice in 1883. An expedition, consisting of three ships, under command of Commander Schley, U. S. N., is now fitting out, and no effort or expense is being spared to make a successful attempt to bring away the survivors of the party, if any.

The Austrian party have returned from Jan Mayen, and the Swedish party from Spitzbergen, without casualty or illness. The Dutch expedition lost their ship, which was nipped by the ice in Waigatz Strait, but carried on all their observations successfully except those relating to magnetism, although they did not reach their intended station at Port Dickson. The other parties returned safely to their respective countries.

Under the auspices of the Danish Geographical Society the Dijmphna, commanded by Lieutenant Hovgaard, of the Danish navy, was dispatched from Denmark in the summer of 1882. Lieutenant Hovgaard intended to proceed first to the mouth of the Yenesei, then to Cape Chelyuskin, and then to penetrate northward along the east coast of Franz Josef Land. Leaving Vardö, in Norway, on August 3, 1882, the Dijmphna soon found the way blocked by heavy ice, and it took all of August to reach the Jugor Strait, between Waigatz Island and the mainland of Siberia. A short distance to the eastward, on September

20, the Varna was met, beset in the ice, bound for Dickson Haven, with the Dutch meteorological party on board, and in two days more both vessels were frozen in. During October, November, and December both vessels drifted about with the ice, reaching nearly 71° north latitude. The Varna became uninhabitable, and all hands were taken on board the Dijmphna. No event of importance happened except the rapid erosion and disappearance of the ice during June and July, and on July 24 the Varna sunk, the Dijmphna drifting toward Karagate and being set free from ice on August 2. The crank-shaft breaking, the ship returned under sail to Vardö, arriving October 10. The greatest cold experienced seems to have been about February 1, when it reached 46°.8 C. During the time the ship was drifting in the ice soundings were constantly taken, so that valuable materials for correcting the charts were secured.

Captain Sorenson, of the Norwegian sloop William, reports having seen high land northeast of the northern promontory of Spitzbergen and about 100 miles from Rep Island. Dr. Karl Pettersen, of the Tromsö Museum, points out that this land is probably the same as that seen by Captain Kjeldsen in 1876, and called by him Hvide-Oe, or White Island.

A most valuable treatise on the Properties of Water and Ice, by Dr. Otto Pettersen, forms a volume of the publications of the Vega Expedition. The physical and chemical properties of both water and ice are discussed at length, and the nature of various kinds of ice are explained very clearly.

In *Nature*, for August 30, 1883, Dr. Karl Pettersen proposes a new system of Arctic research. On the hypothesis that the condition of the ice in the Arctic basin is not always the same, but undergoes periodical changes, Dr. Pettersen proposes that, selecting the most proper localities, an arrangement should be made between the various European nations to equip a certain number of expeditions which should be sent to the same locality every summer for a period of ten or eleven years. Dr. Pettersen thinks that during certain years of such a period opportunities would certainly occur for penetrating very far into the Polar Basin. In 1881, for example, Norwegian hunters found the sea north of Spitzbergen so clear of ice that a steamer could have apparently proceeded northward to a considerable distance, and there is reason to believe that the sea to the northeast of Franz Josef Land is also navigable at times. Dr. Pettersen is convinced, from observing the motions of the ice north of Spitzbergen and Novaya Zemlya, that there is a strong probability of a more or less open Polar sea.

GREENLAND.

Under the command of Baron Nordenskjöld, a Swedish expedition has been engaged in an endeavor to explore the interior of Greenland from the east coast, one of the objects of the expedition being to fix the sites of the ancient Norse colonies. The expenses of the journey were defrayed by the munificence of Mr. Oscar Dickson. A large party of scientific experts accompanied Baron Nordenskjöld, sailing from Gothenburg, on May 23, in a small steamer of 180 tons called the Sofia, and arriving at Iceland June 1. After coaling, the ship sailed for Southern Greenland, and on July 4 an ice party started inland from Auleitswik fiord, but were prevented from advancing with sledges nearer than about 90 miles to the border of the glaciers by soft snow; but the Laplanders, who had been taken for the purpose, advanced 140 miles farther on snow-shoes over a snow desert at a height of 7,000 feet. Baron Nordenskjöld reports the whole inland covered with ice, with quantities of fine dust, which he considers as cosmical. The party landed twice on the east coast, but found it ice-bound almost everywhere. Some relics of the ancient colonists were said to be found. The predictions of Baron Nordenskjöld that the interior of Greenland would be found free of ice were therefore not verified. The expedition returned by way of Iceland, arriving at Thurso early in September.

A Danish expedition, under command of Lieutenant Holm, has also been engaged in exploring the east coast of Greenland during the summer of 1883. Several extensive fiords were discovered, and the charts as far north as latitude 61°, where the work terminated, will be seriously modified by the survey. After the summer's work was done winter quarters were prepared at Nanortalik, where meteorological and magnetic observatories were established. The same party will continue their work of exploration and survey during 1884.

METEOROLOGY.

By Cleveland Abbe.

I.—INSTITUTIONS AND INDIVIDUALS.

The second meeting of the International Committee was held at Copenhagen August 1 to 5, 1882. The principal resolutions related to the organization of an exhibit in London in connection with the International Fisheries Exhibition, May, 1883; at which the proposed meteorological exhibit should specially include whatever relates to (1) weather predictions and storm warnings; (2) the publication of meteorological data, especially the time of rainfall, the monthly mean for the preceding month, and the publication in full of meteorological observations during the year of international polar observations; (3) the preparation of daily charts of the Atlantic Ocean by the co-oporation of Captain Hoffmeyer and Dr. Neumayer; (4) the scientific and practical importance of the submarine cable connecting Iceland and the Faroe Islands; (5) the publication of international meteorological tables as prepared by Mascart and Wild; (6) the preparation of individual catalogues of the meteorological literature of the respective nations. (*Z. O. G. M.*,* XVII, p. 358.)

Dr. Assmann states that means have been provided to re-establish on the Brocken (at the expense of the Magdeburg Brocken Club) the meteorological station which has just been abandoned by the Prussian meteorological office. He hopes before long to have a telegraph cable and continuous records. (*Z. O. G. M.*, XVIII, p. 68.)

Prof. Emil Plantamour was born at Geneva May 14, 1815, and died on September 6, 1882. His life and energies were equally given to astronomy and terrestrial physics. After several years' study under eminent astronomers in Europe he was settled, in 1839, as professor and director of the observatory at Geneva, which place he continued to fill until his death, and whence he exerted a great influence both as an astronomer, geodesist, and meteorologist. (*Z. O. G. M.*, XVIII, p. 1.)

Johann Albert Arndt, born May 27, 1811, in Saxony; died August 21, 1882. In 1847 Professor Arndt became one of the observers of the

*The initials *Z. O. G. M.* designate the *Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie.*

Royal Prussian Meteorological Institution at Torgau, where he had been professor since 1840. In 1866 he was called to Berlin, and in 1874 became Dove's assistant at the institute, since which time, both as an assistant and during the past three years as temporary successor to Dove, he conducted most of the work of that office. (*Z. O. G. M.*, XVII, p. 489.)

II.—GENERAL TREATISES.

In general climatology the publication of Hann's *Handbuch der Klimatologie* (Stuttgart, 1883, 8vo, pp. x + 764), marks an important epoch by reason of the precision of thought and the extent and freshness of the numerical data. Many of the author's views are worthy of wide attention and adoption, and are therefore here reproduced as follows:

"By climate we understand the sum total of the meteorological phenomena that characterize the mean condition of the atmosphere at any one place on the earth's surface. That which we call the weather is only one phase, a single act, or part of the succession of phenomena whose complete course, more or less uniform, year after year constitutes the climate of any locality. The climate is the totality of the weather for a longer or shorter portion of time, as it ordinarily occurs on the average at this time of the year; but we speak of the weather of a special day or month or season; *e. g.*, the climate of England is mild and damp in December, although the weather of December, 1879, was very cold. We never speak of the rainy climate of the summer of 1882 in Germany, but the rainy weather. The theory or philosophy of the weather and of climate will therefore respectively treat of the daily changes and the average condition of the atmosphere.

"Meteorology includes both weather and climate, and shows the causal dependence of these upon the fundamental simple principles of physics. The principal climatic factors are temperature and moisture of the air, rain or snowfall, force and direction of the wind, &c. Of these the temperature is undoubtedly the most important, and not only the temperature of the air itself as given by thermometers protected from radiation, but equally so the temperature, or rather heat, due to direct radiation of sun, air, and earth. This latter radiation is an extremely variable quantity, even at one and the same locality, while the air temperature proper is comparatively uniform over a large extent of territory and time.

"I. The elements of the air temperature that are most important for the correct presentation of any climate are the following:

"1. The monthly and annual mean temperatures of the air.

"2. The magnitudes for each month of the daily variation of temperature.

"3. The mean temperature for at least one early morning hour and afternoon hour about the time of the lowest and highest temperatures, and if possible also for a later hour in the evening.

"4. For long series of observations, the extreme limits between which lie the mean temperatures of the individual months.

"5. The mean of the monthly and annual extreme temperatures as well as the resulting non-periodic variation of temperature within each month and the whole year.

"6. The absolute highest and lowest temperatures that occur within a given interval of time; the length of this interval should also be given.

"7. The mean variability of the temperature, as expressed by the difference of consecutive daily means and by the frequency of such changes in temperature arranged according to definite scale, *e. g.*, from 2 to 2 degrees.

"8. Mean limit or date of frosts in spring and fall, and the number of days free from frosts.

"As most of the published long series of temperature observations refer to stations within cities, it is also necessary to have in mind the systematic differences between city and country temperatures, the former being generally warmer. The above requisites for complete climatological study are exemplified in the following table based on observations within the city of Vienna:

TABLE I.—*Characteristics of the temperature of the air in the city of Vienna.*

[Temperatures by centigrade scale. Latitude, 48° 12′ north; longitude, 16° 22′ east of Greenwich. Altitude, 194 meters.]

Month.	Monthly means.		Mean departure from the monthly means for 90 years.	Means from observations for 20 years, at the respective hours—			Daily variation of temperature from 20 years of observation.		Mean of monthly and annual extremes for 20 years.		Mean monthly and annual variation for 20 years.	Absolute extremes for the interval 1829–1875—47 years.		Variability of daily temperature.
	Twenty-four observations daily for 20 years.	Various observations daily for 100 years.		6 A. M.	2 P. M.	10 P. M.	Periodic.	Non-periodic.						
	°	°	°	°	°	°	°	°	°	°	°	°	°	°
December	−0.8	−0.3	2.3	−1.5	0.6	−1.0	2.1	4.7	9.6	−11.2	20.8	19.1	−22.6	2.0
January	−1.3	−1.7	2.5	−2.3	0.3	−1.6	2.7	4.9	9.7	−12.1	21.8	18.8	−25.5	2.1
February	0.4	0.1	2.2	−1.2	2.6	0.1	3.8	6.1	11.4	−10.0	21.4	20.0	−20.0	2.0
March	4.2	4.3	1.8	1.6	7.4	3.6	5.9	7.8	16.7	− 5.9	22.6	24.[illegible]	−13.3	1.8
April	10.0	9.9	1.7	6.2	14.0	9.0	7.8	9.6	23.9	− 1.0	24.9	28.8	− 7.0	1.9
May	15.1	15.1	1.5	11.4	19.3	13.8	8.2	10.2	28.5	2.7	25.8	36.0	− 1.6	1.8
June	18.6	18.8	1.2	15.5	22.4	17.1	7.6	9.9	31.5	9.1	22.4	37.8	3.8	1.9
July	20.3	20.5	1.3	16.9	24.3	18.9	7.9	10.1	32.6	11.0	21.6	38.8	8.0	1.9
August	19.6	19.7	1.3	16.0	23.7	18.2	7.9	9.7	32.9	9.8	23.1	37.5	5.6	1.8
September	16.1	15.9	1.2	12.2	20.4	14.8	8.2	9.6	28.3	4.9	23.4	33.5	− 0.6	1.7
October	10.5	10.0	1.4	7.7	14.3	9.5	6.6	8.3	23.2	0.6	22.6	27.1	− 6.8	1.5
November	3.7	3.9	1.4	2.5	5.5	3.3	3.1	4.9	14.9	− 5.9	20.8	21.3	−15.0	1.8
Year	9.7	9.7	0.74	7.1	12.9	8.8	5.9	8.0	33.9	−15.1	49.0	38.8	−25.5	1.9

"II. The elements of radiant heat that are important as climatologic factors cannot be stated so definitely as are those of air temperature. It would appear that we need to know the energy and the totality of the two radiations, *i. e.*, that received from the sun and that given out by terrestrial objects, but unfortunately thus far satisfactory observations of these phenomena are almost wholly wanting; even the apparatus proper for the measurements is as yet too crude to be available for accurate work. The solar radiations possess no such differences among themselves as to justify the terms 'heat rays,' 'light rays,' 'chemical' or 'actinic rays;' they have variations of wave length and intensity, *i. e.*, rapidity and extent of vibrations, and one and the same ray will produce either or all of the above three effects (heat, light, chemism), according to the nature of the surface or body on which it falls. The energy or *vis viva* of a ray of a given wave length and intensity is proportional to the quotient of the square of the amplitude divided by the square of the wave length; it is the total radiant energy that is desired in climatic researches. The most recent observations indicate that the central part of the solar spectrum is most energetic not only in producing light, but also in respect to heat and chemical effects."

Meteorology still has to deplore the absence of sufficient observations of the optical, thermal, and chemical effects of solar radiation. The importance of insolation (the amount of direct sunshine) has long been recognized by physicians, and by agriculturists, by its effect on animal and vegetable life. Of the instruments with which regular observations have been made in the effort to obtain comparative data, Hann mentions the "black-bulb thermometer in vacuo," as used by the English as of the first importance, and puts in the second rank the Arago-Davy actinometer. [We may be allowed to add that this can only be allowable by reason of the fact that no satisfactory study of these instruments has yet been published, and our author's decision will perhaps be reversed after the publication of an exhaustive memoir by Ferrel, now in print.]

"A record of phænological phenomena, such as times of blossoming, fruiting, &c., gives some interesting results bearing on the insolation. The amount of heat reflected from the soil and water into the atmosphere has been approximately measured by Frankland, Dufour, &c., and may amount to as much as 70 per cent.

"III. The nocturnal cooling of the free surface of bodies due to radiation of heat is another important subject that as yet eludes direct observation. An approximation is sought by observing minimum radiation thermometers fully exposed to the sky, and whose bulbs are respectively on the ground and directly above a close-cropped grass lawn.

"IV. The temperatures of the ground at the surface, and to the depth of one or two meters, constitute a most desirable climatological element.

"V. The measurement of atmospheric moisture, both vaporous and condensed, ranks next to temperature in importance. The following items are desirable:

"(1) Monthly means of the absolute, and

"(2) Of the relative aqueous contents of the atmosphere. The absolute measures are usually given in millimeters of vapor tension, but preferably in weight of vapor per cubic meter. The relative humidity is given in per cent. The ordinary observations with hygrometric apparatus give the aqueous vapor in the immediate neighborhood of the observer, and tell nothing as to the amount or tension at any considerable distance; the relative humidity, with the temperature of the air and the wind, gives the evaporating power of the atmosphere, which has so great an influence on plants and animals.

"(3) The precipitation of moisture, as rain, snow, hail, dew, frost. Under this head the following are desirable: (*a*) The monthly and annual sums of total precipitations of rain and melted snow; (*b*) the maximum precipitation per day and per hour; (*c*) the number of days having one-half millimeter or more of precipitation, including dew or frost; (*d*) the percentage of rainy days in each month or the probability of a rainy day; the number of rainy days is a better indication of a moist or dry climate than the total rainfall; (*e*) the number of days with snow, the depth of the snow covering, the duration of the snow covering, the dates of frost, and last snowfall; (*f*) similar data for the days with hail; (*g*) similar data for the days with thunder-storms.

"(4) The precipitation of moisture as clouds. Under this head are important, (*a*) the amount of cloudy sky expressed in tenths or hundredths of the whole celestial hemisphere (the number of clear, cloudy, and threatening days does not seem sufficiently precise); (*b*) the percentage of cloudiness is an ordinary substitute for the direct measure of the intensity of solar radiation, and as it varies very regularly in diurnal and annual periods, it is desirable to give monthly means for three or more separate hours of observation; (*c*) the thickness of the cloud layer is recorded by Campbell's sunshine recorder by the effect of a burning lens in charring prepared paper—this apparatus gives us the amount of clear sunshine whence we deduce the ratio of observed amount of strong sunshine to the greatest amount possible at the respective seasons and stations; (*d*) the number of foggy days, or the total number of hours of fog, and the times of forming and dissipating; (*e*) the number of nights or the quantity of dew.

"VI. The wind affects humanity and equally the fauna and flora in innumerable particulars, but the comparison of observations, especially of force or velocity, is greatly hindered by the irregularities of methods of observing. It is, however, possible to draw some comparative conclusions from the following data:

"(1) The monthly means (or totals) of wind velocity or estimated wind force.

"(2) The frequency of winds from different directions (to eight principal compass points); this is most conveniently expressed in percentages of the total number of observations, or else the number of observations of each wind is divided by the number of observations made each day, so that we receive as quotient the number of days that each wind has blown.

"(3) The frequency of the winds for each hour of observation thus showing the diurnal changes in wind direction, this may generally be given for the annual sums instead of the individual months.

"(4) The meteorological peculiarities of each wind direction as to (*a*) temperature, (*b*) moisture, (*c*) cloudiness, (*d*) probability of rainfall, are shown by the respective wind-roses (thermic, atmic, nephic, aqueous); one such series of wind-roses suffices to show the climatic characteristics of a large section of country.

"VII. The atmospheric pressure and its variations are climatologic factors of secondary importance in strong contrast to the important part that these elements play in meteorology. The mean annual pressure may be given to within a millimeter as an index to the density of the air and the facility of evaporation, but the variations that occur at any locality are too small to have any direct sensible effect on animal and vegetable life. It is only as a basis for the explanation of the distribution of other climatic factors that we may need accurate barometric observations at numerous stations. [The marked effect upon many persons of a gradual removal of residence from lowlands to regions higher by several thousand feet is daily exemplified by the experience of the numerous invalids who resort to the Rocky Mountain plateaus and the higher portions of the Appalachian Range. The freedom from noxious dust floating in the air and settling by its own weight or washed down by falling rain and snow, is, in the absence of direct observations, approximately indicated by the height of stations above sea-level or the annual barometric pressure, combined with the height above lowlands in the neighborhood; these heights may of course be deduced from accurate barometric observations.]

"VIII. The total effect of temperature, pressure, humidity, and wind upon free water surfaces respectively in the shade and in the sun is to produce an evaporation the measure of which should be of the highest importance in climatology. The apparatus hitherto devised for measurements of the amount of evaporation are, however, apparently very unsatisfactory. [Some adopt instead the depression of the wet bulb as indicative of the total effect of the preceding causes upon a moist surface that is very similar to that of leaves—the human skin, &c. It is perhaps proper to consider the depression of the dew-point temperature as indicating the need the air has of moisture, but the elevation of the wet bulb above dew-point, as showing the rate at which this need is being supplied, and the elevation of the air temperature above the wet bulb, as showing the rate of strain that every surface is under in its effort to give up its moisture to the absorbing atmosphere.]

"IX. (1) The constitution of the air, so far as its dry gases are concerned, is too uniform throughout the world to allow of its entering as a factor in studying climatic differences; it varies but a fraction of 1 per cent. from 21 volumes of oxygen and 79 volumes of nitrogen, with 0.03 of one volume of carbonic-acid gas. The most important variable in the air is the amount of aqueous vapor (see V (1), above). The percentage of volume of vapor to dry gases is given by dividing the tension of vapor by the barometric pressure. The result is, in extremely moist climates, equivalent to a dilution of the air to an extent of perhaps 3 per cent. of its volume. Thus for Batavia in one volume of the dry gases, we should have oxygen 21.0, nitrogen 79.0 per cent., but in one volume of the whole atmosphere, oxygen 20.4, nitrogen 76.8, aqueous vapor, 2.8 per cent. The direct effect of the slight change in oxygen must be imperceptible.

"(2) Local or artificial impurities—dust, gases, or smoke from factories, burning forests, volcanic eruptions, the salts due to ocean spray, dust due to roads, sandy deserts, &c.—can hardly be considered as belonging to general meteorology, but are important in local climatology.

"(3) More general and more important are the minute particles of dust that almost elude microscopic vision, and which are in reality spores or germs of organic life; to these are due the various processes of fermentation and putrefaction, and especially the large class of diseases known as miasmatic, which were formerly attributed to noxious gases, and to which all animal life is very susceptible. The warm, moist climates are in general most favorable to these germs; they are comparatively rare in very dry climates and over desert places; they are also rare over the sea and during sea breezes on the sea coast, and also after a rain has washed the atmosphere pure and brought down fresh air from above. [The effect of rainfall in dragging down the air which then flows outward from under the rain was fully recognized by Espy and Henry in 1840, and has frequently been dwelt upon by the present writer, so that it can hardly be called a new observation, as is done by Hann on page 50. Experiments for the determination of the amount of air brought down were verbally suggested to Professor Pickering in 1871 as a subject for experimentation by his students in physics.]

"(4) Either ozone or the hyper-oxide of hydrogen, or possibly nitric oxide, is apparently at times efficacious in increasing the oxidizing effect of the air, the result being that all organic matter is destroyed thereby. The methods of observing these gases are, however, too uncertain to allow of comparison between different localities, or even different portions of the same series.

"(5) The electrical condition of the atmosphere is not known to exert any considerable direct influence upon life, nor have we even observations that would allow of comparisons of various localities in respect to the electric potential. This subject is therefore to be omitted, at least at present, from climatology, notwithstanding many popular expressions of belief in its importance. The occurrence of thunder-storms has already been considered—see V (3), (*g*)—but this is because of other features than the electric phenomena.

"X. Phænologic observations have frequently been introduced as a guide to comparative climatology, but the fact that plants can accommodate themselves to climatic peculiarities renders this a study that must be pursued very cautiously. As yet it has not been possible to state the dependence of the development of plant life upon temperature so securely as to allow of inversely inferring the temperature from the observed stage of development. However, such studies are not to be wholly discarded; they are especially useful as indications of the climatic differences at different elevations on the slope of a mountain; also when a large number of special plants are studied they show the retardation of vegetation in northern regions. Thus, for example, the blossoming of plants in early spring is at Trieste, Gorz, and Villa Carlotta twenty to twenty-five days earlier than at Vienna, and at Paris nine days earlier, but at Lemsberg sixteen days later, and Zlozow twenty-one days later. On the plateau of the Harz Mountains the retardation is thirty-four days, and the same also at Moscow. In the Alps, at 46½° north latitude, 1700 meters altitude, the retardation is forty-five days, or the same as at St. Petersburg. It is, however, proper to consider such phænologic observations as illustrations of climatic characteristics rather than as defining them."

The following table gives for Vienna some of the preceding additional climatic characteristics. For want of space Hann omits the details of wind direction:

TABLE II.—*Additional climatic elements for Vienna.*

Months.	Aqueous vapor, observations for 20 years.					Rain and snow.		Cloudiness, on scale of 0 to 10, average of 20 years.	Sunshine, average of 3 years.		Mean wind velocity, anemometer record for 6 years.	Total evaporation, average of, for 5 years.	Ozone; Schönbein papers, on 0 to 10 scale, 20 years of observation.	
	Mean vapor-tension.	Relative humidity.				Total amount average of 34 years.	No. of rainy days, average of 20 years.		Observed durations in hours.	Percentage of greatest possible duration.			Day.	Night.
		6. A. M.	2 P. M.	10 P. M.	True mean.									
	mm.	*p. ct*	*p. ct*	*p. ct*	*p. ct.*	*mm.*	*d.*		*h.*	*p. ct.*	*meters per sec.*	*mm.*		
December ..	3.7	86	77	86	83	40	12.4	7.3	51.4	20	2.4	18	3.1	5.5
January ...	3.6	87	77	86	84	35	12.8	7.2	86.1	31	1.7	13	3.2	5.8
February ...	3.8	84	70	83	80	36	11.2	6.7	100.8	35	2.6	27	4.2	6.0
March	4.4	81	58	76	71	43	13.1	6.2	141.8	38	2.2	39	4.2	6.2
April	5.7	76	48	68	63	42	12.3	5.2	140.3	34	2.4	71	4.6	5.7
May	8.2	76	49	71	64	64	13.0	5.1	221.4	47	2.0	87	5.2	5.4
June........	10.0	75	50	71	64	66	12.7	4.9	234.7	49	2.4	93	5.2	5.6
July	10.9	75	48	70	63	65	13.3	4.5	290.1	60	2.2	113	5.3	5.3
August	11.0	79	50	73	66	72	11.8	4.5	212.5	48	2.1	94	5.1	5.4
September..	9.3	82	53	75	69	45	8.3	4.5	156.9	42	2.0	77	3.9	4.5
October.....	7.2	85	61	81	76	44	10.6	5.4	69.3	21	2.0	47	3.0	4.3
November ..	4.8	84	72	83	80	43	12.6	7.4	65.9	24	3.0	32	3.0	5.1
Year....	6.9	80	59	77	72	595	144.1	5.7	1771.2	37	2.2	711	4.2	5.4

Having, in his introduction, thus defined our general conception of the range of climatology, Hann devotes 175 pages to a consideration of the principal features of the earth's climate—first, as depending on the solar radiation; and, next, as modified by physical conditions, *i. e.*, moisture, altitude, distribution of land and water. This section of his work constitutes a popular treatise on meteorology that is fit to form a separate treatise, and is by far the best at present extant, the only ones comparable for accuracy and clearness being that of Blanford in *The Indian Meteorologist's Vade-Mecum.*

The remaining 550 pages of Hann's treatise are devoted to the description of the special climatology of the zones and districts of the earth, constituting a very complete climate-geography. Through the whole volume are distributed occasional notes and pages dealing with the causes of atmospheric phenomena, so that the work is an indispensable and admirable preliminary to the study of, or development of, a systematic treatise on philosophical, deductive, and mathematical meteorology.

It may not be presumptuous to add that if the idea of climate is to cover every known relation of the weather to human affairs, then there are still many important features only lightly touched upon by Hann that must be more fully considered than they have been even in this introduction, which we have so fully analyzed in the preceding lines. Some of these have indeed been taken up by the author in his subsequent chapters on general or special climatology, and we enumerate them here in order to direct attention to them, and at least partially complete our enumeration of what data are called for in a treatise on "climate." They are as follows:

(1) Exhilarating and depressing weather is the effect of or may be represented as a function of the simultaneous temperatures (t), wind (v), barometric pressure (p), and relative humidity (h), and is not fully expressed by the enumeration of the simply hot and moist days, but must be determined by a special observation of the days in which the human organism experiences such special feelings as are defined by the expressions "closeness," "oppression," "weakening," "harshness," "rawness," "penetrating," "chill," "mildness," "softness," "balmy," "soothing," "invigorating," "exhilarating," "stimulating," "nervous," "restless-"ness," "gloominess," "cheerfulness," &c. In the absence of this personal or subjective record one may seek an approximate method by calculating such an arbitrary function of t, v, p, h as will give numerical results on a scale of 0 to 10. Personal records of this character were kept at Washington by J. W. Osborne and others as early as 1873.

(2) The number of general storm-centers that pass over a locality, and their general geographical distributions. As such storms are preceded by southeast to southwest winds, warmer, cloudy and rainy weather, and followed by westerly winds, colder, clearing, drier weather, their frequency is directly indicative of the changeableness of the climate, and presents in one datum a very concise summary of the features that bear on health, business, domestic life, forestry, and commerce. A map of storm frequency explains at a glance the distribution of northwest and southwest winds in the United States, and the peculiarities of our climate as given by Hann on page 556. Such charts were attempted by Espy in 1836, but actually compiled first by the present writer for the statistical atlas of the United States Ninth Census, Washington, 1874. A general review for Europe and America has recently been given by Köppen.

(3) The frequency of severe local storms, such as the tornadoes of the United States. (A first attempt at collecting these data is given by Finley. Professional Papers Signal Service No. 4.)

(4) The frequency of calms as causing poor ventilation, and being accompanied by stagnant or unwholesome air.

(5) The durations of twilight and the general color of the sky by day, and the special colors at sunrise and sunset, as indicative of the reflection, transmission, and absorption of the solar radiation. In the tropics,

the blue sky is replaced by a white or opaline tint, and the total amount of light and heat thus diffusely reflected to the observer is one-half as much as that directly coming from the sun. The bluest skies are indicative of the absence of moisture, the reddest skies are apparently due to vapors or exceedingly fine particles of moisture or of dust, the white sky to the larger aqueous particles that are apparently of the size of the finest cloud or fog particles.

(6) The number and extent of the sudden changes from warm and moist to cold and dry, or, *vice versa*, cold and dry to warm and moist, as distinguished from the general variability of these elements (shown for example in the next paragraph, without regard to the direction in which the change occurs. A few words on this subject by the author will be found in the Sanitary Record for July, 1879.)

(7) The frequency and extent of changes in the mean temperature of successive days; this is held by Hann to be the best way of expressing the effect upon mankind of variability of temperature, and on page 504 he gives the following valuable comparative table:

Variability of mean daily temperatures, as shown by the frequency per month of 30 days of the occurrence on successive days of mean temperatures that differ by definite amounts.

Geographical district.	Northwestern Europe.	Central Europe.	North and East Europe.	West Siberia.	East Siberia.	Shores of the Mediterranean.	Sub-tropics, southern hemisphere.	United States, eastern portion.
Number of stations	3	5	5	4	4	8	5	5
Mean latitude	52°. 0 N.	48°. 8 N.	56°. 3 N.	55°. 4 N.	54°. 7 N.	39°. 6 N.	34°. 1 S.	42°. 9 N.
Differences of mean temperature (degrees centigrade).	FREQUENCY IN WINTER.							
0 to 2	17.5	17.0	11.1	9.0	11.6	23.3	20.2	9.9
2 to 4	8.4	8.5	7.6	7.1	9.0	5.4	7.6	8.2
4 to 6	3.1	3.1	5.0	4.9	4.9	1.0	1.8	5.2
6 to 8	0.9	1.0	2.8	3.5	2.7	0.3	0.4	3.2
8 to 10	0.1	0.3	1.7	2.2	1.1	....	0.04	1.6
10 to 12	....	0.1	0.8	1.5	0.5	....	....	1.0
12 to 14	....	....	0.5	0.9	0.1	....	....	0.6
14 to 16	....	....	0.3	0.4	0.1	....	....	0.2
16 to 18	....	....	0.1	0.2	....	....	....	0.1
18 to 20	....	....	0.1	0.2	....	....	....	....
20 to 22	....	....	....	0.1	....	....	....	....
22 to 24	....	....	....	0.03	....	....	....	....
	FREQUENCY IN SUMMER.							
0 to 2	20.3	18.2	17.1	16.4	18.1	23.3	17.6	17.4
2 to 4	7.8	9.0	8.9	8.9	8.3	5.6	8.3	9.1
4 to 6	1.6	2.2	2.7	3.0	2.7	0.8	2.8	2.5
6 to 8	0.3	0.5	1.0	1.3	0.6	0.3	0.9	0.7
8 to 10	0.04	0.1	0.2	0.3	0.2	....	0.3	0.2
10 to 12	....	....	0.1	0.1	0.04	....	0.1	0.1
12 to 14	....	....	0.03	0.04	0.03	....	....	....

(8.) The frequency of sudden irruptions of very dry winds (generally but not necessarily cold) which by their desiccating power destroy tender vegetation, a factor that can of course be well presented by the changes from small to great daily evaporation or from great to small elevations of wet-bulb above dew-point temperature.

In numerous suggestive notes Hann leaves the dry field of descriptive climatology proper and wanders a little over into the fascinating border-land of dynamic meteorology. Usually he thus intensifies our interest in the subject by the clear and satisfactory explanations. But confining ourselves to the problems of the future, we quote the following.

The annual mean distribution of atmospheric pressure reduced to standard gravity and at sea-level and for all meridians is given for each 5° of latitude in the second column of the following table:

Latitude.	Mean annual— Temperature. Ferrel and Hann.	Mean annual— Pressure. Ferrel.[4]	Ratio of land to water. Foster and Dove.	Latitude.	Mean annual— Temperature. Ferrel and Hann.	Mean annual— Pressure. Ferrel.	Ratio of land to water. Foster and Dove.
Degrees.	°C.	*m.*	*Per cent.*	*Degrees.*	°C.	*m.*	*Per cent.*
North 90	—17.0	...	...	South 5	...	758.3	22.6
85	...	...	...	10	25.9[3]	759.1	20.4 22.6
80	—15.8	760.5	...	15	...	760.2	22.6
75	...	760.0	...	20	23.5[3]	761.7	22.5 22.6
70	—10.2	758.6	48.3	25	...	763.2	22.6
65	...	758.2	...	30	19.2[3]	763.5	20.5[2] 20.5
60	— 2.2	758.7	56.8	35	15.6[3]	762.4	9.7 9.7
55	...	759.7	...	40	12.9[3]	760.5	4.1[2] 4.1
50	+ 6.5	750.7	56.3	45	10.1[3]	757.3	3.1 3.1
45	...	761.5	...	50	6.7[3]	753.2	1.9[2] 1.9
40	+14.4	762.0	44.5	55	3.8[3]	748.2	1.8 1.3
35	...	762.4	...	60	0.3[3]	743.4	...
30	20.4	761.7	43.4	65	...	739.7	...
25	...	760.4	...	70	— 4.8[3]	738.0	...
20	24.3	759.2	30.8	75	...	(34)[1]	...
15	...	758.3	...	80	— 8.2[3]	(36)[1]	...
10	26.4	757.9	23.4	85	...	...	...
5	...	...	...	90	— 9.3[3]	...	...
0	26.8	758.0	21.6 20.8[2]				

[1] Hann, Klimatologie, pp. 92, 93, and 742.
[2] Dove, Zeit. Erdkunde, 1862, xii, and Hann, p. 90.
[3] Hann, pp. 92, 93.
[4] Ferrel, Met. Researches, part 1.

"The pressures here given agree with the distribution of the atmosphere required by the mechanical conditions for the general circulation of the atmosphere as published by Ferrel in 1858 and 1860. We see that the pressure diminishes from either circumtropic latitude towards the corresponding pole, especially in the southern hemisphere, where the whirl around the pole can develop with the least disturbance. The zone of highest barometric pressure lies further from the equator in the northern than in the southern hemisphere (it lies in the former somewhat north of the 35th degree north latitude, but in the latter between the 25th and 30th degrees south latitude), and the accumulation of air is less there since the process of circulation is more restricted and therefore less energetic.

"This circulation of the atmosphere (delineated in the previous paragraph according to Ferrel's views as given by him in his Motions of

Fluids, &c.) is subject to an annual period. It is most intense in the hemisphere in which winter prevails, for in this hemisphere the difference of temperature between the tropics and the higher latitudes is greatest, and therefore also the temperature gradient in the upper strata, which sets the circulatory current in action, and which latter, in its turn, brings into play the centrifugal forces. In the hemisphere that is enjoying summer the upper temperature gradient is slightest and the interchange of air between the tropics and the higher latitudes is feeblest. In general an accumulation of air exists always over the hemisphere that is enjoying winter. Since the northern hemisphere in its winter cools much lower than the southern in its, therefore also the upper currents of air are much stronger in the winter of the northern hemisphere than in the winter of the southern. The difference between the warmest and coldest latitudes in the northern hemisphere during its winter is about 60° C., while on the other hand for the winter of the southern hemisphere it is only about 40° C. Since, also, during the winter of the northern hemisphere the local temperature differences between the oceans and the land are very great, reaching, indeed, nearly the same amount as the general difference between the tropics and the pole, therefore the local circulation attains its greatest intensity and is able to materially modify the general circulation. Therefore there develop over the warmer northern oceans, the permanent cyclones of the Atlantic and Pacific Oceans and the anti-cyclones over the continents of Asia and North America. Parallel with this there is a more frequent and intense occurrence of smaller whirls—the ordinary cyclones—which, in the temperate zones, advance with the general movement of the atmosphere from west to east. This is therefore in general the season of the development of greatest activity in the movements of the earth's atmosphere, the greatest differences of pressure and greatest variations of pressure occur, and with these the greatest variability of temperature. In the winter of the southern hemisphere no similar increase in the motions of the atmosphere is to be expected, since its cooling is not, by far, so great as that of the northern hemisphere. Therefore, also, the upper temperature gradient is not so marked, and consequently the intensity of the upper air currents toward the pole. At the same time also the temperature differences of the meridians and the local currents fail because the continents in high latitudes are missing. Consequently the currents of the general circulation can develop themselves much more regularly and intensely, as we have already seen is indeed the fact. The difference in the movements of the atmosphere between winter and summer is much slighter. Therefore, also, the change in the variations of barometric pressure from one season to the other and its consequences. Equally must the variability of the temperature be less. In short, the whole meteorological *régime* assumes a more constant type and shows a smaller annual periodicity. In the equatorial region of the Atlantic

Ocean it has in fact been observed that above the trade winds more air is flowing at high altitudes (toward the pole) in that hemisphere in which winter is prevailing. Toynbee says that during the northern winter and spring the upper clouds above the trade winds move northward more frequently than in summer and autumn. The reverse is true during the winter of the southern hemisphere.

"If the temperature of the tropic zone is subject to periodic changes, as Köppen has shown is probable, since periods of greater intensity of solar radiation follow parallel with the periods of greater or less frequency of solar spots, then must similar changes also exist in the general atmospheric circulation. At the time when the temperature of the tropics attains a maximum the descent of air in the upper strata from the tropics towards the pole is greatest and the circulation most intense. The low pressure in the equatorial belt will experience a further diminution, while the high pressure in the middle latitudes will increase, and in the circumpolar regions the atmospheric pressure, in consequence of the increase in the rotating ring (vortex ring), will further diminish. The whole energy of the atmospheric movements will increase, but what influence this may have upon the temperature and precipitation in the middle and higher latitudes cannot easily be deductively inferred. On this point only investigations based upon sufficient observations can give satisfactory conclusions.

"Recently, Blanford has called attention to a relation of this character between the distribution of pressure in the tropics and in higher latitudes, in that he shows that the periods of low pressure in Indo-Australian tropical regions coincide with periods of high pressure on the northern Asiatic continent. Especially is this the case in winter. The air that flows at high altitudes out of the tropics streams towards and accumulates where the descent in the higher strata (the thermic gradient) is greatest. Since high atmospheric pressure (a maximum barometer) is associated with greater and permanent clearness of the sky, therefore also with greater radiation of heat outwards and cooling of the lowest strata of air in winter (origin of a local pole of cold), whereby conversely the thermic gradient and the inflow of air from above is again increased—it is thus quite possible that periods of great warmth and low pressure in tropical regions should correspond with periods of great winter cold in high latitudes.

"The discovery of such relations between the temperatures of the tropical zone and the general weather of the middle and higher latitudes is one of the most important present problems of meteorology and comparative climatology. We have already seen that the influence of the tropics is actively opposed to that of the temperate zone of either hemisphere in its winter season in the ratio of 10 to 6.5. The mean condition as to temperature in the tropical zone on which depends the energy of the upper currents of air which become the prevailing ones in the temperate zone must, therefore, have the greatest influence upon the general character of the weather in the latter zone. Therefore, by the observations in the temperate zone alone we can never completely trace its weather back to its fundamental causes."

In closing our summary of Hann's important work we may be pardoned for referring to the great stride made during the past twenty years in our knowledge of meteorology, and to the Americans, Henry, Espy, and Ferrel, who have correctly penetrated to the ultimate causes and laws of the principal phenomena. Their views have a most profound influence in the daily work of the Weather Bureau of the Army Signal Office, and are amply illustrated in its daily maps and monthly reviews, and are now become the foundation of such works as the present by Hann. Especially has the present writer never ceased to urge the necessity of studying the atmosphere of the whole globe in one comprehensive chart. To this end the Bulletin of International Simultaneous Observations was undertaken, and it already offers data for solving the difficult climatological problems that Hann has so clearly set forth. Great mathematical problems delay the progress of the work; as with Faraday in electricity, and many other physicists, so here, doubtless, the observational and inductive methods must always prepare the way for analysis, but on the whole they go hand in hand, first one step forward and then the other, as the parent teaches the child to walk, until finally both run together. (Hann, *Handbuch der Klimatologie*, *Stuttgart*, 1883.)

Climate and agriculture.

Friesenhof remarks, on the utilization of meteorology for agricultural purposes, that this may be divided into the following sections: (I) Climatology of the plants; (II) climatology of the region; (III) local meteorological knowledge; (IV) weather predictions; (V) crop predictions. Each of the five sections demands a special study, and a practical active system of agrarian meteorology must carry them all on simultaneously. One central station will not suffice to solve all the problems, but it has its part to fulfill about as follows:

I. *The climatology of plants* includes the sum of all climatological elements that influence their prosperity. The influence of each element and of their most varied combinations must be studied; in other words, an investigation of the relation of the plant to the climate wherever it is cultivated throughout the world. This will require the following meteorological data: The quantity and distribution of precipitation; temperature, winds, cloudiness, insolation, and dew; these can be obtained with sufficient accuracy from the records of the present meteorological stations.

II. *The climatology of the region* gives information as to the unequal distribution of the individual meteorological elements in localities that are comparatively near together. This is the special problem of agricultural stations, and cannot be demanded of the central meteorological institute. The latter deals with general problems over very extended territories, and cannot possibly go into minute detail. Excepting barometric pressure, these agricultural stations should observe all the atmospheric phenomena. As many as possible are needed in every land, reporting to the central agricultural station. The most important subjects of observation are (1) rainfall, *i. e.*, the quantity, time, and accompanying cloud motion; (2) temperature by means of self-recording maximum and minimum thermometers; (3) accurate notes of time and direction of thunder-storms, as well as the directions at which electric discharges are seen; (4) estimate of the dew, as none, light, moderate, heavy, very heavy; (5) maximum temperature of the air in the sun. If all of these cannot be observed, then the first item at the very least must be obtained.

III. *The local meteorological data* differ only in form, not in kind, from the preceding. They include all climatic elements of any importance in agriculture; viz, (1) the pressure and its changes; (2) atmospheric moisture; (3) the temperature, its changes and extremes, both in shade and sunshine, and in protected secluded spots; also in the earth at various depths, and at slight depths under various kinds of superficial soil; (4) wind force and direction; (5) cloudiness and its influence in diminishing insolation, to which latter end, in addition to the ordinary scale 0 to 10 of area covered by clouds, there should be an additional record (*i. e.*, clear, somewhat obscured, moderately obscured, greatly, almost entirely, and entirely obscured), according to the measure of the deprivation of sunlight, and that, too, not only for the moment of observation, but also the general average for the interval elapsed since the last record—in this regard the Campbell sunshine recorder is to be recommended; (6) precipitation, amount, times, and rapidity of fall; (7) dew measured instrumentally; (8) evaporation; (9) ozone, although its importance is not yet evident.

All these current values, as observed, should be compared with the normal mean values, and the results, together with a similar comparison of agricultural and phænological phenomena be fully published. The normal values should proceed by decades of days, as a month is too long, and daily means are not yet available.—(*Z. O. G. M.*, XVII, pp. 8–11.)

The Deutsche Seewarte has published an important atlas, embracing thirty-six charts of the Atlantic Ocean, showing its physical relations, its commercial routes, &c.; especially interesting to the meteorologist are the charts of depth, temperature of water, and meteorological phenomena which occupy two-thirds of the volume, and are followed by magnetic and other charts. The work offers the most exact and exhaustive collection of scientific data accessible for the student of the physics of the Atlantic Ocean. (*Z. O. G. M.*, XVIII, pp. 44 and 70.)

Angot has published for Paris the diurnal variations and the extremes of temperature and pressure and vapor tension, based on seven years of direct hourly observations by Renou at the observatory in the park of St. Maur. In regard to this important work, Hann remarks that it is notable that we have never before received for any part of France any similarly thorough work on diurnal variations, nor have we as yet any systematic collection of climatic data for France, such as corresponds to the need of modern climatology, and is well illustrated in his own admirable text-book. (*Z. O. G. M.*, XVII, p. 290.)

Buchan has published in the new edition of the Encyclopædia Britannica, vol. xvi, a general popular treatise on meteorology as distinguished from climatology. There seems to have been a widespread expectation that this treatise would be substantially a new edition of his famous handy book of meteorology, for which many have been waiting these ten years past; but it may be doubted whether the 45 quarto pages of the Encyclopædia, excellent as they are, will be considered to replace the hoped-for volume; in fact, no satisfactory philosophical treatise on meteorology can now be written without having as a basis the works of Espy, Ferrel, Guldberg, Mohn, Hann, and numerous other mathematical students of the mechanical and physical questions involved, and such studies seem to be as yet entirely ignored in Great Britain (Haughton, Everett, and Archibald alone excepted). In fact, the hopeless confusion of ideas that there prevails cannot be better illustrated than by the fact that this same Encyclopædia divides meteorology into two grand divisions, and allows the first as written by Buchan to be followed by a memoir (of 25 pages) on terrestrial magnetism by Balfour Stewart. This second memoir is apparently a strong plea for the parallelism and interdependence of meteorology and magnetism, the reader being throughout disarmed of all unreasonable prejudice against this innovation by the frequent use of the expression "magnetic weather," lately adopted by Stewart, and by which is strictly meant the fact that magnetic phenomena (declination, dip, force, and their variations) present many analogies with meteorological phenomena. The author, in his closing section (144), considers that terrestrial meteorology has somehow produced and maintained the magnetic state of the globe, and that, therefore, they ought to be studied together, as the phenomena of the one will explain those of the other.

If this latter view is the proper one to take, then we have Meteorology the fundamental science, magnetism one of its many applications. The magnetist must understand meteorology, just as with the student of the tides, of navigation, of geographical distribution of plants, of hygiene, of climatology, or of geology and vulcanology, for all these and many other sciences have intimately to do with meteorology. But it would be folly to say that these constitute parts of the study of meteorology any more than of astronomy, or that the meteorologist must necessarily study these. Meteorology stands in a general way as the fundamental or parent science for the whole range of studies embraced under the title of "terrestrial physics." Therefore we regret, not to have found Balfour Stewart's excellent article published in its proper place under "terrestrial magnetism," in a succeeding volume of the Encyclopædia.

Buchan's treatise is too short to do much more than touch upon the salient points of meteorology, which he declares to be restricted to the description and explanation of the atmosphere as grouped under the terms "weather" and "climate." In a few words relative to the historical development of this study the author glances at the progress due to Humboldt, Dove, Loomis, Le Verrier. Perhaps it was impossible in the space at his disposal to do justice to all, but as the whole work is evidently written for the American and English public, and is not free from national prejudice, it seems strange that the great series of daily weather maps 1838 to 1843, published by Espy, and the great daily map of the Smithsonian Institution, 1854 to 1860, should have been passed by in the following very misleading sentence: "The method of practically conducting this large inquiry (the paths of storms) in the most effective manner was devised by the genius of Le Verrier, and begun to be carried out in 1858 by the daily publication of the Bulletin International, to which a weather map was added in September, 1863." This paragraph seems to well illustrate the great difficulty of acquainting one's self thoroughly with what is going on in divers countries, and emphasizes the importance of such indexes to the Bibliography of Meteorology as those of Hellmann (Leipsic, 1883) and Symons (not yet published).

The whole of this essay is divided into two capital sections—*i. e.*, "Diurnal phenomena" and "Monthly annual and irregularly recurring phenomena." Under this head the respective phenomena are treated of in separate paragraphs apparently quite independent of or with a very slight thread of interdependence. In the former of these sections the illustrative examples are so frequently drawn from the results of observations made on the Challenger, or from the publications that are due to Buchan, that we almost forget the numerous able coworkers in this field. Among the new data and results not heretofore published or but little known, the following are worthy of mention: The depth below the surface of the sea to which the influence of the sun's heat is felt has been shown by the observations of the Challenger to be about 500 feet. The rate at which this heat is distributed in perfectly clear water at different depths is a problem that has not yet been worked out. During 1859 to 1863 Captain Thomas frequently observed hourly the surface temperature of the sea off the northwest coast of Scotland with the following results: Total mean daily oscillation of temperature, $0^{\circ}.3$ Fahr.; minimum, 0.17, at 6 A. M.; mean, 0.0, 10 A. M. and 2 A. M.; maximum, +0.13, between 3 and 4 P. M. From the records of the Challenger Buchan deduces the results of simultaneous observations of sea and air temperatures as given in the first three columns of the following table:

Observations on board H. M. S. Challenger, 1873–1876.

Hour.	Departures from daily means of observations taken every two hours.							Force of wind.		Amount of cloudiness, 277 days, open sea.
	Temperatures.			Elastic force of vapor.		Relative humidity mid-ocean 84 days. Mean relative humidity, 80 per cent.	Barometric pressure, 1875, September 1-12, latitude 1° 8' south, longitude 150° 40' west. Mean, 29.928.	Open sea, 650 days.	Near land, 552 days.	
	126 days in mid-ocean.		76 days near land.	Mid-ocean, 84 days. Mean elastic force, 0.659 inch.	Near land, 76 days.					
	Air.	Sea-water.	Air.					Beaufort.	Beaufort.	
	° F.	° F.	° F.	Inch.	Inch.	Per ct.	Inch.			Pr. ct.
2 a. m	—1.13	—0.24	....	—0.015	—0.003	+2	—0.012	2.98	1.74	59
4 a. m	1.40	.33	{ Min. —2.05 }	— .020	— .009	+2	— .022	2.89	1.68	59
6 a. m	1.41	.29	....	— .016	— .010	+1	+ .003	2.82	1.66	62
8 a. m	—0.21	— .12	....	— .007	— .003	0	+ .028	2.82	1.73	62
10 a. m	+0.78	+ .06	....	+ .004	+ .014	—1	+ .032	2.86	2.00	58
Noon	1.45	.24	{ Max. +2.33 }	+ .017	.011	—2	+ .006	2.92	2.29	56
2 p. m	1.80	.47	....	+ .020	.007	—3	— .043	2.92	2.36	58
4 p. m	1.56	.47	....	+ .017	.015	—2	— .055	2.87	2.30	59
6 p. m	+0.73	.26	....	+ .007	000	—1	— .028	2.87	2.02	57
8 p. m	—0.30	+ .02	....	+ .002	— .004	0	+ .004	2.89	1.74	57
10 p. m	—0.80	— .19	....	— .005	— .005	+1	+ .013	2.93	1.68	57
Midnight	—1.02	— .35	....	+ .003	— .007	+2	+ .012	2.90	1.75	57

Thus the amplitude of the daily fluctuations of the air is 3.21, or nearly four times greater than that of the surface of the sea below it.

Near the land on 76 days the daily range of air temperature was still larger. Part but not all of the observed greater range of air over the sea surface is doubtless owing to the effect of heating the vessel's deck, but the general fact remains as one of considerable interest. The diurnal variations at sea of elastic force of vapor and of relative humidity are shown by the fifth and sixth columns of the table drawn from the Challenger observations. The disturbanee induced by proximity to land is very notable. The land breeze delays the minimum vapor tension two hours, *i. e.*, from 4 to 6 A. M., and the sea breeze produces a secondary minimum, +0.007 at 2 P. M.; similar minima occur at Batavia and at Bombay, apparently owing to the same cause, namely, the mixing of descending dry air with the moist sea breeze. The diurnal variation at sea of relative humidity is given in the seventh column and that of barometric pressure in the 8th; the latter evidently represents only a small portion of the whole series of observations at his command; these however are quoted by Buchan principally as illustrating his explanation of the origin of the diurnal period in pressure. On this interesting though comparatively unimportant subject, Buchan has made a most extensive study, parts of which have been published some years ago, both in the article "Atmosphere" and in his memoir in the Edinburgh

Philosophical Transactions. In the present essay he gives his latest views, devoting to the subject four pages or rather more space than would have seemed appropriate had he not paid such special attention to this subject. In the main, his argument is that the warming and expansion of the atmosphere by the sun causes a compression or tension that increases until it overcomes the resistances due to the inertia and viscosity of air, when the latter by its expansive movement experiences relief and the tension diminishes until the accession of heat from all sources ceases. Moist air absorbs heat and expands more than dry, therefore the diurnal fluctuation is greater over moist than over dry land, and is largest within 10° of the equator; the sea surface temperature varies so little during the day that the diurnal fluctuation of pressure over the ocean is not entirely due to that temperature but to direct heating by absorption by the molecules of air and vapor. These expansions are followed by contractions at night, and as the air cannot mechanically flow to and fro fast enough to fill the vacua, a consequent diminution of tension is observed. On land the heated ground imparts to the air a much larger diurnal variation of temperature, and by so much increases the barometric fluctuation which, other things being equal, is found to be greatest when the sky is clearest, *i. e.*, where the most sunshine reaches the earth, and least when it is covered with dense clouds and sunshine is cut off, being thus the reverse of what is observed over the open sea. [Although nothing is said about the diurnal period due to the vapor thrown into the air by evaporation during sunshine, and abstracted by nocturnal cooling, yet such would seem to be equally important. The defects of this and all other similar theories, of which there are many, have long since led the present writer to abandon them, and in general adopt a view that he has frequently communicated to others and referred to in various publications, *i. e.*, that this periodicity in pressure is principally a dynamic phenomenon deducible from Ferrel's formula for general and special atmospheric movements, whenever they shall have been satisfactorily developed into sine and cosine series, with the time as the argument. A matter however that at present offers more difficulties to the analyst than even the most complex of astronomical theorems relative to the motions of the heavenly bodies.]

The Challenger cruise has also afforded Buchan excellent results as to the diurnal variations in the force of the wind at sea. In columns 9 and 10 we give the force in Beaufort's scale numbers as read from Buchan's illustrative wood-cut. The diurnal curve shows no distinct uniform or reliable maximum or minimum on the open sea, but a marked maximum at 1 or 2 P. M., when near land. The diurnal variation in in the wind force or velocity thus depends largely on heating of earth and water by direct solar radiation, and the explanation of Espy and Köppen is practically adopted by Buchan in saying that the ascension of the air during the day thus brings down portions of the rapidly moving upper strata, and communicates at least a portion of their greater velocity to the lower strata, or, as Buchan says, the influence of the higher temperature of the earth's surface is "to tend to counteract to some extent the retardation of the wind's velocity resulting from friction and from the viscosity of the air." [This explanation loses much of its force in cloudy weather, especially during extended heavy storms, when the wind velocity still shows a marked diurnal periodicity, but this has always seemed to the present writer explicable in consideration of the fact that the solar heat is then all absorbed at the upper surface of the cloud layer or of closely adjoining cumulus clouds and is doing its great work there, *i. e.*, expanding them and evaporating their vapor particles and in both ways rendering them still lighter than the surrounding air; their ascensive force is thus increased, the up-draft of air from the earth the horizontal supply winds, and the rotatory in-draft, are increased, and thus the diurnal period in our winds is maintained; similarly the diurnal period in rainfall is maintained with a second maximum in the early morning hours due to radiation from upper cloud surface and consequent condensation of cloud particles into rain. Similarly the whole development of an extended storm passes through its diurnal period, including a periodic rise and fall of the barometric pressure due to the varying force of the wind and resulting whirl; all which, as has often been said, lies concealed in Ferrel's dynamical formulæ.]

The diurnal variation in the direction of the wind is illustrated by the following figures, whence we see that even at sea the influence of the sun in heating up neighboring lands or air masses makes itself visibly felt in this item:

Mean wind direction.

Challenger, 1873.	In northeast trade regions.	Mauritius observatory.	
2 A. M. to 6 A. M	E. 47° N.	4 A. M.	E. 22° S.
10 A. M. to 2 P. M	E. 56° N.	1 P. M.	E. 7° S.

The percentage of sky covered with cloud is given in the last column of the table of results of observations in the Challenger; the slight variations do not seem to the present writer to exceed the probable uncertainty of the observations. The diurnal and annual variations in the times of the occurrence of thunder-storms, *i. e.*, the hours in which thunder is heard, and which is, therefore, equivalent to the hours in which lightning occurs, and is quite distinct from the attending rain, hail, or wind, is beautifully illustrated in the following table based on fourteen years (1859 to 1872) of observations at Ekaterineburg, Ural Mountains, which is given by Buchan without quoting the source (probably Woeikoff or Wesseloffski), to which we add the hourly distribution of 162 tornadoes in the United States as given by Finley (also quoted by Buchan, without mention of source):

Hour ending—	Frequency of thunder-storms at Ekaterineburg, 1859–1872.							Frequency of tornadoes in the United States.	Frequency of hail-storms at Coimbra.
	April.	May.	June.	July.	Aug.	Sept.	Year.	Year.	Six years.
1 a. m	......	......	5	5	5	......	15	2	0
2 a. m	......	......	1	5	2	......	8		
3 a. m	......	......	1	4	1	......	6	5	1
4 a. m	......	......	1	2	3	......	6		
5 a. m	......	......	2	1	1	......	4	3	2
6 a. m	......	......	3	3	......	......	6		
7 a. m	......	......	2	3	......	......	5	4	1
8 a. m	1	......	5	2	2	......	10		
9 a. m	1	......	4	4	1	......	10	1	3
10 a. m	1	......	6	7	5	......	19		
11 a. m	1	......	8	12	4	......	25	7	20
Noon	1	2	14	30	5	1	53		
1 p. m	3	4	19	25	5	4	60	13	15
2 p. m	2	8	21	29	12	2	74		
3 p. m	3	10	22	35	15	4	89	47	13
4 p. m	3	6	26	45	20	1	101		
5 p. m	2	5	24	33	9	......	73	52	3
6 p. m	1	6	25	30	11	2	75		
7 p. m	2	7	15	20	10	......	54	17	1
8 p. m	2	5	16	20	9	......	52		
9 p. m	2	6	14	14	6	......	42	7	0
10 p. m	2	3	8	10	5	1	29		
11 p. m	......	1	6	6	5	......	18	4	0
12 midnight	......	1	7	6	8	......	22		
Sums	27	64	255	351	144	15	856	162	59

From these and other considerations Buchan concludes: "Given an initial difference of electric potential, it is easy to understand how the most violent thunder-storms are produced."

"The formation of the electrical manifestations of the thunder-storms and tornadoes requires aqueous vapor and that there shall be masses of descending cold air along with the ascending current of warm moist air; thus at Mauritius there are no thunder-storms so long as during June, July, August, and September the island remains in the heart of the southeast trades where the conditions of descending cold currents of any considerable volume are not present." In our present almost utter ignorance of the actual electric potential of the air and vapor as distinguished from that of the clouds, the earth, and the apparatus, it would seem best for the meteorologist to await the studies of the physicists and refrain from advancing crude explanations. Observations and inductions are always in order; working hypotheses are very helpful as suggesting further observations and study, but they should not be put forward as satisfactory explanations. Perhaps the most important new contribution in this essay is Buchan's new charts, based on the eleven years, 1870 to 1880, and giving the January and July isotherms, isobars, and winds; these must immediately replace his older ones of 1868, and even those of Ferrel, Met. Res., Part I, (1877,) after applying the reduction of barometer to standard gravity, which has been omitted by Buchan.

In his comments on these charts our author seems not to clearly state the mechanical problem of the connection between isobars and winds; he says, "Winds set in from where there is a surplus to where there is a depression of air, and observations teach that the isobars and the prevailing winds are in accordance with each other," and in his subsequent detailed exposition of these accordances the fact seems to be lost sight of that our winds are primarily due to differences of temperature and moisture as affecting density, and that from the winds and the rotation of the earth follows the distribution of pressure, as shown on his valuable maps, whose isobars are, therefore, the result, not the cause, of the winds.

This dynamic phenomenon, so ably exposed by Ferrel, Babinet, Everett, Hann, Finger, Sprung, Thiesen, Roth, Overbeck, Guldberg, and others, will, we hope, ere long be accepted by English meteorologists. In such sentences as, "differences of pressure and consequently all winds, originate in changes of temperature, &c.," or, "all winds may be regarded as caused directly by differences of pressure," Buchan alludes to differences measurable by the barometer as is generally the case in storms, and known as barometric gradients, whereas these gradients are the result and not the cause of the wind, the true cause being the very slight gradients of pressure due to differences of density; these fundamental gradients are very slight, and in the exact direction of the wind, while the resulting ordinary barometric gradient is measured perpendicular to the isobars, and therefore frequently at a considerable angle to the wind.

It is impossible for one familiar with recent advances in dynamic meteorology to accept the explanation that Buchan offers of the cause of the general low pressure over the sea in winter and the land in summer, and perpetually at the equator and poles, based on the simple principle that moist air is lighter and that the condensation of moisture leaves a perceptible vacuum. "Air charged with vapor is specifically lighter than when without the vapor; the condensation of vapor in ascending air is the chief cause of the cooling effect, being somewhat less than that which would be experienced by dry air. From these two principles, which were established, the former by Dalton and the latter by Joule and Sir William Thomson, it follows that the pressure of vapor in the air and its condensation exercise a powerful influence in diminishing the pressure." In this sentence the two principles are correct, and due to the physicists named, but the conclusion is Buchan's, and, as stated, does not follow from these principles, but from others, about which he is silent.

[If there were no vapor at all in the air, and were the seas replaced by polished silver and the continents by dry rock, we should still have a similar general distribution of pressure, due then, as now, not to vapor in and of itself, but to the winds that will themselves be produced by unequal distribution of temperature and density. That the condensation of vapor to fog and rain does not directly produce a diminution of barometric pressure has been thoroughly demonstrated. On the contrary, the latent heat evolved by condensation of vapor expands the air so much that a decided increase of pressure should result. The simple truth is that ascending currents must be followed by inflowing descending and horizontal currents to fill the vacancy. These soon set up a whirl, and the barometer falls as a result of the centrifugal forces developed by the two motions, *i. e.*, about the earth's axis and about the center of low pressure. It is therefore very improper to say that the air flows inward because of the great observed barometric depression, or that the presence or the condensation of the aqueous vapor causes the depression.]

[Buys Ballot's law of wind and pressure, as worded by Buchan, is the expression of the concordance of two results, and is not an expression of physical laws connecting cause and effect. It is a rule, not a law. The frequent mention of Buys Ballot's law by Buchan and others, especially English writers, long since led the present writer to look up the history and bibliography of this rule, and it will perhaps be a matter of surprise to many to find that Buys Ballot himself never published or claimed it in anything like its present form. It would be much more proper to attribute the law as first enunciated by Buchan in 1866 to Buchan himself or to the cyclonologists Reid, Piddington, Redfield, &c., and attach Buys Ballot's name merely to his own rule, namely: "In Holland, when on any day the barometric departures from normal values indicate a gradient between any two stations, then within the next twenty-four hours the wind will blow nearly at right angles to that gradient, and from left to right if one's face be towards the lower barometric reading."]

In his section on the connection between steepness of barometric gradient and velocity of attending winds, Buchan gives recent results for 8 A. M., deduced by Whipple from the continuous anemometric records at Kew Observatory for 1875 to 1879, inclusive, as compared with the gradients on the morning weather-maps of the London Meteorological Office, as shown in the following table:

Gradient.		Wind velocities at Kew.
Barometric change in 15 nautical miles.	Barometric change in 1° of great circle.	Mean of the year.
Inches.		*Miles per hour.*
0.002	0.008	5.0
0.005	.020	7.0
0.007	.028	7.5
.010	.040	9.2
.012	.048	11.6
.015	.060	12.6
.017	.068	15.0
.020	.080	16.5
.022	.088	19.1
.025	.100	22.0
.027	.108	22.0
.030	.120	25.5
Mean.. .016	0.064	14.4

Relative velocities for the same gradient.

October, November, December ....12.5 miles per hour.
January, February, March..........................14.8 miles per hour.
April, May, June ....17.2 miles per hour.
July, August, September...........................12.6 miles per hour.

The year ....15.7 miles per hour.

The increase of velocity in April, May, and June, Buchan explains as due to the fact that the wind blows over a surface warmer than itself. The variations are precisely parallel to the diurnal velocity of the wind where also the greatest velocity occurs when the air blows over surfaces warmer than itself, "and the ascensional movement of the air tends to counteract the effect of friction and viscosity between the lowermost stratum of the air and the ground. At night-time there is a deep descensional movement, and the friction between the wind and the surface of the earth is thereby increased." It would seem that Buchan has here joined together as cause and effect phenomena that are only very indirectly related to each other. We have little or nothing to substantiate the idea that gaseous friction and viscosity diminish sensibly with rising temperature. It would seem much simpler to adopt at once the rigorous demonstration and clear explanation of these two phenomena given by Ferrel and Köppen.

J. A. Plumandon, adjoint meteorologist at the observatory of Puy-de-Dôme, has published an excellent popular work on the prediction of weather, especially for central France, from which we take the following notes for observers at isolated stations:

The prediction of weather depends upon the possibility of discovering the existence, the position, and the future progress of areas of low and high barometric pressure. The direction of motion of the clouds is the direction of the true wind that has important meteorological influence. The number of days that fine weather will last after the barometer has slowly risen is equal to the number of days that has elapsed between the preceding bad weather and the time of maximum pressure. The approach of very violent storms is indicated, (1) by a very sudden fall of barometer when the barometer is already quite low; (2) by the backing of winds and clouds towards the southwest and south;* (3) by the more or less complete but sudden disappearance and reappearance of clouds previously covering the sky; (4) by the rapidity with which the lower clouds traverse the sky; (5) by the presence of special clouds of an opaline whiteness that form in the region of the sky from which the wind blows.

Thunder-storms are not local phenomenon, as was long supposed. They are a consequence of the general state of the atmosphere; the storm that devastates a single county is the result of atmospheric conditions over the area of several states. "The study of general depressions furnishes one of the best means of predicting thunder-storms two or three days in advance. The forecast is infallible if the approach of one of these depressions combined with the general situation of the atmosphere gives rise in our section to a belt of almost uniform pressure." It has been observed that at every season of the year the sky assumes a stormy appearance as soon as the pressure becomes uniform in central France. This uniformity of pressure may be considered as eminently proper for the production of thunder-storms in the zone where it manifests itself without the zone being subject to the direct action of a center of low pressure. Thunder-storms rarely occur when the barometer is high.

The approach of a period of thunder-storms is announced by a fall of the barometer, by copious dews, and by very pronounced maxima and minima of temperature. Cumulus clouds do not always bring storms. Often, on the contrary, they accompany a long period of fine weather. When this is the case they are less developed and traverse the sky isolated, like balls of cotton. They disappear after sunset to reappear on the morrow at 9 or 10 o'clock in the morning. If they appear in the evening after sundown it is a sure indication that the weather is about to be stormy.

The torrential rainfalls accompany thunder-storms or secondary depressions that are but slightly developed. The general rains of long duration in France are produced principally when a depression of low gradient prevails or a series of small depressions succeed each other

* These directions for France would become northeast and east on our Atlantic coast.

rapidly. Rain may come with any wind, but principally with those be tween southwest and northwest; for France these are from the ocean, but for our Atlantic States the rain-winds are from northeast to south.

Fogs frequently arise when a warm current succeeds a cold current or the reverse. They last longer in the second case than in the first. They always accompany the zones of high pressure when these zones are narrow and elongated between two depressions.

The heat increases or the cold is tempered every time the barometer undergoes a notable depression, for at such times southerly winds prevail; cold weather comes with high barometer and the attending northerly winds.

Two kinds of hail are to be distinguished: (1) The hails of winter; (2) the hails of autumn and spring. Disastrous frosts coincide with short periods of fine spring and autumn weather, and are frequently produced by terrestrial radiation alone. The frosts of autumn and spring are easily foreseen two and even several days in advance. They are to be feared, (1) after a depression has passed over England and France, and (2) when a depression exists in the Mediterranean Sea.

A remarkable case of nocturnal radiation occurred on July 29, 1881, in the middle of a long period of oppressive heat; the temperature was 38° centigrade in the sun, and fell during the night to 2°.3 centigrade. This reduction during clear nights has led many to erroneously suppose that the moon is the cause of the frosts, an error that is now happily being rapidly dissipated.

III.—APPARATUS AND METHODS.

Hamberg describes a modification of Lamont's earth thermometer that he uses in Sweden, and which for moderate depths may be recommended elsewhere. The thermometer proper is enveloped in glass and wood and muslin pads, both to protect it from injury and to cut off rapid changes of temperature. It is let down through a copper tube into the mercury contained in an iron cylinder fastened at a proper depth, and is pulled out, read off, and returned whenever an observation is made. (*Z. O. G. M.*, XVII, 116.)

Sprung having devised a simple form of self-recording balance barometer, described already in 1876, has lately published results of actual records as a demonstration of the high degree of accuracy attained by it. The formula of reduction for instrumental corrections as given by Sprung is exceedingly simple. The accuracy claimed is expressed by the "probable error" (or the error whose size is such that it is equally easy to make a smaller or larger error,—or one whose probability is 0.5), which is $\pm$ 0.11^{mm}, as determined by comparative readings of a standard barometer, but only $\pm$ 0.07 if determined by independent comparative readings of the barometer belonging to the barograph itself, a part of the difference being due to the sluggishness of the latter. A peculiarity of Sprung's barograph is that the special apparatus for registration works with perfect correctness, and without injurious reflex action upon the accuracy of the barometer proper; it is surprising that many pieces of self-registering apparatus are still used in which this important condition is neglected.

The probable error of the self-registering Hasler barometer (Wild's), at St. Petersburg, has only lately and after several years of experience been brought down from 0.23 in 1871 to 0.085 in 1878, and this by virtue of many laborious computations and reductions. The probable error of the Schreiber baro-thermograph is still about 0.24. In general the performance of Sprung's balance barograph—with sliding rod and sliding weight, and invariable position of barometer tube—has proved thoroughly satisfactory, and proves it to be an exception to the statement of Dr. Schreiber, in December, 1881 (*Z. O. G. M.*, XVI, p. 500), that all other systems of registration, except those depending on the motions of the barometer, are mere methods of interpolation. The insulation of the recording and the measuring portions of the apparatus as accomplished by Sprung has been applied by him to thermometers, rain-gauges, &c. [Was it not first applied to meteorological apparatus by G. W. Hough at Albany, in 1861, whose printing barograph and thermograph still serve as the typical apparatus, though by no means giving such accurate results as those of Wild, Schreiber, and Sprung.] (*Z. O. G. M.*, XVII, p. 46.)

Crova has described a modification of Regnault's dew-point hygrometer, which promises to give highly accurate results. Crova draws the air to be examined into the interior of a highly-polished tube, whose outer surface is cooled by evaporating ether or other processes, and whose temperature can be determined by a thermometer immersed therein. The dew is deposited on the interior of the polished tube, and its appearance and disappearance can be accurately detected. (*Z. O. G. M.*, XVII, p. 374.)

Mignon and Renard describe a condensation hygrometer so arranged that all the vapor present in the air is precipitated and is collected in a special vessel for measurement. Fonvielle suggests that this instrument is especially adapted to collect for investigation the dust particles swimming in the atmosphere, and that interesting results would be obtained by such apparatus on balloon voyages among and above the clouds. (*Z. O. G. M.*, XVII, p. 375.)

Stellung and Wild have devised a form of evaporimeter which floats in a river or basin of water, thereby preserving the evaporating water at the same temperature and as nearly as possible under the same conditions as the main body of water in the river itself. The quantity of water evaporated is accurately measured to one-twentieth of a millimeter. When rain falls and fills the evaporating dish above a certain level the surplus is carried into the interior of the apparatus and can subsequently be poured away; if rainfall is too heavy, in consequence of which the whole apparatus would sink beneath the river, then it is supported by two wires. (*Z. O. G. M.*, XVII, p. 367.)

Th. Langer publishes comparative observations with four Piche evaporimeters exposed under various conditions: (1) in free sunshine and wind; (2) freely near a large mass of water; (3) shaded by tree or house; (4) within a shelter. The relative quantities evaporated were: 100, 98.3, 98.5, and 62.0, respectively. Langer concludes that for the sake of uniformity it will be advisab'e to use only evaporimeters located within shelters, as thereby the variations due to temperature of the water in the tube are greatly diminished. [As the direct effect of sunlight or solar heat upon the water in Piche's tube can easily be obviated by adapting a small shade, there seems no reason why the whole apparatus thus shaded should not be hung in a free exposure to the wind, whereby the above relative percentage of 62 would undoubtedly be increased.] (*Z. O. G. M.*, XVII, p. 375.)

Of all the recent contributions to hygrometry, the short memoir of April 8, 1883, by Pernter, "Psychrometer Studien" (*Sitzungsbericht* of the Vienna Academy, vol. LXXXVII, 2 Abtheilung), is so excellent a summary of the present state of our knowedge of this subject that the following historical and critical portions are worthy of being reproduced in this place:

"In recent times the psychrometer has been again much studied, since we have endeavored, both theoretically and experimentally, to arrive at a more accurate formula for the computation of the atmospheric moisture from the psychrometric data.* By the assistance of the Royal Academy of Sciences of Vienna it was also made possible for me to institute comparisons of psychrometers on the Ober at an altitude of 2048 meters above the sea-level. The apparatus that I applied to this purpose were: (1) a Wild's ventilation psychrometer; (2) a Regnault's dew-point hygrometer; and (3) a Schwackhöfer's volume hygrometer."

[As these observations extended only over a few weeks, and were confessedly unsatisfactory, I need give only the following abstract of this portion of Pernter's memoir:

"Let t = dry-bulb temperature in Celsius degrees.
t' = wet-bulb temperature.
t_0 = observed dew-point temperature.
p_0 = true atmospheric vapor tension corresponding to t_0.
p_1 = the vapor tension corresponding to t'.
P = atmospheric pressure in *m m*."

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* Blanford, Journal Asiatic Society of Bengal, vol. XLV, part vi, 1876.
Chistoni, Memorie e Notizie Meteorologiana Italiana, anno 1878, fasc. 1, 2, and 5.
Chistoni, Annali della Meteorologi, Part I, 1880.
Sworikin, Repertorium für Meteorologi, VII, No. 8, 1881.
Angot, Journal de Physique, 2d series, 1882, No. 1, p. 119
Maxwell and Stefan, Zeitschrift d. österreichischen Gesell. Meteorologie, bd. XVI.
(Maxwell's original study is published in the Article Diffusion, Encyclopædia Britannica, 9th ed., vol. VII.)

Assuming t to be the true air temperature and the p_0 to be correctly given by t_0, we have the ordinary psychrometer formula of August—

$$p_0 = p_1 - A\,(t - t_1)\,P, \text{ whence, } A = -\frac{p_0 - p_1}{(t - t_1)P}$$

Thirty observations of the dew-point and psychrometer gave Pernter A = 0.0010415, or considerably larger than as deduced from observations at low altitudes. Pernter further considered that a similar result, A = 0.001284, deduced from eight observations with the Schwackhöfer hygrometer, justifies at least the general conclusion that the factor A increases with diminution of pressure.]

"The object that such comparative observations always have is to construct empirically a formula whose application to psychrometric observations will give the tension of atmospheric vapor with the greatest attainable accuracy. Regnault, long ago, and since him others, have shown that the theoretical deduction of the psychrometer formula gives no satisfactory result, and thus it might appear that one would do best to renounce the theory and simply seek an empirical formula that shall correspond to the results of observations. I, however, believe that it is precisely the theory of the psychrometer that gives the best starting-points, in order, with help of comparative observations, to arrive at a satisfactory formula, and I must therefore introduce some theoretical views.

"*From theoretical considerations* we possess two forms of the psychrometer formula—the one deduced from the convection, the other from the diffusion and conduction theory of this instrument. It was August who first deduced his familiar formula from the theory of convection. Maxwell repeats this concisely in the following manner [see the reference before given; but it should be noticed that the following is merely Maxwell's exposition of Dr. Apjohn's reasoning. See *Trans. Royal Irish Academy*, 1834.]

Let m = the mass of a quantity of atmosphere.
t = temperature " " "
p_0 = true tension of the aqueous vapor.
P = total barometric pressure.
σ = the density of aqueous vapor relative to air.
λ = the latent heat of evaporation.

Then will

$\frac{p_0}{P} m\,\sigma$ = the mass of the vapor in this quantity of atmosphere.

Let

p_1 = the vapor tension corresponding to the temperature t' to which the wet thermometer sinks; then will

$(p_1 - p_0)\frac{m\,\sigma}{P}$ = the quantity of aqueous vapor evaporated from the wet bulb, and

$(p_1 - p_0)\frac{m\,\sigma}{P}\lambda$ = the quantity of heat necessary to such evaporation.

In the condition of equilibrium this amount of heat will be conveyed (to the wet bulb) from the quantity m of air with specific heat S that flows past the wet-bulb thermometer; therefore,

$$m\,(t-t')\,S = (p_1 - p_0)\,\frac{m\,\sigma}{P}\,\lambda$$

or—

$$p_0 = p_1 - \frac{P\,S}{\lambda\,\sigma}\,(t-t') \qquad . \quad . \quad . \quad . \quad (A)$$

In this reasoning a small quantity has been neglected, which, however, as can be easily shown, is entirely negligible.*

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* In respect to the individual cases of deduction of this formula, as given by August himself, and by Belli (*Corso di fisica esperimentale;* Chistoni, *Formale psichrometrische*, *Zeitschrift f. Met.*, XVI, p. 81), I consider it important to demonstrate that with all the accuracy demanded by August and Belli, the above formula, as deduced by Maxwell, is equally accurate.

August (Pogg. *Ann.*, bd. V, p. 77) considers that aqueous vapor is also contained in the air that is flowing to the thermometer, and he introduces air and vapor according to their weights into the formula. If, then, ρ is the normal weight (at 0°C., and 760^{mm}) of the unit volume of air, we have—

$$\text{Weight of the dry air} = \frac{P - p_1}{760}\,\rho\,\frac{1}{1+\alpha t}$$

$$\text{Weight of the original aqueous vapor} = \frac{p_0}{760}\,\rho\,\sigma\,\frac{1}{1+\alpha t}$$

$$\text{Weight of the evaporated aqueous vapor} = \frac{p_1 - p_0}{760}\,\rho\,\sigma\,\frac{1}{1+\alpha t_1}$$

Therefore, if the specific heat of aqueous vapor under constant pressure is k, the above formula for the condition of equilibrium becomes—

$$(P - p_1)\,S\,(t-t') + p_0\,\sigma\,k\,(t-t') = (p_1 - p_0)\,\lambda\,\sigma$$

or—

$$\frac{P\,S}{\lambda\,\sigma}\left(1 - \frac{p_1}{P} + \frac{p_0}{P} \times \frac{k\,\sigma}{S}\right)(t-t') = p_1 - p_0$$

Let us assume $\frac{p_1}{P} = \frac{p_0}{P}$, as is certainly allowable [in the first term], and we have—

$$\frac{P\,S}{\lambda\,\sigma}\left(1 - \frac{p_1}{P}\,(1 - \frac{k\,\sigma}{S})\right)(t-t') = p_1 - p_0 \qquad . \quad . \quad . \quad (B)$$

[We can estimate the accuracy of this approximation by the following considerations]: in the most unfavorable cases $\frac{p_1}{P}$ may equal 0.02; $\left(1 - \frac{k\,\sigma}{S}\right)$ is a constant, and equals -0.26, and therefore in the most unfavorable case

$$\frac{p_1}{P}\left(1 - k\,\frac{\sigma}{S}\right) = -0.0052$$

or the entire bracket equals 1.0052, and can therefore be put at unity, and the formula remains as given in the above text.

Belli really deduced his formula under the same assumptions, it is therefore, *a priori* certain that it will lead to the same results; since, In this reasoning (of August, Apjohn, and Maxwell) no attention has been given to the influence of radiation; if one had considered this, then,

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however, Chistoni ascribes to it high importance, I will show that it also reduces to the formula given in the text:

Belli starts with the masses of air and the vapor instead of with the weight, as did August. Let m be the total mass of both; the ratio of the masses of air and aqueous vapor is as $P-p_0$ to $p_0\sigma$ so that the mass of the air is

$$\frac{m(P-p_0)}{P-p_0+p_0\sigma}$$

and the mass of the vapor is

$$\frac{mp_0\sigma}{P-p_0+p_0\sigma}$$

and the sum of both is m. When the air has cooled to t', and becomes saturated with vapor, then the new vapor-mass p_1 is to the mass of air which has remained unchanged, and is still

$$\frac{m(P-p_0)}{P-p_0+p_0\sigma}$$

as $p_1\sigma$ is to $P-p_1$: whence

$$p_1=\frac{mp_1\sigma}{P-p_0+p_0\sigma}\cdot\frac{P-p_0}{P-p_1}$$

and therefore the mass of the newly developed vapor is

$$\frac{m}{P-p_0+p_0\sigma}\left(\frac{P-p_0}{P-p_1}p_1-p_0\right)\sigma$$

we have, therefore, as the equation for the permanent maintenance of this condition

$$\left(\frac{P-p_0}{P-p_1}p_1-p_0\right)\lambda\sigma=[(P-p_0)S+p_0\sigma k](t-t')$$

or

$$\frac{P-p_0}{P-p_1}p_1-p_0=\frac{PS}{\lambda\sigma}\left[1-\frac{p_0}{P}\left(\frac{1-\sigma k}{S}\right)\right](t-t')\ \ldots\ldots\ (C).$$

Since, now, $\frac{P-p_0}{P-p_1}$, is only a little larger than unity and is in the most unfavorable case 1.01, and since the expression

$$1-\frac{p_0}{P}\left(1-\frac{\sigma k}{S}\right)$$

is also, as before shown, only a little greater than unity, we can, therefore, certainly replace each by 1 considering that in the result for p_0 the hundredth part can never be exact and is not even necessary, and thus there remains again the expression given above in the text.

I have not disdained this presentation, trivial as it may seem, because it frequently seems as though a psychrometer formula is considered as better the more complicated it is, and especially because Chistoni only recently (see his treatise above cited) has claimed for the formula of Belli an advantage over that of August, and declared it as the best that at present exists.

The formula of August, as well as that of Belli, are both based on the consideration of convection, and by omitting the radiation give absolutely the same result. Therefore, theoretical considerations will not prove the more complicated formula to be the more accurate.

since the radiation (I) can be put $=$ OR $(t-t')$, where O $=$ the surface and R $=$ the coefficient of radiation, we should have had

$$\text{OR}\,(t-t') + m\text{S}\,(t-t') = (p_1 - p_0)\,\frac{m\sigma\lambda}{\text{P}}$$

or,

$$p_0 = p_1 - \frac{\text{PS}}{\lambda\sigma}\left[1 + \frac{\text{OR}}{m\text{S}}\right](t-t') \quad . \quad . \quad . \quad . \quad . \quad (\text{D})$$

[This is, therefore, the *Pernter-Maxwell* formula, in which convection and radiation are both considered.]

The deduction of psychrometer formulæ under the assumption of perfectly calm air (*i. e.*, neglecting convection and considering only radiation, conduction, and diffusion) has been completely given by Maxwell,* and Stefan,† and they have arrived at the following expressions, respectively:

Maxwell, . . . $p_0 = p_1 - \frac{\text{PS}}{\lambda\sigma}\left(\frac{\text{K}'}{\text{D}} + \frac{\text{R}r}{\rho\text{SD}}\right)(t-t')$ . . . . (E)

Stefan, ... $p_0 = p_1 - \frac{\text{P}}{\text{D}\lambda\rho\sigma}(\text{K}+\text{R}r)\,(t-t')$ . . . . (F)

which latter becomes the same as the former if we put $\text{K}' = \frac{\text{K}}{\rho\text{S}}$, *i. e.*,

Maxwell-Stefan, . . . $p_0 = p_1 - \frac{\text{P}}{\lambda\sigma\rho}\left(\frac{\text{K}}{\text{D}} + \frac{r\text{R}}{\text{D}}\right)(t-t')$ . . . . . . (G)

In these equations we have [assumed the thermometer bulbs to be spherical and of radius r, and] put

ρ = the normal weight of the unit of volume of the air;
K = the coefficient of conduction of the air;
D = the coefficient of diffusion of aqueous vapor in the air.

Since, now, $\text{K}' = \frac{\text{K}}{\rho\text{S}} = 0.18$, according to the experiments and computations of Stefan, and D is also $= 0.18$, according to the statement of Stefan, therefore the formula deduced for quiescent air acquires the same form, *i. e.*,

$$p_0 = p_1 - \frac{\text{PS}}{\lambda\sigma}\left(1 + \frac{\text{R}r}{\rho\text{SD}}\right)(t-t') \quad . \quad . \quad . \quad . \quad . \quad (\text{H})$$

as that deduced from the convection theory.‡ This must arouse sus-

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* See *Encyclopædia Britannica*, 9th edition, Vol. VII, Art. Diffusion, London, 1878, and *Zeit. Öst. Gesell. Met.*, XVI.

† See *Zeitschrift der Öst. Gesell. für Meteorologie*, XVI, p. 177.

‡ Since D, the coefficient of diffusion, may be an unfamiliar term, I will here, by its deduction from Stefan's diffusion theory, briefly show what meaning it has in our formula. Let A_{12} be a constant depending only upon the nature of aqueous vapor and the air, then the process of

picions against the derivation from the convection theory, for the derivation for quiescent air is certainly free from all objection.* In fact an hypothesis was made in the assumption of the convection theory that certainly is not proper, namely, that the arriving air in the instant of its passing by gives up the whole quantity of heat $mS\ (t-t')$ that is to say that it is cooled through the whole interval $t-t'$; with this also

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diffusion is represented (see Stefan, *Sitzungsbericht*, Vienna Academy, vol. LXVIII, page 385) by the formula:

$$\rho_1 \xi_1 = -\frac{\delta p}{\delta \nu} - A_{12}\, \rho_1\, \rho_2\, (u_1 - u_{12})$$

where

ρ_1 = the density of molecules of aqueous vapor;
u_1 = the velocity of molecules of aqueous vapor;
ρ_2 and u_2, the same data for the air;
ξ is the acceleration, which = 0 under the present assumed state of equilibrium; so also in this case is the evaporation, or $u_2=0$. Therefore, we have

$$\frac{\delta p_1}{\delta \nu} + A_{12}\, \rho_1\, \rho_2\, u_1 = 0$$

Since, now, $\rho_2 : \delta_2 = p_2\, T_0 : p_0 T$, where δ_2 is the normal density, for $p_0 = 760^{mm}$, therefore, multiplying and dividing by δ_1, we have

$$\frac{\delta p_1}{\delta \nu} = -\frac{A_{12}\, T_0\, \delta_2\, \delta_1}{T p_0} \frac{p_2}{\delta_1}\, \rho_1\, u_1$$

But $p_2 = P - p_1$; furthermore, $\rho_1\, u_1$ is the quantity of evaporation for the unit of surface; for the spherical bulb of the psychrometer, therefore, this quantity is $Q = 4\pi\, r^2\, \rho_1\, u$. Therefore, if we put

$$\frac{1}{D} = \frac{A_{12}\, T_0\, \delta_2\, \delta_1}{T\, p_0}$$

we have

$$\frac{1}{P-p_1} \frac{\delta p}{\delta \nu} = -\frac{Q}{4\, \pi\, r^2\, \delta_1\, D}$$

and after integration

$$\log \frac{P-p_1}{P-p_0} = \frac{Q}{4\, \pi\, r\, \delta_1\, D}$$

or

$$Q = 4\, \pi\, r \frac{\rho\, \sigma\, D}{P} (p_1 - p_0)$$

whence, evidently, $D = \frac{\rho_0 T}{A_{12}\, \delta_1\, \delta_2\, T_0}$. Since $p_0 = 760$ and $\frac{T}{T_0}$ can be put = 1 for the temperatures occurring in psychrometer observations, therefore D is nearly constant.

* [Even this derivation, however, implies certain assumptions that need further investigation.—C. A.]

falls the further hypothesis that as much vapor is developed as is necessary to the saturation of the air at t' degrees. Both of these conditions are only approximately fulfilled. It is, therefore, certain that the convection theory affords only an approximate formula.

Therefore, we abide by the hypothesis of perfectly quiescent air; for which case the Maxwell Stefan formula (F or G) holds good with perfect exactness. If for this hypothesis we compute the factor.

$$A=\frac{1}{D\lambda\sigma\rho}\left[K+Rr\right]=\frac{p_1-p_0}{t-t'}\frac{1}{P}$$

assuming spherical thermometer bulbs, we obtain for the first part $\frac{K}{D\lambda\sigma\rho}=0.000630$; and if we put $R=0.000097$, according to Stefan, and take $r=0.57$ centimeters, whence

$$Rr=0.000055$$

the second part becomes

$$\frac{Rr}{D\lambda\sigma\rho}=0.000630$$

whence $A=0.001260$.

In fact, Regnault found $A=0.001280$ from observation in perfectly quiet air in a small closed room (Pogg. *Annalen*, LXXXVIII, p. 428), and Sworikin (Wild's *Repertorium*, VII, No. 8, p. 17) finds from 0.001100 to 0.001500 for quiet air, therefore again on the average 0.001300.

But in fact we almost never have to do with perfectly quiet air, and even because of the cooling of the air close to the wet thermometer a convection is always present there. If one would obtain results to any extent consistent with themselves he must, since convection is unavoidable, provide for one that will assure a permanently uniform movement of the air. This is attained by means of the ventilation-psychrometer.

If, therefore, we begin with assuming a ventilated psychrometer, and therefore strong convection, we have no theoretical formula for this case. We can, however, attempt to adapt the formula for quiescent air to the case of ventilation.

Stefan (*Zeit. f. Met.*, XVI, p. 181) has remarked that in the formula [G] for quiescent air it can be assumed that the introduction of convection simply causes K and D to increase uniformly; therefore, $\frac{K}{D}$ will remain very nearly constant. This being assumed, it is plain that for increasing values of D the second part $\frac{rR}{D\lambda\rho\sigma}$ of the factor will therefore become smaller. Herein we find a reason why the theoretical value of the whole factor A is not attained in the comparisons of the ventilation psychrometer. In fact the value empirically determined for a barometric pressure of 760^{mm} is almost exactly 0.000800 on the average of the various trials.* Since now the factor A consists of the constant invariable part $\frac{K}{D\lambda\rho\sigma}$, and the variable part $\frac{rR}{D\lambda\rho\sigma}$ we can, since $\frac{K'}{D}=1$ write the formula thus (see the formula H):

$$p_0=p_1-\frac{PS}{\lambda\sigma}\left[1+\frac{Rr}{aDS\rho}\right](t-t') \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (I)$$

where a denotes a new constant that under the assumption of a uniform ventilation and constant barometric pressure should be invariable.

From this we see that the term depending on radiation can indeed be diminished by ventilation, but certainly not so much that it can be wholly neglected.

It will not be superfluous at this place to indicate how very erroneous it has been to neglect the influence of radiation in the deduction of the psychrometer formula. In fact it proves to be for still air quite as large as the theoretical factor in August's formula, if one assumes a spherical thermometer bulb of 0.57 centimeters radius, as is the case at the observing stations of the Vienna K. K. Central Institute for Meteorology and Terrestrial Magnetism.

If we would possess a uniform formula for all the various thermometers, we must seek a method of carrying out the suggestion of Kämtz.† He remarks, "As a pendulum occupies only approximately equal times for a vibration over large and small arcs, equally so different thermometers give only approximately equal results. As with the pendulum the arcs must all be reduced to one of infinitely small amplitude, so with the thermometer we must undertake a reduction to an infinitely small one."

We can, however, in using the ventilation-psychrometer, consider this reduction as already partly made, since in that instrument the term that contains the influence of radiation is materially diminished.

A further influence that has not at all been considered in the formula, is that of the muslin cover of the wet-bulb thermometer. In the deduction of the formula no consideration was given to this. Now, Kämtz (being made observant by reason of the frequent cases that he had occasion to observe‡ where the wet thermometer stood sometimes as high, and sometimes higher than the dry, when a comparison with the hair hygrometer showed the air to be not saturated with vapor) has investigated the cause of the phenomenon, and found it in the muslin covering of the wet thermometer. According to his experiments, at low temperature the wet thermometer stood too high by 0.46° C.

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* This is the value that Regnault gave as long ago as 1845. The form of the psychrometer formula, as it has since then been almost universally adopted, contains this value; it reads

$$p_0=p_1-0.480\,\frac{t-t'}{610-t'}P$$

† Käntz *Repertorium für Meteorologie*, bd. II, p. 56.

‡ Käntz *Repertorium*, bd. II, p. 54.

If this is an influence of radiation, as undoubtedly it is with dry muslin, the consequence would be that this influence would increase with increasing difference $(t-t')$. But the fact is that this influence disappears in psychrometer comparisons more and more in proportion as $(t-t')$ increases at least with the air in motion. This behavior demands still more thorough investigation. I will, however, now mention that I consider this phenomenon as attributable to a "sluggishness" of the wet bulb in the neighborhood of the point of atmospheric saturation, so that with very damp air the evaporation does not proceed fast enough in proportion to the passing current of air. The experiments also confirm this view.* If one would in the formula take account of this "sluggishness" of the psychrometer, then a correction to the psychrometer differences $t-t'$ can be so applied that it shall be a maximum for $t-t'=0$ and be inversely proportional to this difference. If we call v the maximum value, then this correction will in general be $\frac{v}{(t-t')+1}$; if, with Kämtz, we take $v=0^\circ.5$ centigrade, then will this correction have a sensible influence only up to a depression $(t-t')$ of 9° C., in fact only up to those of 6° C.

I have applied this correction to my observations and obtain, then, on the average A=0.000943 instead of 0.0010415. [Pernter here alludes to his thirty observations of dry and wet bulbs and dew-point on the summit of the Obir, spoken of in the first part of this paper. In these observations $t-t'$ ranged from $3^\circ.6$ C. to $0^\circ.5$ C., and its values, corrected by this new formula for sluggishness, ranged from $3^\circ.7$ C. to $0^\circ.8$ C.]

There remains now only an investigation of the constant a in our psychrometer formula. The psychrometer factor is [see (E) and (I)]

$$A=\frac{S}{\lambda\sigma}\left[\frac{K'}{D}+\frac{Rr}{aD\rho S}\right]$$

If the air is motionless, then will $a=1$. For a definite velocity of ventilation and equal air-pressures a increases to a value that is constant under these conditions. If however the rate of ventilation remains the same and the barometric pressure varies, then we must investigate whether or not a depends on the pressure of the air. This we attain in the following way; for absolute calm at both high and low pressures $\frac{K'}{D}$ is equal to unity. In the change from calm to constant rate of ventilation K′ and D increase uniformly (at least very nearly so) whether the change goes on at high or low pressures; aK′ will always remain equal to aD. Undoubtedly, however, aK′ will not be so large at low as at high pressure, since certainly in the latter case the mass of the arriving air is

* Wüllner and Grotrian found that fluids in the neighborhood of their points of saturation almost entirely cease to evaporate, and that even when quite far from it, between glass rods (*e. g.*, drops of water), dissipate only very slowly and with difficulty, and this certainly also applies to the meshes of muslin. (See Wiedemann, Annalen, XI, p. 553 to 555; also Macaluo, Grimaldi, *Gazetta Chimica Italiana*, vol. XII. 1881.)

greater than in the former. Therefore, also, aD will be larger for high than for low pressures; that is to say, a must be greater for high pressures than for low.

But from this it follows that $\frac{Rr}{a\,D\rho S}$ is smaller for high and greater for low pressures; that therefore A increases with altitude above the ocean surface. And this is precisely what my observations give for the summit of the Obir.

According to the preceding, it is to be expected that a stands in a simple direct ratio to the air-pressure, so that if a_1 is its value for 760^{mm}, then for any other pressure $a = \frac{P}{760}\, a_1$.

For the investigation of this dependence there are some experiments at my disposal. Chistoni, Angot, and Blanford (see the previous references) have submitted a large quantity of material for high pressures.* I have taken the mean of their determinations, and find for A the following values:

Blanford	0.000827
Angot	.000851
Chistoni	.000851
Mean	0.000843

Since these comparisons, especially those of Blanford, were made with large differences $(t-t')$, I have not considered it necessary to apply the correction

$$\frac{v}{t-t'+1}$$

Since now [the preceding formula and reasonings give]

$$A=0.000630+\frac{0.000630}{a}$$

where I have assumed for Rr a mean value of 0.000055 [which, as before shown, is especially applicable to the thermometers of the Austrian observers], it follows that for the above three series of observations $a_1=3.0$.

$$\left[i.\,e.\ \ a_1=\frac{0.000630}{0.000843-0.000630}\right]$$

My own comparisons on the summit of the Obir, after applying the correction $\frac{v}{t-t'+1}$ give $A=0.000943$, whence $a_2=2.0$. If a' is smaller in the ratio of the diminution of pressure, then should this latter have given $a_2=3.0\frac{595}{760}=2.3$ and A would have been found 0.000904 instead of 0.000943.

* Since Regnault's time the factor 0.000800 has been generally retained. Still, all later investigators have from their comparisons deduced even larger factors. Only Sworikin finds 0.000725 and Macé de Lépinay with a swing-thermometer (thermometre á fronde) even 0.000693. This latter determination seems to differ too far from the others, especially the long series of Chistoni and Angot, for me to consider it quite reliable.

Now it seems to me that, considering the difference of the thermometers and ventilators employed, this difference is easily to be explained, and although still further experiments remain to be made in this direction, they can only in substance confirm this result.

I will now briefly collect the results of the investigation:

(1.) The derivation of the psychrometer formula under this assumption of the existence of convection leads to no result,* since the hypothesis that the air flowing past is cooled from t to t' by contact with the thermometer bulb does not agree with the facts.

(2.) The derivation of the psychrometer formula of Maxwell and Stefan for absolutely motionless air is perfectly exact for this condition. If we endeavor to introduce into the formula a modification, in order that it may also hold good for moving air, then it undoubtedly loses its precision but does give a very approximately correct expression, that when we consider the sluggishness of the psychrometer in the neighborhood of saturation, reads as follows:

$$p_0 = p_1 - \mathrm{P}\,\frac{\mathrm{S}}{\lambda\sigma}\left[\frac{\mathrm{K}'}{\mathrm{D}} + \frac{\mathrm{R}r}{a\,\mathrm{D}\rho\mathrm{S}}\right]\left[(t-t') + \frac{v}{(t-t')+1}\right]$$

or if we put $v = 0^\circ.5$ C. and insert the other numerical values [as given above, assuming $r = 0.57$ centimeters], we have:

$$p_0 = p_1 - \mathrm{P}\,0.000630\left[1 + \frac{1}{a}\right]\left[(t-t') + \frac{0.5}{(t-t')+1}\right]$$

(3.) The term depending on radiation does not disappear even for rapidly-moving air. For absolutely calm air it is, indeed (for bulbs of the radius 0.57^{cm}), quite as great as that depending on conduction.

(4.) For equal wind velocities and barometric pressures the constant a is invariable. Assuming equal velocities, it is smaller with lower pressures and most probably in the ratio $\frac{\mathrm{P}}{760}$. The maximum value of a for pressures of about 760^{mm} results from observations as $a_1 = 3.0$; therefore, in general,

$$a = 3.0\,\frac{\mathrm{P}}{760}$$

This value, introduced in the above formula, gives

$$p_0 = p_1 - \mathrm{P}\,0.000630\left[1 + \frac{760}{3.0\,\mathrm{P}}\right]\left[(t-t') + \frac{0.5}{(t-t')+1}\right]$$

or for stations at low levels

$$p_0 = p_1 - 0{\cdot}000843\left[(t-t') + \frac{0.5}{(t-t')+1}\right]\mathrm{P}$$

This simple formula, as has been above shown, should not be made more complicated by giving the factor A some other form, since in no case will a greater accuracy be thereby attained.

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* If we abstain from considering as an important expression the second term within the brackets in the convection formula (D), and seek only to find for m a numerical value that corresponds to the observations, we find $m = 78.0$ for barometric pressure 760^{mm}, to which (since m indicates the mass of air) it is difficult to attach any intelligible idea.

(5.) From all this it results, however, that we have little or no prospect of attaining to an exact psychrometer formula, and therefore need not expect to obtain the vapor tension accurate to 0.1^{mm} by means of the psychrometer. (Pernter, *Psychrometer Studien.*)

Wild, in some remarks upon the establishment of anemometers, opposes the statement of Dr. Schreiber that the self-recording Robinson anemometer is better adapted than Wild's tablet anemometer by the statement of his own convictions that the latter is not only much more convenient but also more accurate; in this last particular his anemometer seems to have exceeded Wild's expectations, his original idea having been merely to devise an instrument that should be more convenient and simple, and therefore adapted for the use of numerous stations. In simplicity and cheapness the tablet anemometer apparently cannot be excelled. Wild's experience in northern regions shows that the self-recording Robinson anemometer cannot be kept in continuous operation owing to the cold, the snow, and frost-work, and that it is only practicable to use it at second-class stations when the observers are thoroughly drilled as at the Army Signal Office. With regard to the Hagemann aspiration-anemometer, especially as made by Nyrop, in Copenhagen, he finds that it is simple, easy to use, convenient, and accurate to read, even at night time, since the dial can be placed within the building while the conical point is established above the roof; the price of this apparatus is twice that of the tablet anemometer, and this alone is an objection to its general introduction. (*Z. O. G. M.*, XVII, p. 211.)

H. Louis F. Melsens presented to the Congress of Electricians a memoir on the lightning conductor and its history since the days of Benjamin Franklin. The two principal forms of protection against lightning are, first, that of Gay Lussac, who advocates a small number of conductors having large sections and raised to great altitudes; and, second, the system of Melsens, who advocates the employment of numerous conductors having small sections and numerous points not greatly elevated, the whole forming a sort of wire cage. He elaborates in full the scientific reasons that have led to these two forms of the original lightning conductor of Benjamin Franklin. (*Z. O. G. M.*, XVII, p. 49.)

Dr. K. Weirauch contributes formulæ and methods for the convenient application of Bessel's sine and cosine formula to meteorological observations in hopes that from numerous such applications one may derive values of the constants for many localities by the study of which latter further progress may be made in climatology. He gives four methods for the determination of these constants from equidistant phases, namely, interpolation by differences (two methods), parabolic interpolations, goniometric interpolations. The differences between the results of these four methods are slight but important; the last two are rigorous and preferable. (*Z. O. G. M.*, XVIII, p. 20.)

IV.—CONSTITUTION AND PROPERTIES OF THE ATMOSPHERE.

Prof. C. A. Vogler, of Bonn, reviews the question of the variations of the amount of oxygen in the atmosphere. His own views differ so radically from Morley, and are so important in connection with many climatological questions, especially the formula of barometric hypsometry, that further investigations and observations are necessary; the question must still be considered as undecided as to whether the variations of oxygen may not explain the formation of barometric maxima, the cooling of the lower strata, and the variations in the coefficient of the hypsometric formula, and it is too early as yet to hope for a decision. (*Z. O. G. M.*, XVII, p. 175.)

Hill has used the observations of Hennessey, Cole, and Hodgkinson in India towards answering the question what gaseous constituent of the atmosphere it is that absorbs the solar heat. He concludes to attribute this to the aqueous vapor. (*Z. O. G. M.*, XVII, 334.)

Hill has attempted to deduce the relative absorption of heat by aqueous vapor and by dry air from observations in India; he concludes the former to be 764 times greater than the latter, but the observations appear to us scarcely sufficient to establish this result. (*Z. O. G. M.*, XVII, p. 48.)

Hennessey has published in full the actinic observations of October and November, 1879, from which the above results are deduced by Hill. The sky was generally covered with thin haze or dust, which must have greatly affected the results. (*Z. O. G M.*, XVIII, p. 80.)

H. Müntz and E. Aubin during a visit to the summit of the Pic du Midi have investigated the quantity of nitric acid contained in the water and snow at that height. Both the methods of Boussingault and Schlösing were employed. These observations determine the location in the atmosphere where nitric acid is formed, and that, in accordance with the views of Boussingault, the nitrate of ammonia does not exist in the atmosphere in a gaseous condition, for if it did it would be distributed uniformly in the atmosphere precisely as are its components, nitric acid and ammonia. (*Z. O. G. M.*, XVIII, p. 71.)

V.—SOLAR RADIATION; TERRESTRIAL TEMPERATURE.

Pernter gives an exhaustive summary of the record of the Campbell-Stokes sunshine records at Vienna for 1881. The total number of hours of full sunshine was 1676.3, or 37 per cent. of the 4472 that was possible for absolutely clear weather. During the winter the greatest duration occurred at noon, but during the summer at 11 A. M. and 2 P. M., similarly as in 1880, owing to the cloudiness at 1 P. M. During the summer the total sunshine in the morning hours exceeds that of the afternoon, but during the winter the reverse takes place; this is contrary to the experience of 1880. Among the totals for each month July has the maximum, 290.5 hours, or 60 per cent. of all that was possible, and October the minimum, 34.4 hours, or 10 per cent. of the possible total. The mean cloudiness for three observations daily, at 7 A. M., 2 P. M., and 9 P. M., gives figures closely following the reciprocals of the percentages of sunshine. (*Z. O. G. M.*, XVII, p. 100.)

Prof. J. Liznar has investigated the relation between the eleven-year sun-spot period and the daily and annual variations of terrestrial temperature. For the daily variation he studies observations at thirteen stations, and finds that a maximum of sun-spots corresponds to a minimum of daily variations, but the latter occurs about two years earlier than the former, a result agreeing with the similar variation in mean annual temperatures discovered by Köppen. Liznar has also studied the annual temperature variations, by means of three long series of observations extending from 1699 to 1873; he finds a close agreement between these and the maxima and minima of sun-spots from 1698 to 1750; but for the succeeding 60 years, like all previous similar investigations, these relations are disturbed and even completely inverted, the maxima of sun-spots now corresponding to minima in place of maxima of temperature. The relation between sun-spots and temperature is therefore still entirely unknown. (*Z. O. G. M.*, XVII, p. 495.)

G. von Boguslawski gives a summary of Hann's memoir on the temperature of the southern hemisphere. The latter has carefully combined a number of recent observations, and has deduced a general formula for the temperature of southern latitudes apparently somewhat more reliable than those of Dove (1852), Hopkins (1852), Forbes (1859), Sartorius von Waltershausen (1865), and Ferrel (1871). He arrives at the following formula for the mean annual temperature at any degree of southern latitude:

$$T\varphi = 26.0^\circ + 6.94^\circ \sin\varphi - 45.28^\circ \sin^2\varphi$$

According to this formula the southern hemisphere is warmer than the northern for all latitudes higher than 45°, the difference amounting to 1½° at parallel 60 S. latitude. Forbes had arrived at exactly the same result, namely, 42½°. (*Z. O. G. M.*, XVII, p. 410.)

Bilwiller notes that the severest cold weather in Switzerland always occurs when snow covers the ground; and that although the descending currents of air in anticyclones are visibly warming the air, yet at the ground severe cold is observed. "The influence of the snow on the temperature of the lower air lies in the fact that as a poor conductor of heat it breaks the connection between the earth and the air. The temperature changes at slight depths below the earth are far smaller and slower than on the surface. In December the earth is decidedly warmer than the air which is thus warmed from below. If snow lies on the ground it cuts off this supply of heat from the air. The surface of the snow cools very rapidly by radiation under a clear sky, and this loss of heat is communicated directly to the air, but only very slowly to the earth. If the snow covering is wanting, an exchange of heat occurs between air and earth, preventing such a very low temperature in the lower-air stratum." (*Z. O. G. M.*, XVII, p. 98.)

[As this is a matter that in 1871 and 1872 became to the writer very important in his daily weather predictions, it is allowable to remark that the amount of heat given up by the upper layer of the soil or rock to the air or snow seemed to him very small and hardly worth mentioning in the above explanation; it rarely amounts to enough to cause the melting of an inch of snowfall into a tenth inch of water. The special low night temperature over snow and ice should be wholly attributed to the clear, dry air, free from slightest haze or dust, which allows freer radiation, and to the exceptionally large radiating power of snow and ice for the red and ultra red or heat rays. The low temperature during sunshine is due to the fact that solar heat is consumed in melting ice (latent heat of liquefaction 79.) instead of warming the air (specific heat 0.267). Similarly we should abstain from assuming, as is too frequently done, that warm air flowing up cold mountain sides is cooled by contact with the earth; *i. e.*, by conduction of its heat into the earth. This is wholly insignificant in comparison with the cooling due to expansion and to the evaporation of moisture. The heat given to the air by the earth surface at midday is not conducted upwards from any depth, but is a purely surface action, by which solar radiation is converted into heat, or the short waves of the upper end of the spectrum and beyond are degenerated to the red end and returned to the air mostly by contact, conduction, and convection—slightly by radiation and absorption.]

Maquenne has investigated the absorption and dissipation of heat by foliage. The results were—

(1.) All leaves dissipate a part of the heat vertically incident upon them; this dissipation amounts to 0.25 of the total heat when the radiation comes from a Bourbouze lamp, but only a few hundredths when it comes from a Leslie cube.

(2.) The leaves dissipate different amounts of heat from their two surfaces; ordinarily the lower side dissipates more than the upper, but occasionally we observe the contrary.

(3.) The leaves absorb a sensible proportion of the heat radiated from a Bourbouze lamp; this absorption depends upon the presence of absorbents in the texture, especially of chlorophyl and water, and upon the dissipation that takes place in the interior on the surface of each cell; it is ordinarily greater on the upper than on the lower side.

(4.) The thick leaves absorb more than the thin ones.

(5.) The absorbing power for the heat of (bodies of the temperature of) boiling water is very nearly equal to that of lampblack.

(6.) Leaves transmit heat better in proportion as they are thinner or younger.

(7.) The radiating power of leaves is for great differences of temperatures nearly like that of lampblack; it diminishes a little as the inclination increases.

(8.) The absorbing power of chlorophyl is, on the average, like that of water for the radiation from the Bourbouze lamp, and increases in proportion as one goes in one direction or the other from the heat maximum. (*Z. O. G. M.*, XVII, p. 21.)

VI.—EVAPORATION, CONDENSATION, ETC.

Stefan has given a summary of his investigations, 1874–1881, into the laws of evaporation, from which we gather the following:

(1.) The rate of evaporation is proportional to the logarithm of a fraction whose denominator is the barometric pressure and whose numerator is this pressure diminished by the vapor tension.

(2.) The rate of evaporation out of a tube is inversely proportional to the distance of the surface of the fluid below the open end of the tube.

(3.) The rate of evaporation is independent of the diameter of the tube.

(4.) Within a closed tube the evaporation is observed by the bubbles that form and rise to the surface, and it is found that the successive intervals within which equal numbers of bubbles develop are to each other as the successive uneven numbers.

(5.) In hydrogen, evaporation proceeds four times as fast as in air.

(6.) The amount of evaporation in given intervals of time increases as the square root of the intervals.

(7.) The amount of evaporation that ascends in a unit of time from a circular surface into the air (assumed perfectly quiet) is proportional to the circumference and not to the area of the circle, assuming that there are no banks or walls to protect the edges. This is also true, to within a tenth, of an elliptical surface of moderate eccentricity, *i. e.*, whose major axis is not more than four times greater than its minor axis.

(8.) If now the vapor, instead of collecting close above the water surface, rises and moves off to a distance by diffusion, then the stream lines for the evaporation are hyperbolas, and those that start from the periphery of the circular border of the basin constitute a hyperboloid of revolution. Like all stream surfaces, this has the property that no vapor penetrates through this hyperboloid so that it can be replaced by a solid wall. Such a hyperbolic border to an evaporating dish will therefore not diminish the amount of evaporation in still air; its proper construction must be determined by Stefan's formula. As the water surface sinks the evaporation diminishes in the ratio of $r-h$ to h, where r is the radius of the dish and h the linear sinking. For large values of h or where $\frac{r-h}{h}$ is nearly unity, the condition is nearly the same as in a deep tube. Small surfaces evaporate more than large in proportion to their area; this latter is also true for the evaporation due to convection as well as diffusion. (*Z. O. G. M.*, XVII, p. 65).

Stelling has published the results of observations by Dohrandt at Nukuss on evaporation of water, and has discussed their connection with temperature and wind velocity. He shows, first, that the observations are represented by Weilenmann's formula somewhat better than by Dalton's, and quite as well as could be expected from the methods of observation. The formula requires the accurate determination of the temperature of the evaporating water and the velocity of the wind at its surface, and applies, therefore, strictly to a freely exposed surface. Evaporimeters established in protected places show great departures from the computed values. In a second memoir Stelling shows that this formula represents with sufficient accuracy the observations made upon a free large surface of water, as in the case of his floating evaporimeter, elsewhere described. (See chapter on apparatus.) In this evaporimeter the temperature of the water in the surrounding river often differs by one degree from that in the apparatus, and the latter is that required in the formula, which reads as follows:

$$v = A \Sigma (S - s) + B \Sigma (S - s) w.$$

Where w is the velocity of wind, S is the tension of vapor corresponding to the temperature of water, s is the tension of vapor in the atmosphere, v is the amount of evaporation, A and B are constants, Σ is the sign of summation. (*Z. O. G. M.*, XVII, p. 372.)

Chistoni discusses the relative merits of two views as to the origin and cause of dew that have sometimes been held to be antagonistic to each other, viz, whether it is the moisture condensed out of the air that comes in contact with surfaces cooled by radiation, as maintained by Wells, 1819, or the moisture freshly evaporated from the earth and plants during the night-time, and which, being too much for the air to absorb, is carried in minute particles to neighboring surfaces that are cooled by radiation and evaporation; a view apparently maintained by Fusinieri, Zantedeschi, and Cantoni.

By an extensive experimental investigation Chistoni demonstrates the following points:

(1.) Bodies that stand free in the air and have unrestricted radiation into celestial space cool [as to their surfaces?] decidedly below the surrounding air. [Chistoni's experiments seem to have been conducted as a wholly independent repetition and confirmation by newer instruments and methods of those of Wells, Glaisher, Melloni, &c.]

(2.) Thermometers under, on, and above the surface of the ground show that when dew is being deposited, the lowest stratum of air is always colder than the ground below and colder than the air above. The temperature of the air increases upwards [a confirmation of Fusinieri's results].

(3.) The quantity of moisture evaporated from the earth and the lower plants, and slowly ascending to be condensed as dew on the leaves of higher plants, is very abundant.

(4.) The influence of electricity claimed by Zantedeschi is not perceptible.

(5.) If we define dew as the aqueous precipitation that takes place during the interval from sunset to sunrise, and is not rain or fog, then its two chief causes are: (1) The cooling of bodies by radiation to temperatures below that of the surrounding air. (2) The larger evaporation from the earth and the plants, frequently the latter and occasionally the former, is the only cause of the dew, but generally both act together. Even in cloudy nights, radiation causes a precipitation at the base of blades of grass, and in connection with the existence of the coldest stratum of air near the earth, is the chief cause of dew. (*Z. O. G. M.*, XVII, p. 113.)

Prof. J. M. Pernter has given an exhaustive mathematical analysis of the thermo-dynamic laws of the cooling and condensation of vapor that may occur when cold and warm air are mixed together according to Hutton's theory of rain. Wettstein has contended that not the slightest rainfall can thus be produced. Hann had already shown by an approximate computation of a special case that slight precipitation can possibly occur. Pernter's formula and method are perfectly general, although the computations are necessarily very tedious. He concludes that only for large differences of temperature can any sensible precipitation occur even sufficient to form cirrus clouds, and that the quantity of precipitation computed by his formula is so small that it is impossible to explain any heavy rainfall by Hutton's theory. (*Z. O. G. M.*, XVII, p. 421.)

Woeikoff has published a memoir on the cloudiness of the skies at Russian stations based on the ten years 1870–'79, of which Köppen gives a short summary. Dividing the Russian domain into thirteen portions, from the Baltic to the Pacific, it would appear that the maximum percentage of cloudiness generally occurs in November and amounts to 85 per cent. for the White Sea, but only 65 per cent. for central Siberia. The annual means of cloudiness show the highest percentage (72) also for the White Sea, and the lowest (31) for the Aral Sea, the next lowest being 34 per cent. for the trans-Baikal stations. In general the stations may be divided into three groups: 1st, European Russia and the Aral, where the minimum is in summer and the maximum in winter; 2d, from Lake Baikal north and west, where the maximum is in October or November and the minimum in March: 3d, the trans-Baikal and the eastern coast of Asia, where the maximum is in summer and the minimum in January. (*Z. O. G. M.*, XVII, p. 358.)

Dr. F. Vettin, as the result of three years' continuous observations at Berlin of the heights and velocities of clouds, publishes a very complete analysis of cloud movements. He measured the angular velocity by a fixed camera-obscura, on whose glass back the image of the cloud is seen to pass over a system of graduation lines. The actual velocity was measured by observations of the shadows of the clouds, as projected upon the earth. From these two data is deduced the actual altitude. For other cases he observed the time at which the cloud was first illuminated by the rising sun or last illumined by the setting sun, whence he computed the actual altitude. He concludes that with increasing altitude the cloud forms alter according to a very definite rule, namely: (1) that the lowest cloud has indefinite boundaries similar to loose masses of fog; 174 clouds of this description were distributed in altitude as shown in the following table: (2) As these clouds rise their boundaries become more definite, they assume rounded forms, appear much brighter, and throw deeper shadows; 246 cases of this kind are given in the accompanying table: (3) Above these latter is a third and very different class; these are smaller with more delicate illumination and shadows, and are generally arranged in platoons regularly grouped in many ways, sometimes giving the heavens a marbled appearance: (4) Far above these little clouds is a group lying as high up as condensed aqueous vapor is any way visible, and showing the well-known forms of cirrus known as "mare's-tails," "mackerel-sky"; 139 of this class are divided into two groups, the first (4) extending between 9,000 and 18,000, and having a maximum at 13,000; the second group (5) extending from 18,000 to 33,000 feet, and having a possible maximum of 22,000 feet. These five forms of clouds, and the corresponding altitudes of maximum frequency have an interesting relation to the corresponding atmospheric pressu res. These latter he has computed by various hypsometric formulæ with results as given in this table.

The seventh column in this table gives the average "projected velocity" of the movement of the clouds in feet per second deduced by projecting all apparent angular velocities upon a plane surface, separating the middle of each layer. A total of about 900 such observations were available during the first two years.

TABLE I.—*Vettin's observations of clouds at Berlin.*

Altitude in feet.	Frequency by classes.					Average.	
	I.	II.	III.	IV.	V.	Altitude.	Projected velocity.
500–1000	27	0	....	....	....	803	920
1–2,000	107	9	....	....	....	1,455	585
2–3,000	35	64	....	....	....	2,440	335
3–4,000	5	72	6	....	....	3,140	228
4–5,000	....	53	4	....	....	4,470	185
5–6,000	....	37	9	....	....	5,380	143
6–7,000	....	8	36	....	....	6,500	144
7–8,000	....	2	34	....	....	7,380	115
8–9,000	....	1	26	....	....	8,400	112
9–10,000	....	....	7	9	....	9,360	95.7
10–11,000	....	....	6	13	....	10,200	81.5
11,000	....	....	....	10	....	11,500	91.3
12,000	....	....	....	33	....	12,300	95.9
13,000	....	....	....	13	....	13,300	84.4
14,000	....	....	....	13	....	14,300	92.9
15,000	....	....	....	10	....	15,200	51.5
16,000	....	....	....	7	....	16,150	60.8
17,000	....	....	....	3	....	17,800	44.5
18,000	....	....	....	....	4	18,000	61.2
19,000	....	....	....	....	4	19,300	91.8
20,000	....	....	....	....	3	20,000	27
21,000	....	....	....	....	6	21,300	46.3

TABLE I.—*Vettin's observations of clouds at Berlin*—Continued.

Altitude in feet.	Frequency by classes. I.	II.	III.	IV.	V.	Average. Altitude.	Projected velocity.
22,000	....	....	....	....	4	22,200	42.1
23,000	....	....	....	....	2	23,000	28
24,000	....	....	....	....	2	24,000	50
25,000	....	....	....	....	....	....	....
26,000	....	....	....	....	....	....	....
27,000	....	....	....	....	....	....	....
28,000	....	....	....	....	1	27,000	80
29,000	....	....	....	....	1	28,000	89
30,000	....	....	....	....	....	....	....
31,000	....	....	....	....	....	....	....
32–33,000	....	....	....	....	1	32,000	70
Total number	174	246	128	111	28		
Mean altitude in feet	1,560	3,780	7,200	12,800	23,000		
Pressure in atmospheres	0.941	0.862	0.752	0.600	0.395		
Average projected velocities in feet from two years' observations	600	216	123	83	57		
Relative velocity	10	3.5	2	1.5	1		

The study of the cirrus during all three years gave the same result as for the first two, viz, that the upper cirri move with one-third less velocity than the lower. It follows that when various cirri are seen together on any day, and are moving with the same velocity, they belong to the same layer, either upper (23,000 feet) or lower (12,800 feet).

The variations with season in the altitude and velocity of motion of these five classes of clouds are given in the following table, based on two years' observations, where the projected velocities of the five strata are referred to that of the upper cirrus (57 feet per second) as unity. The absolute altitudes are given in hundreds of feet and the relative altitudes in terms of that of the lower clouds:

Season.	I. Velocity. Absolute.	I. Velocity. Relative.	I. Altitude. Absolute.	I. Altitude. Relative.	II. Velocity. Absolute.	II. Velocity. Relative.	II. Altitude. Absolute.	II. Altitude. Relative.	III. Velocity. Absolute.	III. Velocity. Relative.	III. Altitude. Absolute.	III. Altitude. Relative.	IV. Velocity. Absolute.	IV. Velocity. Relative.	IV. Altitude. Absolute.	IV. Altitude. Relative.	V. Velocity. Absolute.	V. Velocity. Relative.	V. Altitude. Absolute.	V. Altitude. Relative.
Summer	492	8.5	17	1	151	2.5	42	2.4	98	1.6	76	4.4	90	1.5	144	8.3	59	1	(251)	(14.5)
Autumn	650	12.0	16	1	231	4.3	37	2.3	128	2.4	70	4.4	91	1.7	133	8.3	54	1	(230)	(14.3)
Winter	770	10.3	14	1	277	3.7	32	2.3	149	2.0	63	4.5	119	1.6	117	8.3	75	1	(201)	(14.3)
Spring	590	8.4	16	1	182	2.6	38	2.3	110	1.6	74	4.55	101	1.4	124	7.6	70	1	(231)	(14.2)
Year	626	10.0	16	1	198	3.2	38	2.4	116	1.9	72	4.5	97	1.5	129	8.2	63	1	230	14.4

By studying the relative *velocities* and *durations* of the cloud motion and the winds for each direction, Vettin determines approximately the motions of the masses and volumes of the atmosphere, as shown in the following, Table III, where the figures represent the product of the percentage of duration of each movement by the total movement, but for economy of space only the nearest hundreds are given:

TABLE III.—*Relative volume of air transported by each wind or cloud-direction.*

Pressure in atmospheres.	Class observed.	Altitude.	Direction of movement from—									Resultants.	
			SW.	W.	NW.	N.	NE.	E.	SE.	S.	Total.	Equatorial.	Polar.
		Feet.											
0.0	Computed ...	....	20	20	15	6	1	1	1	9	74.4	30.5	22.6
0.2	Computed	41,000	16	18	14	7	2	1	2	8	67.0	25.3	22.8
0.4	Upper cirrus .	23,000	12	15	13	7	2	1	2	6	59.6	20.6	22.2
0.6	Lower cirrus .	12,800	9	13	12	7	2	1	2	5	51.8	16.4	21.2
0.75	Mackerel sky .	7,200	7	10	9	4	1	1	1	3	35.0	10.8	13.1
0.86	Cumuli	3,800	5	9	8	3	1	1	1	2	30.4	9.2	11.8
0.94	Lowest clouds.	1,600	6	11	10	4	2	2	1	1	37.4	8.3	15.8
1.00	Surface wind .	....	4	4	3	2	2	1	2	3	19.8	8.7	6.3
	Mean....	....	11.3	14.0	11.8	5.6	1.7	1.2	1.5	5.3	52.5	18.1	19.1

For the whole atmosphere the greatest average movement is from the west; the least is from the east. In general as much air flows from the north (the polar current) as from the south, the ratio being 19.1 to 18.1, and an exact equalization must therefore occur for a direction about 2° east of north. This direction is subject to annual variation on either side of the mean. (*Z. O. G. M.*, XVII, pp. 267–351.)

O. Jesse criticises Dr. Vettin's method of computing cloud heights, but apparently does not impugn the general accuracy of the conclusion. (*Z. O. G. M.*, p. 430, XVII.)

In reply to some criticisms by Prof. O. Jesse, Dr. Vettin gives further details as to the method of measurement, and shows that in the case of the cirrus clouds his results are all confirmed by the separate consideration of the cases in which he has determined the altitude by either of the three methods, viz, the trigonometric, the sunset illumination, or the projected velocity. Vettin also describes in detail the camera-obscura and the formulæ used in the observation and computation of cloud altitudes. The great need and general dearth of accurate cloud observations should attract observers to the use of some equivalent apparatus; that used by Vettin consisted of a camera box or tube mounted with altitude and azimuth motion. The observer looking upon the lower end sees the cloud image thrown upon a ground-glass plate by the lens at the upper end of the camera; on this ground-glass plate a divided circle is etched. The observation consists in noting the sides of this plate towards which the cloud-image moves, and also the inclination to the vertical of the axis of the camera. The observation is thus made as simple and speedy as possible, while the formulæ and tables give the true direction and velocity of cloud movement with equal ease. (*Z. O. G. M.*, XVIII, pp. 90–92.)

Prof. O. Jesse describes three methods of determining the altitude of the clouds, as follows: First, a beam of brilliant light is thrown upon some spot on a cloud which being thus illuminated is observed as to altitude and azimuth from two stations, and a trigonometric calculation gives the altitude. Second, an observer is furnished with a simple plane table divided into small squares of 1^{mm} each; at an observed moment the location of the cloud is observed on this plate; the same is done a second time without change of instrument, whence results the apparent movement of the cloud. Let the observer now change his location by a known distance perpendicular to the direction of movement of the cloud and make a third and fourth observation of the cloud's location on his plane table and he has at once all the material necessary for determining height and motion of the cloud. Third method: this is similar to the preceding, except that a camera-obscura replaces the plane table. [It may be worth while to note that in 1872 and 1874 the writer presented for the consideration of General Myer a sketch of numerous methods for determining the altitude and motions of clouds, some of which at that time had already been published, while others seemed new. Among these latter were the following: First, by means of two cameras mounted on alt-azimuth circles, successive photographs of clouds are to be taken, whence their altitudes and internal changes could be determined. Second, by a vertical beam of light and the observation of the illuminated spot overhead calculate the height of the lower surface of clouds at night. Third, by a mirror movable about horizontal and vertical axes observe the apparent altitude and vanishing point of the horizontal movement of a cloud in any portion of the sky. Fourth, by two small houses a few hundred feet apart, fitted up as camera-obscuras, with lenses overhead and horizontal tables below, record on sheets of graduated paper the locations at successive moments of the image of clouds, whence altitudes and motions can be calculated. While this note can at present have but slight historical interest, yet the subject continues to be one of growing importance, and will, it is hoped, commend itself to the attention of the reader.] (*Z. O. G. M.*, XXXI, p. 181.)

Dr. W. W. Linss publishes an essay on the origin of streaky forms of cirri ordinarily known as "mare's tails," polar bands, and other varieties. The principal striæ are either homogeneous masses or they show the beautiful incipient formation known as mackerel sky. The axes of the principal striæ are almost always straight lines, and often of great length; the secondary striæ are either perpendicular or parallel to the original, forming a system of equidistant wave-marks. Linss maintains that the formation of these striæ is ultimately due to the relative movement of the air and the clouds under the influence of gravity and the laws of hydro-dynamics; he rejects any influence of terrestrial magnetism or atmospheric electricity; he allows the condensation of vapor by three methods, namely, thermo-dynamic cooling, by mixture of cold and warm air, and by radiation, to be of equal importance considering the various circumstances under which these thin clouds are formed. His views are elaborated with skill and corroborated by reference to actual observations. (*Z. O. G. M.*, XVIII, pp. 57–81.)

Hann has collected the records of diurnal periodicity of rainfall at several European stations. Confining ourselves especially to the rainfall, but giving a little weight to the snowfall, the records of which are so much more difficult and uncertain, Hann finds in general an afternoon maximum between 2 and 4 p. m., and a night maximum between 2 and 4 a. m. At some stations a third maximum between 10 p. m. and midnight, and at one, Vienna, the third maximum between 8 and 10 a. m. At one station, Bern, the afternoon (2 to 4 p. m.) maximum does not occur, but in its place a decided evening maximum between 10 and 11 p. m. (*Z. O. G. M.*, XVII, p. 53.)

Sprung recommends the more detailed study of rainfall in connection with the movement of barometric depressions as theoretical considerations indicate the great relative importance of these two subjects. To this end continuous records must be made of rain, the same as temperature and pressure; he recommends that Nipher's rain-gauge be established upon the roof, the snow caught therein being warmed by the hot air ascending through a surrounding pipe, and the rain or melted snow conducted into the measuring apparatus in the room below. The arrangements for measuring and recording may be devised to suit the observer's ingenuity, but Sprung recommends a method of weighing and recording similar to that adopted by him for the pressure, temperature, and moisture, which methods have proven remarkably satisfactory. (*Z. O. G. M.*, XVII, p. 140.)

Dr. A. Augustin contributes to the study of the daily periodicity of rainfall some items additional to those collected by Hann. He finds for Castelton Moor and Greenwich three maxima and three minima of quantity but only two of frequency. For New York three maxima and minima exist both in respect to quantity and frequency. In all three stations during the colder portions of the year the morning and afternoon maxima occur closer together than during the warmer portion of the year. (*Z. O. G. M.*, XVII, p. 235.)

Dr. F. Augustin has investigated the daily period in rainfall at Prague based on twenty years' observation; he finds as above three maxima and three minima for both frequency and quantity. The intensity of rain, namely, the quantity per minute and the probability of rain at any minute, has the same periods as the quantity and frequency. (*Z. O. G. M.*, XVII, p. 243.)

Billwiller, from a study of the rainfall in Switzerland in the autumn of 1881, concluded that this season, as also that of August, 1880, studied by Hann, and other cases, shows "that in fact the advance of a barome tric maximum into the region of a dry stationary depression or the precursor of such (especially when the latter lies between the zones of high atmospheric pressure or when the air, blowing out from the maximum, strikes a rising surface of ground) gives occasion for heavy protracted rainfalls. The practical art of weather predictions can sometimes take notice of this correction, even if we are still far from being able to satisfactorily explain theoretically the process that goes on." (*Z. O. G. M.*, XVII, p. 5.)

G. Mantel, of Zurich, has studied the distribution of simultaneous rainfalls throughout Switzerland. If over an interval of *a* days among which there are *r* days on which more than half of the Swiss stations report rainfall and *s* days on which more than half the stations show dry weather, then the law of probabilities give us a formula from which to compute how many stations have experienced a simultaneous rainfall. The percentage of such stations varies from 80 for the winter and spring months to 84.7 for the summer and fall, the average being 82 per cent. for the whole six years; that is to say, on any day of the year 82 per cent. of the area of Switzerland simultaneously enjoys the same weather, namely, either dry or rainy. Similar computation was made some years ago by Winkelman for Southern Germany, from which seemed to follow that a prediction of uniform weather over either of these portions of Europe is not likely to be verified over more than 85 per cent. of the area. Percentages greater than 85 are more frequent during dry weather than during rain. (*Z. O. G. M.*, XVII, p. 377.)

J. B. Lawes, J. H. Gilbert, and R. Warrington have communicated to the Journal of the Royal Agricultural Society of England the results of their observations since 1870 on the amount and composition of rain and drainage waters collected at Rothamsted. These experiments were conducted on a magnificent scale. The drainage is measured by collecting-vessels placed 20, 40, and 60 inches below the surface. The general average is shown in the following table:

Interval.	Rainfall.	Drainage at depths of—		
		20 inches.	40 inches.	60 inches.
1871–'74	27.34	9.68	9.48	7.75
1875–'80	34.19	16.94	18.54	16.90
1871–'80	31.45	14.04	14.92	13.24

It is not clear why the 40-inch drain should, during 1875–'80, have collected more than the 20 or 60 inch drains. The greatest drainage occurs in autumn and winter when the evaporation is a minimum. (*Z. O. G. M.*, XVII, 446.)

Symons quotes the following as the best results of the studies of Phillips, Bach, Jevons, Dines, Field, and others, into the diminution of rainfall with altitude: [The physical question is indeed thus far almost entirely resolved into an instrumental one, *i. e.*, what are the sources of error, or how much are the rain-gauge records affected by local peculiarities.]

Jevons and Dines have shown that the wind eddies, due to the very presence of the rain-gauge and its support, largely affect the result. The following points, however, may now be considered demonstrated:

(1.) The ratio of the rainfall on a tower and on the earth depends upon the direction of the wind.

(2.) In a calm the rainfalls on a tower and on the earth are equal.

(3.) For a given prevailing wind the rainfall on the tower on the windward side is smaller than on the earth, whilst on the leeward side the rainfall is equal to or greater than that on the ground.

(4.) The excess on the leeward side compensates the deficiency on the windward side.

(5.) On a very large roof the rainfall at the center is the same as on the ground. (*Z. O. G. M.*, XVII, p. 114.)

Whipple has published a discussion according to a simple method of the question whether five or thirteen year periods are any ways apparent in the long series of rainfall records at Paris, London, Milan, &c. He concludes that no periods, and especially none so short as these, are deducible. (*Z. O. G. M.*, XVIII, p. 47.)

VII.—WINDS AND CURRENTS.

Prof. A. Overbeck, of Halle, has published a highly important memoir on the movement of the atmosphere on the surface of the earth. Assuming the surface to be level and smooth and the frictional resistance proportional to the velocity of the wind, he finds from the differential equations of motion of an incompressible fluid conclusions relative to the inclination of wind to the gradients, some of which had already been given by Guldberg and Sprung. Overbeck gives detailed formulæ and computations for the inner and outer portions of a cyclone and anticyclone, presenting conclusions not very different from those of Ferrel (Met. Res., Part 2), but of course strictly applicable only to the ideal earth and atmosphere. (*Z. O. G. M.*, XVIII, p. 106.)

Helmholtz' scientific memoirs having been reprinted, Hann calls renewed attention to a memoir of 1873 "on a theorem relative to geometrically similar motions of fluid bodies, &c." Starting with the statement that we have long known the correct differential equations of fluid motion, but cannot generally obtain the integrals therefrom, Helmholtz shows that for a large class of motions, where the compressibility of gas or liquid under pressure does not affect the phenomena, the laws of motion in gases are similar to those in far more incompressible fluids, and the motions on a large scale of a very compressible gas or liquid are similar to those on a small scale and with small velocities of a correspondingly less compressible fluid. Similarly with the friction, its effect is also less important in motion on a large scale; in fact, in experiments on large fluid masses, the principal resistances are those that arise from the acceleration of the fluid and especially in consequence of the formation of dividing surfaces (on either side of which independent movements simultaneously take place). These resistances increase with the square of the velocity until that due to friction only is proportional to the first power of the velocity and is specially apparent only in experiments with quite small tubes and inclosures. (*Z. O. G. M.*, XVIII, p. 106.)

Sprung gives a critical review of the three important memoirs by Ferrel on the mechanics of motions in the atmosphere; he deduces Ferrel's fundamental equations in a more general manner, but as his equation cannot be conveniently reproduced here it suffices to state that by an almost entirely independent course of reasoning he is led to a general system of atmospheric circulation and to special systems of cyclonic circulation entirely similar to that which was published by Ferrel. As to the origin of areas of high and low pressure, the inclination of the so-called axis of the cyclone and the causes of the progressive movements of the storms he also adopts Ferrel's views. (*Z. O. G. M.*, XVII, p. 161.)

Sprung makes the following remarks in respect to Hadley's principle *i. e.*, that a body that is relatively at rest on the earth's surface at the latitude φ_0, and revolving about the earth's axis with the absolute velocity proper to this latitude, $R\,\omega\cos\varphi_0$, has the same absolute velocity at any other latitude to which it may attain by virtue of some impulse, v, in a meridional direction.

(1.) On arriving at the latitude φ, the body is found to have a relative east and west velocity of $E = R\,\omega\,(\cos\varphi_0 - \cos\varphi)$. If we consider this to be the result of a steady deflecting force, continuously acting like the force of gravity, then E is the integral of the differential expression $\frac{dE}{dt} = R\,\frac{d\varphi}{dt}\omega\sin\varphi$; where $R\,\frac{d\varphi}{dt} = v$ is the above uniform meridional velocity due to the initial impulse.

(2.) If we consider the earth and meridians as stationary, then, at the end of the time t two bodies starting from $\varphi_0\ \lambda_0$, one moving east and the other polewards as well as east, will have respectively arrived at the two points (φ_0 and λ), and (φ and λ_1) where

$$\lambda_1 = R\,\omega\cos\varphi\,t \text{ and } \lambda = R\,\omega\cos\varphi_0\,t$$

The difference of longitude will be

$$y = R\,\omega\,(\cos\varphi_0 - \cos\varphi)$$

The difference of latitude

$$vt = R\,(\varphi - \varphi_0)$$

whence

$$y = \frac{R^2\,\omega}{v}(\varphi - \varphi_0) \times (\cos\varphi - \cos\varphi_0)$$

whence

$$\frac{dE}{dt} = \frac{d^2y}{dt} = 2\,v\,\omega\sin\varphi$$

This second value is twice the preceding, and is that also deduced from the principle of the preservation of areas, which shows that the radius rector projected upon the plane of the equator will describe equal areas in equal times. (*Z. O. G. M.*, XVII, p. 76.)

Dr. P. Andries describes some pretty experiments in producing steady and progressive whirling movements in the atmosphere and in the water. He infers that a strong, horizontal current at some distance above the earth is sufficient to produce in a mechanical way horizontal and vertical whirlwinds in a lower quiet stratum of air. The low barometer within a hurricane or tornado is, he concludes, the consequence, not the cause, of the whirlwind motion. There is a continual inflow of fresh air taking up the whirling motion while other air is pushed out to make room for it; an anti-cyclone lies above each cyclonic movement. The progressive movement is due to upper currents of air. His theory requires that every tornado should be accompanied by another simultaneously pursuing a parallel track and having its rotation in an opposite direction. [Both these conditions are utterly opposed to the facts collected in Finley's memoirs on American tornadoes.] (*Z. O. G. M.*, XVII, pp. 307 and 385.)

Richter gives the results of some observations for four years, 1877 to 1880, of the direction of the cloud movements at Ebersdorf in Silesia. He distinguishes the direction of the motion of lower clouds in the morning hours 6 to 10 A. M., and the afternoon hours 0 to 4 P. M. The percentages of movements from the north and northwest were appreciably less in the afternoon than in the morning. Those from the southwest and west were greater in the afternoon. Any group of three or four months showed the same phenomenon; the southwest and west movements being on the whole about 8 per cent. more frequent, while the northwest and north were 9 per cent. less frequent than the average, so that during the day there was a general shift in the lower cloud directions towards the south or backward. On the other hand, the comparison of the afternoon observations with those taken between 5 and 10 P. M., shows nearly equal tendency of cloud direction to shift back toward the north. A part of this shift may possibly be due to the high mountains east and west of the station. The observation of the upper clouds show no such daily period, as they retain nearly the same direction throughout the day. (*Z. O. G. M.*, XVII, p. 245.)

Colding, in an elaborate study of the storm of November, 1872, and its effects in Denmark, deduces the effect of the wind on the waters of the North Sea. He shows the piling or accumulation of water pressed forward by winds to be represented by the formula

$$V = -2579 \sqrt{\frac{h}{l}}\ H, \text{ or } h = \frac{l}{H}\left(\frac{V}{2957}\right)^2$$

where V equals wind velocity in meters per second, H the depth of the sea in Danish feet, h the piling up for a distance, l or $\frac{h}{l}$ = the accumulations per unit of length. The rise of water on the southern coast of the Baltic amounted to from 4 to 10 feet above the mean sea level, and as there was a corresponding depression at the north end of the sea the elevation above the simultaneous level of water on the coast of Finland amounted to from 6 to 14 Danish feet; almost the same difference results from comparison with the sea level at stations on the Skager-rack. (*Z. O. G. M.*, XVII, p. 78.)

Dr. Hann has revived the discussion of the origin of the Föhn wind by an analysis of seventeen years at Bludenz, where the Föhn comes from the southeast, from the valley of the Upper Ill. This valley at its southeast end is bounded by the mountains covered by heavy glaciers, the lowest part being 2,000 m. above Bludenz. On examining the cases when the relative humidity is under 35 per cent., Hann finds the temperatures are invariably far above the normal and the pressure somewhat below the average; two thirds of these days occur in autumn and winter. A special detailed examination was made of thirty-seven Föhn days on which relative humidity was as low as from 6 to 20 per cent. On these days the temperature was much higher and the humidity much lower at Bludenz than at neighboring stations in open country to the north and south, as, for instance, at Stuttgart and Milan. The barometric gradient, as deduced from the general observations of the Swiss stations, show that the stormy upper winds blowing over and down the mountain side are not always necessary in order to produce Föhn winds in the valley; in fact, the latter comes not from a distance, but is due to the air lying above the summits gradually settling in valleys beneath, without having at any time risen up the opposite mountain ridge. Its temperature is due both to the normal warmth of the upper strata of air and the rapid increase of temperature due to the compression of the sinking air. (*Z. O. G. M.*, XVII, p. 461.)

Dr. W. Köppen presents some views concerning the rapid fluctuations of temperature observed at elevated stations during anti-cyclones, suggested by observations in Switzerland and Bavaria. The most remarkable illustration of this variability is shown by observations by Trogne, December 5–7, 1869, when from hour to hour the temperature and relative humidity went through rapid variations from — 7.0 C., and 100 per cent. to + 10.2 C. and 30 per cent. In explanation ot these Köppen allows that the insolation and the dynamic warming due to compression play a part, but that the more important feature is the existence of temporary horizontal gradients, producing currents and mixtures of warm air with the cold air from the low-lying plains, where nocturnal radiation has its greatest effect. (*Z. O. G. M.*, XVII, p. 468.)

VIII.—BAROMETRIC PRESSURE.

Prof. H. Wild, in a memoir on the relation between monthly and annual isobars and isabnormals of temperature, finds that these lines run parallel to each other, the latter lying to the south and east of the former, so that southeast of a low barometer there is always a maximum of positive temperature departures; southeast of a high barometer is a local maximum of negative temperature—isabnormals. This relation corresponds closely to a similar relation shown by the daily simultaneous weather chart. Following this generalization, Wild extends his isobars into regions where but few barometeric observations are available. By reading off the barometric pressure at every five degrees of latitude and longitude, he compiles a table showing the mean pressure of the northern hemisphere, which we have directly compared with the one given by Ferrel in 1877, in *Meteorological Researches*, Part I, p. 37, as follows:

Mean barometric pressure reduced to standard gravity.

Latitude.	Ferrel.			Wild.		
	Year.	January.	July.	Year.	January.	July.
Degrees.	700 *mm.* +	700 *mm.* +	700 *mm.* +	700 *mm.* +	700 *mm.* +	700 *mm.* +
+ 20	59.2	60.6	57.8	59.7	62.0	57.5
25	60.4	62.0	58.8	60.8	63.2	58.1
30	61.7	63.4	60.0	61.7	64.1	58.5
35	62.4	64.1	60.7	62.2	64.4	58.7
40	62.0	63.6	60.4	62.3	64.4	58.7
45	61.5	63.0	60.0	62.0	64.1	58.5
50	60.7	62.1	59.3	61.3	63.2	58.3
55	59.7	61.0	58.4	60.4	61.8	58.0
60	58.7	59.7	57.7	59.7	60.7	57.6
65	58.2	58.8	57.6	59.4	60.5	57.2
70	58.6	59.0	58.2	59.3	61.3	56.8

(*Z. O. G. M.*, XVII, p. 328.)

F. Singg, as the result of some studies on the influence of the Alps on the phenomena that occur during an area of high barometric pressure, arrives at the following conclusions:

1. The surfaces of equal atmospheric pressure will be raised in proportion to the horizontal extent of the mountainous region and the height of the mountains. This effect of the mountains extends upward to a neutral surface.

2. The atmosphere sinking down upon the mountains comes under a given pressure, and by compression experiences a higher temperature, sooner than at the same level over a country destitute of mountains.

3. The inclination of the surfaces of equal pressure is therefore from the center of the mountains outward in all directions; wherefore the descending atmosphere acquires an outward flow with increasing velocity.

4. This latter movement hinders the cooling influence of the snow-covered surface of the mountains upon the air that is flowing into the valleys around, so that it brings to these a temperature more nearly corresponding to that due to the compression of the air.

5. This atmospheric current finding no outflow in the closed valleys, must fill up the latter to the level of the surrounding ridges, flowing from one valley to the next until it reaches the limit of the mountainous area.

6. The bottom of such an outward flow of air is therefore at the level of the ridges of the mountains. Below this there prevails in the valleys calm and fog and low temperatures.

7. Above this limit prevail cloudless skies, and the air sinks from regions of slight pressure down to levels of higher, and notwithstanding the steady rise in its temperature it falls lower, step by step, to the foot of the mountains and thence outward, distributing a comparative warmth throughout the low lands.

8 and 9. When the descending and outflowing masses of air are hindered by outlying mountain ridges they pile up to a level sufficient to give them impulse to further outflow. This level forms then a dividing surface like that over the valleys within the mountains; whence follow also similar temperature anomalies, but inequalities in the surface of equal pressure are wanting, as also the gradients that give rise to increase in movements.

10. The progressive rise of the equal pressure surfaces over the mountains up to the neutral surface forms a hindrance in the upper depression, in consequence of which the center of maximum pressure must move from the mountain system towards the latter. (*Z. O. G. M.*, XVII, p. 214.)

Dr. Hann, in some remarks on the study of movements of barometric maxima and minima, proposes to call these the chief centers of action of the atmosphere, and the regions of the earth covered by such centers the chief centers of action of the earth's surface. The importance of considering these centers seem to have been fully appreciated by Taste in a memoir read before the Paris Academy of Sciences in September, 1871; but the importance of the movements of these centers can only be appreciated by the study of the daily weather charts, whence it results that besides the movements of centers of depression there are also changes in the location of the principal belts of maxima, such as those of the tropics, which, of course, affect the weather over large portions of the continent. Hann regrets that the rapid progress recently made in the study of the daily weather charts for small portions of the earth's surface has lessened the esteem in which students at present hold the study of monthly and annual means over large portions of the earth's surface. He maintains that most important insight into the causes of long-enduring abnormal departures of temperature, pressure, and wind are to be obtained by mean charts for each month over large portions of the earth, and that to this there should be an international co-operation for the increase of stations in lower latitudes; that, in fact, the key to the weather of the temperate zones lies in the tropics and subtropics, and not in the polar regions, since the former has an area of 79 and the latter 8 per cent. of the whole hemisphere. A further extension of the simultaneous observations initiated by General Myer [probably the first were by the present writer in 1869], although very advantageous for a single continent, has, he thinks, no value for a whole hemisphere, and may even lead to error, since the high temperatures during day-time are much more important than the cooling of the earth at night-time, and these on the simultaneous system are not given for at least one-half of the hemisphere. Neither hydrometry, nor dynamic or climatic problems can be studied by means of *one* simultaneous observation. (*Z. O. G. M.*, XVII, p. 200.)

Januschke exposes the advantage of the study of the so called level surface or surfaces of equal barometric pressure in the interior of whirlwinds corresponding to the similar study by Hann, Ferrel, and others, on the general circulation of the atmosphere over the earth. The influence of the temperature and moisture as affecting density of the air is easily taken into account, but the influence of the rotation of the earth, which becomes more perceptible in the higher latitudes, requires more complicated considerations, but by considering the propositions deduced by the mathematicians and utilizing the graphic presentation he attains to a fairly clear view of the atmospheric relations. (*Z. O. G. M.*, XVII, p. 136.)

Dr. F. Augustin has studied a relation between diurnal periodicity of atmospheric pressures and temperatures, as shown by observations for twenty years at Prague. He finds, in general, that pressure rises when the temperature changes are greater and falls when they are less, and that the changes in pressure are greater in proportion to the rapidity and duration of the changes in temperature. The oscillations of the barometer by day are greater than by night because the temperature rises from maximum to minimum much more rapidly than it falls. (*Z. O. G. M.*, XVII, p. 330.)

Hann has collected together what little is known of the diurnal periodicity of meteorological phenomena on the Rocky Mountain plateau. He finds the diurnal barometer curve in summer quite analogous to that of the interior of the Asiatic continent and directly opposed to that upon the mountains of corresponding altitude. It is therefore not the absolute altitude, but the local position on the flanks or the summit of a mountain that materially influences the daily barometer curve. This curve is on high plateaus and in high valleys the same as on the low lands, and the magnitude of the diurnal amplitude is remarkably independent of the altitude. The same is true of the diurnal temperature curve. The stations of great diurnal temperature oscillations are not those of greatest barometric oscillations. According to Hann, with the morning increase of temperature there flows from the air above a valley a certain proportion towards the flank of the mountain, to which is due the earlier occurrence of the morning maximum and the unusual depression of the afternoon minimum. At night time the air flows back again, whence results the diminution of the morning minimum in the valley, but its increase on the flank and summit. An analogous process occurs between land and sea; during the day the air at an altitude above the land flows towards the sea and causes there a rise of pressure that shows itself even on the coast by the delay in the morning maximum and the afternoon minimum. The reverse process occurs at night. This is illustrated in the California barometer curves and those deduced by F. Chambers for the seven English self-recording stations. The elucidation of a general theory of the diurnal barometric oscillation is much facilitated by having clear views of the modifications that this oscillation experiences by reason of the periodical diurnal transfer of air from the land to the sea, and from the valley to the hills. The daily barometric oscillations attain an extraordinary extent in the excessive summer heat and dryness of Arizona ranging from 1.8 mm. above to 2.2 mm. below the daily mean, or an oscillation of 4.0 mm. (*Z. O. G. M.*, XVII, p. 35.)

Köppen, in a study upon the vertical (and horizontal) distribution of the pressure in the atmosphere, discusses the allowable simplification of Ruhlmann's formula for approximate reductions of observations to sea level or other altitudes. He states that since August, 1880, when his formulæ, viz—

$$\log \frac{B}{b} = \frac{h}{18460 + 72\left(t + \frac{1}{52}(45^\circ - \varphi)\right)} = \frac{h}{72\left(256 + t + \frac{1}{52}(66^\circ.5 - \varphi)\right)}$$

were presented to the meteorological committee at Berne, he has used it in the form of a manuscript table for all cases occurring at the Deutsche Seewarte, where greater accuracy was required, although for the daily weather reports the reductions are as before, made without reference to the prevailing air temperature.

He then proceeds to discuss the important question of isobars and gradients for higher levels as revealed by reducing barometric readings upward to an assumed level (say 5,000 or 10,000 feet), the need of which has been felt these many years before by the present writer and of late by others. We desire, namely, to know at what elevation within an area of low pressure the gradient ceases to be inward and above which, therefore, the air must be flowing outward, or at what altitude the pressure above a low area becomes equal to that of the same altitude above a neighboring high area, or again at what altitude and distance from the center of a depression the pressure above any station in the quadrant of cold northerly winds becomes equal to the pressure above another station in the quadrant of warm southerly winds.

Let the lower temperatures and pressures be t and t_1, B and B_1; the height at which pressures are the same over both localities will be given approximately by

$$h = (\log B - \log B_1) \; \frac{72 \, T \, T_1}{T_1 - T}$$

where $T = 256 + t + \frac{1}{52}(66.5 - \varphi)$ and similarly for T_1; or if we neglect the effect of difference of latitude we get approximately

$$h = 62.5 \; \frac{B - B_1}{T_1 - T} \cdot \frac{T \, T_1}{B + B_1}$$

or assuming the lower pressure to be not far from 750 mm. we have

$$h = C \; \frac{B - B_1}{T_1 - T}$$

where C varies from 2,600 at $-6°$ C. to 3,000 at $+12°$ C.

For convenience in acquiring a permanent remembrance of the distribution of the atmosphere and the relative importance of the masses of successive strata, Köppen gives the following table showing the air temperature, vapor tension, and barometric pressure at successive altitudes, so chosen that between each there is contained one-sixth of the weight of the atmosphere.

The temperatures are determined by the admirable formula of Mendelieff, which applies especially to the free air and great altitudes, and in which, however, Köppen adopts the constant 40° from Hann, instead of the 36° given by Mendelieff, whence it becomes

$$\frac{t_h + 40°}{t_0 + 40°} = \frac{bh}{B_0}$$

The vapor tension is given on the assumption that the air is saturated at the temperature given for each altitude.

Pressure.		Temperature.	Vapor tension.	Altitude.
Relative $\frac{b}{B}$	Absolute.			
	mm.	° *Cent.*	*mm.*	*m.*
1	750	+ 20	17.4	0
$\frac{5}{6}$	625	+ 10	9.2	1519
$\frac{4}{6}$	500	0	4.6	3377
$\frac{3}{6}$	325	— 10	2.1	5665
$\frac{2}{6}$	250	— 20	0.9	8808
$\frac{1}{6}$	125	— 30	0.4	14084

Köppen enforces careful attention to the fact that sensible horizontal and vertical gradients of pressure have each their respective importance in the atmospheric motions. He attributes both to differences of density, due mostly to temperature; differences in a horizontal direction give rise to the general atmospheric circulation and the extensive storms; differences in a vertical direction (*i. e.*, departures from a condition of stable equilibrium) give rise to local motions, such as form cumulus clouds, water spouts, tornadoes, &c. "In respect to the rate of diminution of temperature with ascent there is a notable difference between the front and back of a normal depression moving eastward. In the front part the south winds bring warm air, and even more in the middle than in the lowest atmospheric strata, because the currents move faster at an altitude, and because their direction is different, for they flow both from the south and from the minimum, bringing with them the latent heat of the condensation of the precipitation going on within the inner portion of the depression, while the cooler air on the earth's surface is drawn in from the regions that have not yet been reached by the minimum. Therefore, here the temperature diminution, with altitude at least in the lower half of the strata, is slow; but the general excess of heat over the region causes a general gradient directed outwards and a slow ascent of the air, the result of which is cloudy sky and continuous precipitation. In the rear of the depression it is otherwise. Here the wind in the middle strata of the atmosphere has, indeed, in general, the same direction, but the swifter motion of the upper layers and the contact of the lower layers with the surface of the earth still warm from the preceding mild weather [and the rapid evaporation of freshly fallen rain] cause even here an important difference in the relations of the upper and lower portions of the stream of air, and especially a decidedly more rapid cooling of the upper region; a very rapid fall of temperature with ascent for the lower half of the atmosphere, is the consequence. Hence the air in the rear of a minimum acquires the characteristic interchange of shower and sunshine, due to the many local upbursts of the warm lower strata over the whole region where cold air is in the neighborhood of warmer, moister air to the eastward."

A third type of gradient is that presented by the high or anti cyclonic areas, within which the temperature gradient and atmospheric motions are, in general, directed downwards, but the lowest stratum, or sixth, the part of the atmosphere which, of course, has been stopped in its descent, its warming and its drying is found moving slowly outwards. In such anti-cyclones the perfect freedom from clouds favors the radiation of heat from the earth's surface (in winter and at nights), producing such great cooling as to lead to complete inversion of the normal vertical distribution of temperature and to the formation of fog in the lowest part of the stratum. Köppen concludes as follows: "The cold over the continents directly causes the increased density of the air and the initiation of barometric maxima and their descending air currents. For even although the temperature does not suffice to explain the average distribution of pressure with latitude, and mechanical influences have to be added thereto, still for the annual variations in the pressure over continents and ocean, the temperature is the deciding factor." (*Z. O. G. M.*, XVII, p. 92.)

Dr. W. Köppen, in discussing the question of the monthly range of the barometer, states that Kämtz had already, in 1834, in his *Lehrbuch*, graphically presented the lines of equal barometric ranges, a method that has been neglected until in most recent times, when Felberg (1878) and Köppen (1882) have published contributions to this subject notwithstanding the difficulty of obtaining uniform or homogeneous results for many countries. Köppen has been able to make a very extensive collection, fairly representing the whole northern hemisphere, and with numerous points of comparison in the southern hemisphere, from which we extract the following table of mean monthly barometric variability:

Latitude N.	Summer.		Winter.	
	Ocean.	Continent.	Ocean.	Continent.
0°	5 (3)	6.5 (4)	5 (3)	6 (4)
10	6 (6)	8 (6)	5 (4)	6 (5)
20	8	11	6	8 (7)
30	16	13	9	11 (10)
40	29	18	16	12
50	38	25	25	14
60	45	31	28	19
70	40	33	25	18
80	34	....	18	....

By comparing the figures in this table with values based on dynamical formulæ due to Ferrel and Guldberg, Köppen concludes that the great difference between the mean variability over the land and sea is to be referred to the variable influence of the earth's rotation in different latitudes and the resistances offered by the surface of the earth to the movement of the air. He finds that in winter the quantity of air passing over any latitude in a unit of time is the same in all latitudes, but in summer the quantity is sensibly diminished north of latitude 10°, perhaps because of the greater quantity of vapor and latent heat in the tropics. The hypothesis that the friction increases the barometric variation especially explains the relative variations, which are greater on sea than on land in latitudes between 30° and 70° north, but at the equator are smaller on sea than on land. Finally, the inflow of air at the earth's surface, or the outflow in the outer strata is approximately equal in all latitudes during the winter, but in summer diminishes, first rapidly then slowly for increase in latitudes. The general proportionality of the barometer variations to the mean barometric gradient gives us further corresponding variations with the mean velocity of the wind, &c. (*Z. O. G. M.*, XVIII, p. 7.)

IX.—GENERAL AND LOCAL STORMS.

Köppen has published a chart showing the frequency of and principal paths pursued by centers of barometric minima for the region between the Rocky Mountains and the Ural. His charts are based on the publications of the Army Signal Office, Hoffmeyer, Loomis, and the Deutsche Seewarte. He seems not to have access to the similar charts prepared by the present writer for the statistical atlas of the United States Census Bureau and published in 1875. Köppen's charts show seven principal centers through which storm tracks are most likely to pass. Of these, two are in America on the parallel of 45°, and the central over Lake Superior and New Brunswick, respectively. Three belong to the North Atlantic, near the parallel of 65°, and central, respectively, in Davis's Straits, southwest of Iceland and northwest of Norway. The principal European center is central over Denmark and Southern Sweden. For all these six centers thirty or more barometric minima occur on the daily morning charts in the course of the year for each square of 5° in latitude and 10° in longitude. [This statistical presentation of the frequency of storm centers seems imperfect in that it takes no account of the movement of the storm center from one morning until the next; it is simply a summation of what appears on the daily morning maps. The charts of the United States statistical atlas, on the contrary, were based upon actual storm tracks whose paths could be confidently laid down by means of the three or more tri-daily maps of the Army Signal Service; this atlas therefore presents the total frequency for the whole year and the whole day. A new edition of these charts, embodying all the work of many years, has been prepared by Finley and is now in press.] In some remarks on his charts Dr. Köppen states that the minima which pass from America to the English Channel require about six days to travel from the 70th to the 10th meridian of longitude, whereas the trans-atlantic storms require nine or ten days, but the irregularity in the rate of storm movement is very great, both by the ocean and the land. The greater part of the storms of America pass over Greenland and Iceland, and daily weather telegrams from islands and borders of the North Atlantic Ocean would afford to European meteorologists a practically useful synopsis of the condition of the weather for the guidance of the navigators. Köppen also remarks that the decided excess in the number of storms passing to the north of Europe over those passing to the south not only affects the climate by the characteristic warm and damp south and west winds, but is also the foundation of the so-called Dove's law of the rotation of the winds, according to which, in Europe, they change most frequently in the order east, south, west, north, or, as frequently expressed, shift with the sun, namely, in the direct and not the backward order of rotation. In Greenland, on the other hand, where the observer is located on the left-hand side of the storm-path the change of wind is in the opposite direction, or they are said to back against the sun or from the west through the south and east. (*Z. O. G. M.*, XVII, p. 257.)

J. Spindler has published a collection of paths of typhoons in Chinese and Japanese waters, compiled for the years 1858 to 1878. He finds the turning-point in their parabolic paths about 30° north latitude.

August and September are the months of greatest frequency for Japanese typhoons, but September and October for Chinese. The velocity of movement is slowest near the apex, and is rather slower in the China than in the sea of Japan. (*Z. O. G. M.*, XVII, p. 336.)

Dr. Assman, director of the local meteorological station at Magdeburg, whence special weather predictions are daily issued, has paid special attention to the phenomena of local thunder storms, and urges the establishment of more numerous stations whence data may be derived for plotting the phenomena of the storm as a whole at short intervals of time. His continuous records of temperature and wind show sudden oscillations of temperature that seem to him to indicate local cyclonic movements. (*Z. O. G. M.* XVII, p. 337.)

A. Richter has analyzed the observation of thunder-storms during four years, 1877 to 1880, at seven stations in the department of Glatz. A thunder-storm is considered to have passed over any locality when the interval between the thunder and lightning is not greater than sixty seconds. The annual and daily periodicity is shown in the following table of frequency:

I.

Month.	Average frequency.
December	0.1
January	0.0
February	0.0
March	0.5
April	1.7
May	4.7
June	8.6
July	6.4
August	5.6
September	2.5
October	0.6
November	0.1
Year	30.4

II.

Hours.	Total number.
12 – 3 a. m.	6.0
3 a. m.– 6 a. m.	3.1
6 a. m.– 9 a. m.	2.5
9 a. m.–12 noon	12.2
12 – 3 p. m.	45.6
3 p. m.– 6 p. m.	63.5
6 p. m.– 9 p. m.	50.7
9 p. m.–12 midnight.	26.9
Total	210.5

III.

Uniform high pressure	3.7
Central region of maximum	2.1
Near a maximum	11.1
Zone between maximum and minimum	43.0
Near a minimum	18.5
Central region of minimum	4.7
Uniform low pressure	2.8

The distribution according to the location of the centers of maximum and minimum pressure is shown by the third table. When the temperature is above or below the normal, the storms occur as follows:

0–2° below normal	17.9
0–2° above normal	27.3
2–4° above normal	26.9
4–6° above normal	12.5

(*Z. O. G. M.*, XVII, p. 329.)

Dr. W. Holtz describes ingenious experiments to prove that tornadoes and water-spouts, &c., are caused by electricity, and are not the mechanical effect of rotation of a portion of the atmosphere. He however quotes equally beautiful experiments of Xavier de Maistre (*Bibl. Univers*, 1832, vol. LI; Silliman's *Amer. Jour.*, 1834, XXV), that fully support the mechanical theory. (*Z. O. G. M.*, XVII, p. 370.)

X.—ELECTRICITY, MAGNETISM, AURORAS, LIGHTNING.

Freeman has investigated the electrical state of a plate or dish from which water or other fluids is being evaporated. He finds no trace of electrification, and concludes that atmospheric electricity cannot be due to evaporation.

L. J. Blake has investigated the electrified condition of the particles of vapor, both condensed and uncondensed, after they ascend from the evaporating dish, and finds that these also give no sign of electrification, whence also it follows that atmospheric electricity cannot be due to aqueous vapor. (*Z. O. G. M.*, XVII, p. 482.)

Dr. Spring has attempted a more satisfactory hypothesis as to the origin of atmospheric electricity, replacing the widely-prevalent view according to which the atmosphere communicates its own electricity to the cloud particles at the moment of their formation by condensation, so that a cloud contains the total quantity of electricity that was previously in the corresponding atmosphere, but in a higher degree of tension because of the change in condition of the aqueous vapor; this electricity now collects itself on the surface of the cloud which discharges itself toward a similar cloud or the earth's surface like any electrified conductor. Spring shows that this explanation is both unsatisfactory and contradictory to well-known physical facts. Starting with certain observations in the Swiss Alps, where Spring had sometimes found himself in the center of a thunder-storm, and had persuaded himself that a cloud does not act as a single conductor, but that the individual drops or hail-stones retain the electric charge, he concludes that possibly the electricity may arise partly from the ascent of the moist air, partly from the friction of the falling drops, and the atmosphere. The intensity of the development of electricity increases with lower temperatures. Dr. Spring quotes in support of his views similar observations by Osborne Reynolds in 1878 and the observations made by H. Spring in 1875, which confirmed the view that the combination of numerous small crystals into one larger is accompanied by enormous increase in the intensity.

Dr. Spring made special experiments as to the possibility of electrifying a solid body by atmospheric friction. He found a decided electrification of a brass sphere produced by blowing against it a warm dry current of air, the effect being somewhat proportioned to the velocity of the current and the atmospheric pressure; he further observed that rapid variations took place in the electrification of the sphere while the current remained constant, as if a process of charging and discharging were alternately going on between the current and the sphere. (*Z. O. G. M.*, XVII, p. 486.)

Prof. H. von Bezold describes an electric phenomenon occurring on February 19, 1882, which consisted essentially in a peculiar cloud reaching from an altitude of 45° down to the south and southwest horizon, from which an intense mild light beamed in streaks resembling auroras, while the mass of the cloud exhibited a glow so intense that it was illuminated as brightly as a whitewashed wall illuminated by a street lamp. This appearance continued until 8 P.M., shifting to various parts of the horizon, and demonstrably was not due either to the moon or the reflected lights of the city. Bezold concludes that this was a case of self-illuminated clouds similar to that described once by Sabine. At the same time in the distant Bavarian forest occurred a few peals of thunder with lightning flashes. [Similar phenomena have been observed in Washington, generally at the end of a period of warm southerly winds when cold westerly winds with light flurries of snow occur. Another form of lightning without thunder has been twice observed by the writer, namely, in Chicago, July 4, 1859, and again in Washington in July, 1874, on both of which occasions the heavens from the zenith to the horizon were for an hour or more brilliant with innumerable simultaneous flashes, stealing with comparative slowness in all directions, apparently on the under surface of a layer of thin, high clouds. No thunder was heard, nor did any rain fall.] (*Z. O. G. M.*, XVII, p. 146.)

Prof. Adams has studied the magnetic storms of March, 1879, by means of photographic traces at Lisbon, Coimbra, Stonyhurst, Vienna, St. Petersburg, and Bombay, in the northern hemisphere, and Melbourne and Mauritius, in the southern. He finds that a diminution of the horizontal intensity occurs with an eastern departure of declination greater at St. Petersburg than at Kew, and *vice versa*, an increase of horizontal intensity occurs with a west departure greater in St. Petersburg than in Kew.

Adams also investigated the much stronger perturbations of August 11–14, 1880, by means of the curves from Lisbon, Kew, Vienna, St. Petersburg, and Toronto. Vienna and Toronto show for hours together strong similarity in their curves and then change to great diversity. The total magnetic intensity at St. Petersburg was changed by nearly one-eighth of its whole value. Any cause that is insufficient to explain the origin of the whole terrestial magnetism could scarcely be considered as sufficient to explain such enormous perturbations. (*Z. O. G. M.*, XVII, pp. 15, 16.)

Wild has also expressed his views as to the origin of terrestial magnetism and magnetic storms in connection with a study of magnetic storms of 1880, August 11–14. From autographic records of Pavlosk, Kew, Zikawei, and Melbourne he concludes: (1) The disturbance of all three elements, declination, horizonal and vertical intensity, began and ended simultaneously. They originated, therefore, from either one single force or from forces that simultaneously began and ended. (2) The individual curves of disturbance at neighboring points, as Kew and Pavlosk, show some similarity, but those of Zikawei and Melbourne are entirely discordant. (3) The characteristic features of this storm are as follows:

Character of disturbances.

Stations.	Declination.	Inclination.	Total intensity.
Kew.	Strong.	None.	Slight.
Pavlosk.	Moderate.	None.	Very strong.
Zikawei.	Slight.	Strong.	None.

(4) The magnitude of the perturbation for each element, especially the intensity, and for each day, shows a diurnal period closely coinciding with normal daily variations. (5) It is probable that the sun is to be considered as the principal agent of the periodic and non-periodic variations of the elements of terrestrial magnetism. However, it must be conceded that this conclusion would require that we assign to the sun a magnetization per unit of mass about 13,000 times that of a unit of the earth's mass, and that at times of great perturbations this varies to and fro by thirty times its own amount; but our present knowledge only justifies our attributing to a unit of mass in the sun a magnetic power 2,000 times that of a unit of the earth, even supposing the sun to be a fully saturated steel magnet. Therefore, it appears not likely that the sun alone is the cause of the normal and abnormal variations. It will be more intelligible to adopt with De La Rive the view that the earth is a Leyden jar, whose inner covering is the surface of the ground, and whose outer surface is the highly attenuated upper strata of air, and that discharges from pole to equator in the atmosphere and also from pole to pole within the earth continually take place. The ordinary charges cause the normal deviations of the magnet, the abnormal cause the perturbations. We have, then, only to assume that the daily position of the sun has an influence upon the direction and force of this discharge, and that the abnormal stronger discharge is caused by special occurrences on the sun. In this way the *cause* is made present on the earth, and the sun comes in only as the medium releasing it and setting it into activity. Observations on earth currents have been instituted in Pavlosk that will perhaps be further explanatory of this matter. (*Z. O. G. M.*, XVII, p. 14.)

Prof. H. Wild has investigated the so-called magnetic weather of January 30–February 1, 1881, by means of the records of magnetographs, at eleven places in America, Europe, India, China, and Australia. He finds that the perturbations began everywhere simultaneously, so far as the time scales enabled the moments to be determined. A perfect similarity in the declination curves existed throughout Southern Europe, but the curves for Pavlosk, Zikawei, Bombay, show no similarity, while for Melbourne and Toronto, the declination curves generally show almost opposite variations. A very similar statement as to the opposite character of the variations in Europe and America would hold good for the curves of horizontal and vertical intensity and the dip of the needle.

The times of occurrence of maxima and minima, and the amplitudes, especially of the variations in declination, correspond very closely to the distance of the stations from the auroral circle surrounding the magnetic north pole, as lately defined by Baron Nordenskiold; hence it would seem to follow that in this circle originate both the aurora and the magnetic declinations. Wild concludes that the source of the perturbing forces is so far distant that these are essentially parallel for all stations, and that possibly, in magnetic perturbations, the total magnetic force of the earth is not changed, but the increase at some stations is compensated by diminution at others; so that the perturbing forces, as it were, merely push over or disarrange the geographical distribution of terrestrial magnetism. He finds evidences of the existence of several independent points in the auroral circle, whence originate the magnetic disturbances that were felt in Europe. (*Z. O. G. M.*, XVIII, p. 97.)

Lemstrom having observed that in Spitzbergen the galvanometer needles had distinctive motions during an aurora when he held it aloft in his hands, took occasion, on his subsequent expedition to Lapland, to establish a staff with metallic point upright on a hill 150 meters high, and connected the point by insulated wire with his galvanometer 4 kilometers distant, and thence to the ground plate of platinum buried a half meter in the earth. Beams of light (the elementary light-needles of the aurora) appeared at night over the hill, and the motion of the galvanometer needle, whenever the circuit was closed, showed the presence of a galvanic current. Lemstrom proposes further investigation of the phenomena in northern regions, but also deems it proper to recommend this to the attention of observers in temperate latitudes, where auroras are frequent. (*Z. O. G. M.*, XVII, p. 115.)

Prof. R. Robinson has published his long-promised second part of his catalogue of auroras observed from 1700 to 1877 in Sweden, concerning which Professor H. Fritz remarks, that it is the conclusion of a labor of the highest importance in this department, especially in that it gives the fullest possible details as to time, place, details and authorities for each aurora. The total number of aurora days is 7,780: the epochs of maxima follow the sun-spot maxima at an average interval of 14 years. The annual periodicity shows the dependence on latitude already developed by Weyprecht and Tromholt and others, viz, the most northern stations show a decided maximum in the winter months, whereas at temperate latitudes this subsides into two maxima at the respective equinoxes. (*Z. O. G. M.*, XVII, p. 441.)

Prof. H. Fritz presents an interesting analysis of the chronological list of auroras compiled by Lieut. A. W. Greely, of the Army Signal Office, which he recognizes as a valuable contribution of data especially towards the determination of the daily and secular periodicity. He finds sufficient confirmation from the long series of observations at Toronto, Gardiner, Cambridge, and Willets Point, &c., of the agreement between the periodic variations of the aurora with the variation of the sun-spots. For the annual period he finds the following numbers, which, however, give but slight indications of the ordinary maxima at the equinoxes:

January	84	July	91
February	77	August	72
March	88	September	95
April	92	October	85
May	87	November	82
June	90	December	74

As regards the daily period, he finds a confirmation of the law announced by him in 1881, namely, that there is an annual variation in the time of daily maximum by reason of which the hour of maximum in the winter half of the year is decidedly earlier than the summer half and the mean duration is greatest at the time of the equinoxes. (*Z. O. G. M.*, XVII, p. 417.)

H. J. Groneman, of Gröningen, combats the statement of Sophus Tromholt, that in many cases the aurora is an apparently local phenomenon, and that it often occurs at slight altitudes above the earth's surface. He examines in detail the observations quoted by Tromholt, &c., and maintains, after minute analysis, that they give no ground for such conclusions. (*Z. O. G. M.*, XVII, p. 187.) [The present writer announced precisely the same conclusions in the Report of the Chief Signal Officer, 1876, p. 311, as based on the study of many auroras, especially that of April 7, 1874, and is still inclined to sustain the views of Tromholt.]

Sophus Tromholt replies to Groneman's criticisms in an equally positive manner and with fullest possible details. He concludes that with one exception all of Groneman's thirty-two objections rested upon observations made carefully by Tromholt himself, and that, conscious of the favorable location whence he observed, of his many years' experience, and of the special care given to the examination of the whole heavens, he must still remain convinced that in many cases the location of the auroral light is very near to the earth's surface, frequently underneath the clouds and sometimes at the surface. (*Z. O. G. M.*, XVII, pp. 342–351.)

S. Fritz has published in Danish a memoir entitled *Recent Investigation on Winds in the Atmosphere*, &c., in which he gives the results of years of personal experience in reference to the auroral phenomena at Ivigtut, Greenland, 61° 20′ north latitude. Within the belt of greatest frequency the aurora is an almost daily phenomenon that fails only when fog or clouds obscure it. North of 80° north latitude it is rarely seen. Between this and the zone of maximum frequency, it is seen to the south of the observer's zenith, and usually as a freely moving wavy band of great horizontal extent. This, "the Arctic form," consists of a series of bars of light arrayed side by side perpendicular to the general axis of the band, while the whole band is always in a wavy, often in a nearly circulating, movement; the individual perpendicular bars that form it have simultaneously a forward and backward movement; the whole band changes its place continuously in the sky, and ordinarily one sees many such bands expanded over the sky. The auroral arches seen by observers stationed at northern latitudes have a more regular invariable form than these bands, and both these forms are seen by observers in the southern part of the zone of maximum frequency. According to Edlund the aurora depends on atmospheric electricity, but a mutual dependence on terrestrial magnetism and sun spots is also acknowledged, and the parallelism of these with the annual daily variations of atmospheric temperature and pressure force us to trace all back to the same source, the sun.

Arsuk Fiord is in 61° 15′ north latitude. This fiord is 2 miles wide by 25 long, and its shores are steep, rocky cliffs from one to four thousand feet high. Midway of its length, on the south side, lies Ivigtut. At this station the aurora light begins with a development in the west over the north of the fiord, and as it progresses eastward follows the direction of the fiord, sometimes covering its entire length, and having outliers over the smaller arms of the fiord; but ordinarily the western part of this auroral band disappears before the development has extended to the eastern end and new bands of light come again from the western end eastward. The phenomenon is best developed at two hours after sunset, and appears then to be near the earth's surface, occasionally only 1,000 feet above sea-level. As a rule, the aurora is fully developed only in calm, clear weather. It most frequently appears during the east wind (the well-known Föhn wind), but is then very unquiet and dismembered. The author then gives his theory that the aurora is due to local currents of warm and cold air. (*Z. O. G. M.*, XVII, p. 320.)

Nordenskiold, in his report on the auroras observed in the Bering Sea during the voyage of the Vega in 1878 and 1879, states that in those regions the aurora presented an entirely different appearance from what is ordinarily seen in Europe. It consisted regularly of an arch of light five or twelve degrees above the horizon, perfectly quiet, without motion or rays. The inside of this arch was sharply defined, and the so-called dark segment wholly free from light, and generally free from clouds or fog. The upper limit of the arch was not sharply defined, and above it the sky was somewhat illuminated; occasionally rays issued from this side, especially when several such arches were arranged above each other, which latter appearance was not rare. The brilliant drapery and beams reaching the zenith, so common in Europe, were very seldom seen.

Nordenskiold proposes the following explanation, namely, that the ordinary auroral arches are due to a luminous ring that remains permanently around the magnetic pole as a central axis, its center being about 2,000 kilometers above the earth's surface, its radius 0.32 of the earth's radius, and the plane of the ring perpendicular to that terrestrial radius that passes through its center. A second ring in the same plane, but of greater diameter, concentrically surrounds the first. There are, therefore, five zones to be distinguished in the study of auroras: (1) A circle with the radius of 8 degrees, whose center lies in or near Smith's Sound, within which the aurora is seldom seen, and then only as a light cloud in the horizon; (2) A concentric ring 8 degrees outside of the preceding, where the single aurora arch is the ordinary phenomenon; (3) The ring between circles of 16 or 20 degrees radius, where the ordinary arch appears near the zenith, and as a faint light, or else it appears as an arch to the north, while in the south another aurora appears; (4) The ring between circles of 20 and 28 degrees radius where auroral rays ordinarily attend the arch and perhaps even extend to a second luminous ring; (5) Between the circles of 28 and 33 degrees radius, the inner or lower arch is no longer seen, but the magnificent drapery, with brilliant and moving rays, is the ordinary phenomenon. (*Z. O. G. M.*, XVII, p. 232.)

XI.—OPTICAL PHENOMENA.

Kerber has studied certain optical phenomena by which to gain some idea of the altitude of the earth's atmosphere. From the value of the constant of refraction, *i. e.*, 57″.3, he deduces the limiting altitude 192.6 kilometers. But from a more critical study of the formula he deduces 189.0 kilometers. Al-Hazen's method of determining this height from observations of the height of the twilight arc that rises in the east after the sun sinks in the west, or *vice versa* in the morning, gives a much lower altitude, but this is apparently due to the fact that the light of the twilight arc comes from those lower strata that contain moisture or dust enough to reflect a sensible amount of light to the eye. Nothing can be determined from this as to how much higher up the attenuated air extends. (*Z. O. G. M.*, XVII, p. 72.) [It is to be hoped that photometric methods may yet become applicable to this interesting problem. The remarkable colors of the twilight and dawn during the latter half of the year 1883 and over the whole world show that at very great heights our atmosphere is subject to changes that only affect the vision, although they may sensibly affect temperatures and weather at the surface and are in some cases believed to have connection with terrestrial and cosmic phenomena.]

Exner gives some of the results of critical study upon the scintillation of stars, especially with the Arago scintillometer. After explaining the various special phenomena observed by Arago, Marius, Nicholson, Montigny, and Respighi, he proves that Arago's theory of interference is not sustained, and we must abide by the views of Hooke, Newton, Young, Montigny, namely, that the cause of scintillation is to be found in the variable refractions experienced by the rays in passing through the irregularities of the atmosphere, and that the colored rays result from this irregular refraction combined with the regular atmospheric spectral dispersion. (*Z. O. G. M.*, XVII, p. 296.)

XII.—MISCELLANEOUS APPLICATION.

Köppen gives an abstract of Hann's paper on barometric hypsometry that was published in 1876, but seems as yet little known, although the main novelty, *i. e.*, Hann's formula for decrease of vapor tension with altitude, has been utilized in Upton's and other hypsometric formulæ. Köppen indorses heartily Hann's method of approximating when the observations of humidity have not been made at either station, namely, to assume a probable value of the relative humidity at the time as being better than Bauernfeind and Schrieber's suggestion to adopt a normal monthly value for the locality, since the absolute humidity varies much more than the relative. By assuming the vapor tension, $f(e)$ as approximately dependent principally upon the air temperature, t, Hann finds from winter and summer observations in the Alps and Himalaya $f(e) = 0.00154 + 0.000341\,t$, and introducing this into his formula obtains as a modified factor for the temperature correction 0.00400, exactly agreeing with La Place.

Possibly a still better method is the following: By means of annual and monthly means of pressure (B and b) and temperature (t' and t'') at two stations determine the temperature constant; for St. Bernard and Geneva from 6 years of observation Hann finds

$$h = 18540 \log \frac{B}{b}\left(1 + 0.0032\frac{t' + t''}{2}\right)$$

and similarly for other parts of the world. From this data determine the effect of geographical location on these constants and deduce a generalized formula for application anywhere. (*Z. O. G. M.*, XVII, p. 70.)

Angot replies to a review of his hypsometric formula and tables by maintaining that the diurnal and annual periodicity in altitudes as computed ordinarily is a physical necessity that ought not to be diminished or suppressed by any method of computation, but rather brought out in its rational proportions until the rational physical formula for its correction can be deduced. He seems to consider that since the warming of the atmosphere causes a part of what was below the upper station to rise by expansion until it is above, there is therefore less air between the two stations, and the barometric difference, as well as the computed hypsometric difference, should be less during day and summer than during night and winter.

Hann replies to this insidious error that the temperature term in the Laplace, Angot, Ruhlmann, and other formulæ would wholly correct this diurnal and annual periodicity if only the true air temperature were known and used; the trouble is neither in the local peculiarities nor in the barometer nor the formula: the periodicity in barometric hypsometry is not a physical necessity nor a fact in nature; it is a result of computations based on man's ignorance of the air temperature and of the effect of the motion of the air, which latter has therefore generally been quite left out of consideration. (*Z. O. G. M.*, XVII, p. 56.)

Hoffman, in continuation of his long series of studies into vegetable physiology, states that in the determination of the thermal constants of vegetation the summation of the daily maximum positive readings of a thermometer in sunshine gives far better results than the use of the ordinary air temperature, since the plant itself is mostly exposed to the full sunshine. The error of the air temperature method is often 10 per cent. of the total temperature sum, while that of the sun thermometer but 1 per cent. The errors of the former method are least in low and shady places, but become very large when applied to high and mountain regions, where the shaded thermometer always reads much lower than the sunshine thermometer. By using sunshine or insolation thermometers of perfectly uniform size and spherical bulbs, Hoffman hopes to make the observation at neighboring stations more perfectly comparable, and refers with satisfaction to the progress made in this respect by Dr. J. Ziegler, of Frankfort. [It would seem that the thermometers used are ordinary bright bulb with a brass scale and not *in vacuo*, and which always agree within 2° centigrade. Whatever objection there may have been to the bright and black bulb *in vacuo*, or the Arago-Davy actinometer, as a means of obtaining the relative intensity of sunshine, have, I think, been mostly removed by recent researches of Prof. Ferrel, now in press, andit would seem that this instrument should be substituted for the thermometer in air.]

The comparative observations made by Hoffman at low and at elevated points show clearly the effect of superincumbent air, mist, haze, smoke, &c.; thus the differences between the reading of the same thermometer exposed ten or twenty minutes in the sunshine and then in the shade in calm and under very clear skies, gave for Giesen, altitude 492 feet, 4°.9 centigrade, while observations on mountains 5,000 to 8,000 feet high, give 16°.4 centigrade. Selecting only observations made on the same day as given by Hoffman, I have compiled the following nearly comparable results :

Date.	Station.	Altitude.	Hour.	Readings.		At Giessen.			Sun–shade.	
				Sun.	Shade.	Hour.	Readings. Sun.	Readings. Shade.	Upper station.	Lower station.
1880.		Feet.		°	°		°	°	°	°
VII, 18	Pontresina........	5,553	10.00 a. m.	26—	13	12.30	27.5	23.6	13	3.9
VII, 28	do	5,553	5.15 p. m.	25—	9	11.25	19.3	13.3	16	6.0
VIII, 2	Bernina Hospice..	8,113	2.45 p. m.	26—	11	11.54	23.3	19.0	15	4.3
VIII, 3	....do	8,113	3.15 p. m.	26—	12	11.16	22.3	18.4	14	3.9
VIII, 5	....do	8,113	2.30 p. m.	29—	11.5	10.00	22.6	17.5	17.5	5.1
VIII, 7	... do	8,113	2.00 p. m.	33—	12	10.15	24.0	18.0	21	6.0
VIII, 8	.. do	8,113	3.00 p. m.	29—	12	12.15	24.4	18.2	17	5.8
VIII, 19	Silver Plana	5,593	3.30 p. m.	26—	78	8.35	17.0	12.0	18	5.0
VIII, 29	....do	5,593	9.30 p. m.	27—	4	9.30	16.0	11.5	23	4.5
	Mean	....	....	......	......	......	......	....	17.2	4.9

These differences are apparently largely due to mechanical impurities in the atmosphere, such as are washed away by every rain or snow-fall, and their importance can be seen from the fact that from observations on the Brocken it is proved that only one-third of the sunrises and sunsets can be clearly seen and these are pretty uniformly distributed through the year.

The ordinary observation of amount of cloudiness gives little or no idea of this obscuration of the solar rays; thus during the interval covered by the above observations the average cloudiness for all the above high stations was almost exactly the same as for the low station Giessen.

The thermal constant of vegetation must, of course, begin at some epoch uniform for all plants. Hoffmann confines himself to plants with closed winter buds and takes the time of first swelling of the buds as the date for which to begin the summation of temperature.

In order to ascertain this movement he paints in black a broad line on one side of the trees and daily observes with a lens until he discerns white lines breaking open in the blackened portion; he finds that the dates can be thus ascertained to within one day when the temperature rapidly increases, but to only within a week when the temperature increases slowly and regularly. (*Z. O. G. M.*, XVII, p. 30.)

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CONTENTS.

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2. Ueber die geographische Vertheilung und säculare Aenderung der Declination und Inclination im europäischen Russland. A. von Tillo. pp. 82, ch. 4.
3. Ueber die Abhängigkeit der Verdunstung des Wassers von der Temperatur desselben und von der Feuchtigkeit und Bewegung der Luft. E. Stelling. pp. 49.
4. Ueber Fluth und Ebbe in St. Petersburg. J. Amelung. pp. 14, ch. 1.
5. Le flux et reflux de l'atmosphère d'après les observations anémométriques faites à l'Observatoire physique central de St.-Pétersbourg. M. Rykatschew. pp. 8, pl. 1.
6. Vertheilung der Nebel über der Ostsee nach Jahreszeiten. N. Paromenskij. pp. 17, ch. 1.
7. Bestimmungen der Horizontal-Intensität des Erdmagnetismus. pp. 81.
8. Ueber die Fluth und Ebbe in der Atmosphäre nach den Anemographen-Aufzeichnungen des physikalischen Central-Observatoriums in St. Petersburg. A. Belikow. pp. 6, ch. 1.
9. Die Cyclonenbahnen in Russland, 1878–1880. E. Leyst. pp. 28, ch. 12.
10. Jahresbericht des physikalischen Central-Observatoriums für 1881 u. 1882. H. Wild. pp. 102.

KLEINERE MITTHEILUNGEN.

1. Die niedrige Temperatur des Octobers, 1881. E. Leyst. p. 1.
2. Ueber die Bestimmung der absoluten Grösse der Verdunstung von einer freien Wasserfläche nach den Beobachtungen im Observatorium zu Powlowsk. E. Stelling. pp. 10.
3. Regen im Juli 1882. E. Leyst. pp. 20.
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PHYSICS.

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GENERAL.

The progress of physical science for the year 1883 has been very considerable, especially in the department of electricity. This advance, however, has been made chiefly in the applications of known electrical principles, rather than in the discovery of new ones.

In a lecture before the Royal Institution, Sir William Thomson has discussed the "size of atoms," using the terms atom and molecule synonymously. He takes the broad view that matter, though we may conceive it to be infinitely divisible, is not infinitely divisible without decomposition; and hence that the question whether we can divide a piece of glass into pieces smaller than the 1–100,000 of a centimeter in diameter, and so on, without breaking it up and making it cease to have the properties of glass, just as a brick has not the properties of a brick wall, is a very practical one. As the result of four independent lines of argument, the molecules of ordinary matter would seem to be from the 1–10,000,000 to the 1–100,000,000 of a centimeter in diameter. These four lines of reasoning are founded respectively on the undulatory theory of light, on the phenomena of contact electricity, on capillary attraction, and on the kinetic theory of gases, the lecture being devoted to their development. (*Nature*, June, July, 1883, XXVIII, 203, 250, 274.)

Reinold and Rücker have communicated to the Royal Society the results of their investigation of liquid films, measuring the thickness of such films when so thin as to exhibit the black of the first order of Newton's rings. They used two methods for this purpose; one, based on a determination of the electrical resistance of a cylindrical black soap-film, the thickness being calculated by means of Ohm's law; and the other an optical method, depending upon the displacement of interference fringes when one of the interfering beams traversed several films which were afterward broken. The mean of the electrical measurements gave a thickness of 11.8×10^{-6} millimeters; that of the optical method, one of 11.4×10^{-6} millimeters. These results are of interest in connection with Sir William Thomson's lecture noted above. If, as he states, the size of the molecules of this liquid is between 2×10^{-8} and 1×10^{-8} millimeters, it follows that the thinnest film measured by the authors, 7.2×10^{-6} millimeters, must contain not less than 3 nor more than 720 molecules in its thickness. As to the surface tension in Plateau's glyceric liquid, the authors give it as about 57 dynes per linear centimeter. Assuming that the thinnest film measured had for its thickness twice the radius of molecular attraction, the average stress parallel to the surface must be 1.6×10^{8} dynes per square centimeter, or eight times greater than is required to tear brick asunder. If this radius is the same for all substances, the stress in the surface of mercury in contact with air must be nearly ten times greater than in the glyceric liquid, or one-fifth of the tension required to rupture steel bars. (*Nature*, June, August, 1883, XXVIII, 142, 389.)

The Adams prize essay of the University of Cambridge for the year 1882, on the subject of the motion of vortex rings, written by J. J. Thomson, has been published. It continues the work already done in this direction by von Helmholtz and Sir William Thomson, and carries the theory of vortex atoms to such a stage that in certain general respects it may be applied to the theory of gases. Indeed, the author concludes that the accurate observation of the phenomena of thermal effusion will enable a decision to be reached between the vortex atom theory and the ordinary kinetic theory of gases. (*Nature*, December, 1883, XXIX, 193.)

The meaning of the word "force" continues to be the subject of discussion. Lamb suggests that the true and proper basis of statics is to be sought for in the principles of linear and angular momentum. Two forces are equivalent only when they produce the same rate of change of momentum in any assigned direction, and the same rate of change of moment of momentum about any assigned axis. Two sets of forces are in equilibrium when they produce no effect on either the linear or the angular momentum of any system. Close points out the necessity of a more careful distinction between force proper—the time-rate of change of momentum or the space-rate of change of energy—and what he calls impulsion; the former being represented by F and the latter by $\int F\,dt$; or, assuming F constant, by Ft. Tait, in a paper on the laws of motion presented to the Royal Society of Edinburgh, maintains that force, being simply the time-rate of change of momentum, has no real or objective existence whatever, matter and energy alone being the only objective realities. (*Phil. Mag.*, March, April, November, December, 1883, V, XV, 187, 248; XVI, 387, 439.)

Smith has suggested a modification of the ordinary ergometer (dynamometer). It consists of a hollow shaft carrying three pulleys; one of these is loose, one is fast to the shaft, and the third is geared to the second by three miter-wheels. The two of these whose axes are perpendicular to the shaft, carry pulleys, on each of which winds a cord attached to a cross-bar, fastened at its middle point to a spiral spring within the shaft. If the second and third main pulleys do not move together, the cross-head is moved forward, stretching the spring and moving an index attached to a rod running through the shaft. To this rod any suitable integrator may be attached. Subsequently, Smith has proposed to show by inspection the rate at which energy is being transmitted, by means of two cross-wires perpendicular to each other, one of which, moving horizontally, indicates the tension on the belt in pounds, while the other, moving vertically, shows the velocity at any instant, in feet per second. The point of intersection of these wires would represent, on a suitable scale, the number of foot-pounds which is being transmitted per second. (*Phil. Mag.*, February, June, 1883, xv, 87, 434.)

Paquet has devised a simple apparatus for illustrating the laws of free fall under the action of gravity. Two weights are allowed to fall freely between vertical wires. One of these, being started first, falls for a time *t* and then reaches and releases the second. A stage, as much below the second weight as this is below the starting point of the first, arrests this second weight after a second time *t*. If now a second stage be so adjusted as to stop the first weight at the same instant, it will be found that this weight has fallen exactly 4 times as far in 2 seconds as the first has in 1. If the stage be placed below the second weight at one-quarter of the distance which this weight is below the first, and this experiment is repeated, it will be seen that in thrice the time the first weight has fallen over 9 times the distance. (*Jour. Phys.*, May, 1883, II, II, 226.)

Béquié has suggested placing a metallic point on the axis of the pulley of the Atwood machine, so that at each revolution it should touch a mercury surface and close the circuit of a Morse register, thus recording the velocities. (*Jour. Phys.*, July, 1883; II, II, 323.)

Gilbert has described a modification of Foucault's gyroscope for showing the earth's rotation. It consists, like the gyroscope, of a heavy revolving disk mounted in a frame. But the frame is supported on delicate knife-edges, the axis of rotation being vertical, and the whole is adjusted so that the center of gravity is on the axis of suspension. By means of a small weight, movable in the prolongation of the axis of the disk, the center of gravity could be lowered slightly so as to oscillate like a pendulum about the knife-edges. If now the disk be revolved 150 to 200 times a second, and the frame be placed on the knife-edges, the line joining them being in the plane of the meridian, the axis of rotation is displaced from the vertical to one side or the other according to the direction of rotation. The results agree with theory. (*Jour. Phys.*, March, 1883, II, II, 101.)

Bosanquet has proposed a simple mode of dividing inch and meter scales. To the screw of his slide rest, the pitch of which was one-eighth of an inch, a micrometer head was attached having two rows of holes, one of 25 and the other of 127. On the former row, 20 holes correspond obviously to one-tenth of an inch, 4 to one-fiftieth, and 2 to one hundredth. On the latter, 40 holes give one millimeter, 4 holes one-tenth of a millimeter, &c. (*Phil. Mag.*, March, 1883, V, xv, 217.)

Extended descriptions have been published of the buildings and apparatus of the International Bureau of Weights and Measures, now located in the Park of St. Cloud, near Paris. This bureau was originated in 1875, and had for its object the securing of an accurate international metric system. Sixteen countries are represented in it and contributed a million francs toward its expenses. The apparatus employed is the most perfect attainable, and the measurements are made with the greatest possible accuracy. (*Nature*, September, 1883, XXVIII, 464, 592.)

The foot-measure in China varies largely with different trades and in different parts of the country. The carpenter's rule at Ningpo has a foot of less than 10 inches, while that of the junk-builders at Shanghai has a foot of nearly 16 inches. The standard foot of the Pekin Imperial Board of Works is 12½ inches. A copper foot-measure of the year A. D. 81 is 9½ inches. (*Nature*, June, 1883, XXVIII, 207.)

Tresca has communicated to the French Academy the results of his examination of two platinum meters which originally belonged to Prony and were used by him in the early part of the century, in connection with the labors of the first metric commission. Both are end meters, but one of them is also a line meter. One of the end meters is 13.98 microns shorter than the meter of the archives; the other end meter is 7.94 microns shorter, while the line meter upon the latter is 30.55 microns shorter. (*C. R.*, March, 1883, XCVI, 667.)

Terquem has described an improved cathetometer constructed for him by Dumoulin-Froment. Among other modifications, this instrument has only a single slide, the telescope being carried on a plate moving on the face of this slide by means of a micrometer screw. This very considerable improvement was used in cathetometers constructed by William Grunow, of New York, ten or twelve years ago. The reading is to 0.01 millimeter. (*J. Phys.*, November, 1883, II, II, 496.)

Rayleigh has suggested the use of an electro-magnetic damping apparatus to control the oscillations of a balance. Two magnets of steel wire 3 or 4 inches long are attached vertically to the scale-pans and underneath one of them is fixed a coil of insulated wire of, perhaps, fifty or one hundred turns and 4 or 5 inches in diameter, placed immediately under the balance case. On completing the circuit of a Lec'anche cell through the coil by means of a key, at suitable intervals, the beam may be brought to rest very promptly. He has also suggested quicker vibrating beams, the delicacy being restored by magnifying the displacement by means of a lens, the scale being illuminated if necessary. (*Nature*, November, 1883, XXIX, 91.)

MECHANICS.

1. *Of Solids.*

Kalischer has studied the molecular structure of metals by removing the surface by means of a suitable liquid. The crystalline structure is generally developed in this way; though sometimes an electrolytic current is necessary, the metal being made the positive electrode. It appears from these experiments that nearly all the metals have a crystalline structure, but that mechanical treatment in general causes this structure to disappear. Heat, however, causes a return to the crystalline condition. Hence the explanation of the increase of conducting power in metals by the process of annealing. (*J. Phys.*, June, 1883, II, II, 285.)

The publications of the Vega expedition contain a memoir by Petterson on the properties of water and ice, in which the discovery is announced that in the vicinity of the melting point the volume of ice decreases as the temperature rises. With the purest distilled water, the ice did not begin to contract till the temperature rose to $-0.03°$ C. With ice made from water from the laboratory stone jar, the contraction began at $-0.3°$ C. With sea-water of specific gravity of 1.0003, containing -0.014 per cent. of chlorine, the ice began to contract at $-4°$ C.; with that of 1.00534 gravity and 0.373 per cent. chlorine, the contraction began at $-14°$ C.; and with that of 1.0094 and 0.649 of chlorine, it began to contract at $-19°$ C. Moreover, the author finds that sea-water ice contains more sulphates, the brine more chlorides, than the sea-water itself. (*Nature*, August, 1883, XXVIII, 417.)

2. *Of Liquids.*

The experiments upon the compressibility of liquids thus far made go to show that water is an exception to the general law that the coefficient of compressibility increases with the temperature. The most accurate of these experiments, however, those of Grassi, were made at temperatures below 53°.3 C. Pagliani and Vicentini have repeated these experiments, using distilled and recently boiled water, and extending the temperature to 100°. They have reached the interesting result that between 0° and 55° the coefficient decreases as the temperature rises, as Grassi had observed; but that between 55° and 100°, it increases with the temperature, like that of other liquids. Hence a temperature exists for which the compressibility has a maximum value. (*J. Phys.*, October, 1883, II, II, 461.)

Volkmann draws the following conclusions from his experiments on the cohesion of saline solutions: (1) The cohesion, or the superficial tension, is modified only very slightly by traces of impurities; (2) the specific cohesion of a saline solution diminishes generally as the amount of the salt present increases, the capillary constant proportionally increasing;

(3) if the salts be grouped according to their formulas, the cohesion for any group increases as the molecular weight diminishes; and (4) when the cohesion of saline solutions is known, that of water being also known, and the adhesion of water and the anhydrous salt, the cohesion of the anhydrous salt may be calculated. When the adhesion between the anhydrous salt and water is less than half the sum of the cohesions of the water and the anhydrous salt respectively, the solid body cannot be mixed with water in all proportions. (*Wied. Ann.*, XVII, 353; *J. Phys.*, April, 1883, II, II, 188.)

Krouchkoll, finding that insulating liquids, such as carbon disulphide, ether, turpentine, not miscible with water, acquire by contact with this liquid very decided conducting power, was led to examine the question whether the capillary constant at the surface of such a liquid and water did not vary under the action of an electro-motive force. The results show that the constant does vary, and in the same direction as that of the water-mercury surface. The higher the resistance of the liquid, the greater the electro-motive force required to obtain the result. (*C. R.*, June, 1883, XCVI, 1725.)

Pribram and Handl have reached the following conclusions with reference to the specific viscosity of liquids in relation to their chemical constitution: (1) Of two isomeric ethers, whose isomerism consists in a simple exchange of acid and alcoholic radical, that possesses the highest viscosity whose alcohol radical is highest in the series; (2) the differences in the viscosity for equal volumes vary as the difference of the molecular weights of the radicals which the ethers contain; (3) when the isomerism consists in the arrangement of the atoms within the radical, then that ether which contains the normal arrangement has always the greatest viscosity, whether the normal radical be oxygenated or not; (4) in aldehydes, propylic alcohols, nitropropanes, butyric acids, and butyl iodides, those having the normal grouping show the maximum viscosity, while for the halogen ethers of propyl, butyl alcohol, and nitrobutane the reverse is the case; (5) the halogen compounds of propyl and allyl, as well as the acetates, show nearly equal viscosities; while in the alcohols which differ by two atoms of hydrogen only, the viscosity of allylic alcohol is considerably less than that of propylic; (6) aldehyde, which has two atoms of hydrogen less than alcohol, shows a marked diminution of viscosity; and (7) the increase of viscosity is in general proportional to the increase of molecular weight; the coefficient of increase, however, depending on the structure of the molecule, is constant only when the terms of the homologous series, considered as binary compounds, contain a constant compound and a single variable. (*J. Phys.*, March, 1883, II, II, 141.)

Warburg and Babo have sought to determine the relation between viscosity and density in fluids. According to the law of Maxwell the viscosity of a gas measured by the coefficient of friction is independent of the density. Experiments were made with carbon dioxide both in the liquid and the gaseous condition under pressures up to 120 atmospheres, the viscosity being measured by the velocity of flow through capillary tubes. The gas above the critical temperature showed no minimum of viscosity at the maximum of compressibility, but, on the contrary, the viscosity increased with the density. When the density, however, reached 500 times its normal value, the coefficient of friction exceeded its normal value only 9 per cent. With a constant density the influence of temperature is feeble, though the viscosity appears to increase slowly with the temperature. The liquid has the smallest viscosity hitherto observed, its coefficient at 15° being 14.6 times less than that of water, and increasing with the density. For densities near 0.8, the viscosity has a minimum value for the temperature of 20° to 32°.6. (*J. Phys.*, March, 1883, II, II, 142.)

Stables and Wilson have tested experimentally the supposition of Plateau that the surface viscosity in some liquids is greater than the interior viscoscity. They used for the purpose a solution of saponin, in which this property is marked, determining the viscosity by the torsional oscillation of a nickel-plated brass disk. The results obtained show that whereas the resistance offered to an oscillating disk 2^{mm} thick in the surface of water is only about half what it is in the interior, at the surface of a 2 per cent. saponin solution it is at least 600 times greater than in the interior. The ratio of resistances in the case of the saponin solution and water is at the surface, 1261; at $0^{mm}.1$ below the surface, 33; while in the interior it is 1.2. (*Phil Mag.*, June, 1883, V, XV, 406.)

Wiedemann has examined the question of the condensation of liquids upon solid surfaces, and comes to the conclusion that it is an entirely inappreciable quantity. (*Wied. Ann.*, XVII, 988; *J. Phys.*, II, II, 232; *Phil. Mag.* June, 1883, V, XV, 440.)

Solution is ordinarily explained by supposing that the salt combines first with a portion of water to form a hydrate more or less stable, and then that this hydrate diffuses through the mass forming a homogeneous mixture. Nicol has suggested the hypothesis that "the solution of a salt in water is a consequence of the attraction of the molecules of water for a molecule of salt exceeding the attraction of the molecules of salt for one another." As the number of dissolved salt molecules increases, the attraction of the dissimilar molecules is more and more balanced by the attraction of the similar molecules; and when these two forces are in equilibrium saturation takes place. The author gives experimental proof of the correctness of this hypothesis. (*Phil Mag.*, February, 1883, V, XV, 91.)

Gernez has measured the duration of solidification in the case of surfused bodies. Using phosphorus, for example, in a glass tube not exceeding $2^{mm}.7$ in diameter, bent in a U form, the column being 6 or 7 decimeters long, the whole was placed in a water bath at a temperature above the fusing point. It was then transferred to a water bath maintained at a constant temperature below the fusing point. After an hour solidification was induced by contact with a fragment of solid phosphorus, the time being chronographically recorded. The progress of the solidification is readily observed, the colorless and transparent liquid becoming opaque. At the instant the opacity reaches the end of the column another chronographic record is made. Where the solidification is very rapid a tuning-fork chronograph is necessary. The author finds, (1) that the duration of solidification is uniform for equal lengths of column; (2) that the velocity of solidification is independent of the temperature at which the phosphorus has been melted; and (3) that this velocity increases from $1^{mm}.6$ per second at 43°.8, to $353^{mm}.35$. per second at 36°, and $1030^{mm}.7$ at 24°.9. (*Jour. Phys.*, April, 1883, II, II, 159.)

Wiedemann has modified the ordinary pyknometer by attaching to it by a ground joint a tube with a lateral funnel for attaching it to a mercury pump. After weighing the bottle and the stopper separately they are put together, connected with the exhaust tube, exhausted, filled with water from the funnel, freshly boiled, and weighed. The powder is then introduced and the operation is repeated. The results agree to the third decimal place. (*Wied. Ann.*, XVII, 983; *Phil. Mag.*, May, 1883, V, XV, 369.)

Decharme has continued his hydrodynamic experiments, and has succeeded in imitating by means of liquid or gaseous currents various physical effects produced by electricity or magnetism; such, for example, as Nobili's rings, magnetic spectra, stratification of the electric discharge, projection of a metallic wire volatilized by an electric discharge, Lichtenberg's figures, &c. He observes that aspiration corresponds to positive electrification in its effects, and a blast to negative. (*Ann. Chim. Phys.*, February, July, 1883, V, XXVIII, 198; XXIX, 404.)

Pfaundler has observed the explosion of a glass tube filled with liquid carbon dioxide, the lower portion of which was immersed in a mixture of solid CO_2 and ether, and contained crystallized CO_2. The tube had frequently been exposed to a temperature of 31°. It is supposed that the tube had been made brittle by the low temperature, though Daguenet thinks it more probable that the expansion of the solid crystalline mass fractured the tube. Pfaundler has called attention also to the explosion of a zinc gasometer which had contained oxygen for six months, when a lighted taper was used to test the gas. It is supposed that the water in the tank had absorbed acid vapor from the laboratory, and that these acted on the zinc, generating hydrogen within the gasometer. (*Wied. Ann.*, XVII, 170, 175; *J. Phys.*, April, 1883, II, II, 191.)

3. *Of Gases.*

Terquem demonstrates the law of Archimedes for gases by suspending a glass balloon in a bell jar by means of a silk filament passing through the neck, the balloon being supported on one arm of a hydrostatic balance. On passing into the bell jar a current of dry air, and adjusting to zero by a suitable tare, the apparatus is ready for experiment. On introducing a current of dry hydrogen the balloon rises and the weights are adjusted nearly to equilibrium. The current of gas is then arrested and the exact balance obtained. The hydrogen is then replaced by illuminating gas and the experiment repeated. A third experiment is made with dry carbon dioxide. From the data thus obtained the density of the coal gas is calculated. (*Jour. Phys.*, January, 1883, II, II, 29.)

Cooke has proposed a simple method of calculating the correction required for the buoyancy of the atmosphere when the volume of the body weighed is unknown. If 30 inches be assumed as the barometric standard, a variation of 0.1 inch will affect the buoyancy by one three-hundredth. Again, assuming 27° C. as the temperature standard, which is 300° on the absolute scale, a variation of one degree will also affect the buoyancy by one three-hundredth; *i. e.*, one degree variation in temperature produces the same effect on the buoyancy as a change of 0.1 inch in the pressure. The correction for temperature, which is the more important of the two, is effected by simply adding to the observed height of the barometer, given in tenths of an inch, the difference between 27° C. and the observed temperature. By means of a few weighings, taken under as great a variation of temperature and pressure as possible, the quotient of the difference in weight by the corrected barometer difference gives the difference in weight corresponding to one tenth of an inch difference in pressure. By multiplying now the difference between 300 and the corrected barometric heights by the constant thus obtained, and adding or subtracting this product, as the case may be, to or from the observed weights, the weighings are all reduced to the standard of 30 inches. (*Am. J. Sci.*, July, 1883, III, XXVI, 38.)

Edelmann proposes to determine the relative density of two gases by causing two columns of these gases of the same height to act on an elastic membrane, the displacement of which is very accurately measured. The membrane employed is like that used in an aneroid barometer, mounted on a metallic box 30 centimeters in diameter, the two sides of the box communicating with vertical tubes about 2 meters long, containing the gases. The movement of the membrane operates a lever carrying a mirror, by the aid of which, with a telescope and scale, very slight displacements may be read. In the author's apparatus one-tenth of a millimeter on the scale corresponds to less than one millionth of an atmosphere in the box. (*Carl. Rep.*, XVII; *J. Phys.*, June, 1883, II, II, 285.)

Amagat has published four memoirs upon the compressibility of gases. In the first he considers certain objections raised against his apparatus or method; in the second he treats of the compressibility of air and of carbon dioxide from one to eight atmospheres pressure and from 20° to 300° C.; in the third the compressibility of rarefied air, hydrogen, and carbon dioxide is considered; and the fourth is on a new form of the relation $f(vpt)=0$ in gases, and on the law of expansion of gases at constant volume. (*Ann. Chim. Phys.*, April, 1883, V, XXVIII, 456, 464, 480, 500.)

Vernon Harcourt has devised an instrument for giving by simple inspection the volume of a mass of air which, saturated with humidity, is capable of occupying unit volume under normal conditions. By dividing the volume of a gas by the indications of the instrument it is reduced to the normal standard. The author has given to the apparatus the name of aerorthometer. (*Proc. Roy. Soc.*, XXXIV, 166; *J. Phys.*, August, 1883, II, II, 374.)

Waitz has studied the law of the diffusion of gases by means of optical methods of great delicacy. Carbon dioxide and air were used in the experiments, the progress of the diffusion being shown by a continuous displacement of the interference fringes. From this displacement the composition of the mixture could be deduced at each instant, and hence the coefficient of diffusion. The author concludes (1) that this coefficient at the same depth depends upon the partial pressure of the carbon dioxide, and (2) that it may be considered a linear function of the depth; consequently the theory of Maxwell cannot be exact, since it leads to a constant value of this coefficient. The same is true of Stephan's formula. Meyer's formula, in which this coefficient decreases indefinitely with the partial pressure of the carbon dioxide, is also inexact. (*Wied. Ann.*, XVII, 201; *J. Phys.*, April, 1883, II, II, 190.)

Mascart has completed the details of construction of his gravity barometer. It now consists of a modified siphon barometer, the lower reservoir being closed, and containing nitrogen under a pressure which sustains a column of mercury a meter high in the tube. To make an observation the barometer is placed in a tin cylinder filled with water and the temperature carefully noted. The upper end of the tube projects above the liquid and the level of the mercury is then read off. Experiments have been made with the new instrument at Hamburg, Stockholm, Drontheim, and Tromsö, as well as at Paris. (*Jour. Phys.*, August, 1883, II, II, 341.)

Dufour and Amstein have described a new registering barometer installed in the Meteorological Observatory of Lausanne. It consists of a glass tube 6 mm. in interior diameter, bent four times at right angles in the same plane, twice at each end, so that the ends project vertically. This tube is suspended by its middle point. As the pressure varies, the center of gravity also varies, and the tube rotates about the point of suspension. A style attached to the lower part of the tube is thus displaced horizontally and records its motions upon a strip of moving paper. It has performed satisfactorily for two years. (*Jour. Phys.*, August, 1883, II, II, 375.)

Teissier has suggested the use of the air-pump for filling vessels terminating in capillary tubes, such as specific-gravity flasks, thermometers, and the like, and has given a description of the apparatus used. (*Jour. Phys.*, October, 1883, II, II, 463.)

Various modifications in the mercury air-pump have been suggested. Among these is that of Karavodine, who modifies Töpler's form of pump by causing the upper reservoir to open into the discharge pipe by a straight instead of a recurved tube. He has also added a valve in the exhaust tube to prevent the mercury from passing into the desiccator or into the vessel to be exhausted. A double-acting mercury pump has been devised by Serravalle. Two similar vessels, containing mercury and connected by a long caoutchouc tube, are raised and lowered alternately with each other on opposite sides of a vertical support. Each vessel has a three-way cock at its top; one opening in a certain position conducts off the excess of mercury, while a second communicates through a rubber tube with a spherical piece fixed laterally near the middle of the vertical support. This spherical piece has three communicating ports, two of them opposite leading into the mercury vessels; the third is connected to the vessel to be exhausted. The three-way cocks at the tops of the vessels are mechanically turned at the upper and lower ends of their course by means of a toothed sector and rack in the one case and a pin and projecting piece in the other. (*Jour. Phys.*, December, 1883, II, II, 558; *Nature*, February, 1883, XXVII, 324.)

ACOUSTICS.

Auerbach has experimented to determine the influence exerted by liquids upon the pitch of the sound given by the cylindrical glass vessels in which they are contained. The number of vibrations was determined on a monochord. In the first experiments, which were made with water, there was always a lowering of the sound produced. He calls geometric fall the ratio of the number of vibrations given by the empty vase to the number given when it is full, and arithmetric fall the ratio of the difference of these two numbers of vibrations to that of the empty vase. He finds that the former of these values, in the case of a vessel filled with liquid, is as much smaller as the sound is more acute, is sensibly independent of the height of the vessel, and is inversely as the diameter of the vessel. The latter varies inversely as the square root of the number of vibrations given by the empty vessel and as the square root of the diameter of the vessel. Relative to the wave-length of the sound given by the empty vessel, the arithmetric fall depends only on the number of wave-lengths contained in the radius of the cylinder, and is inversely proportional to the square root of this number. The fall of pitch depends also on the height of the liquid when the vessel is not full, but is not proportional to it. To produce a pitch one-half less than that given by the full vessel the column of liquid must be from two-thirds to three-fourths of the total height. For other liquids than water Auerbach finds that the specific fall of pitch increases with the density, though less rapidly, and varies inversely as the compressibility. (*Wied. Ann.*, XVII, 964; *J. Phys.*, September, 1883, II, II, 422.)

Wead, in a valuable memoir on the energy and coefficient of damping of a tuning-fork, intended as the first part of a research on the intensity of sound viewed from the standpoint of energy, has discussed the theory of the subject and compared the results with those obtained from direct experiment. The forks used were Koenig's, and the energy in both prongs, when z is the amplitude, expressed in divisions of a micrometer, 220 of which were equal to 1 centimeter, was found to be as follows: For the Ut_2 fork, $z \times 450$ ergs; Ut_3, $z \times 1{,}235$ ergs; Mi_3, 1,820; Sol_3, 2,250; Ut_4, 3,860; Sol_4, 7,500; Ut_5, 12,670 ergs. From the time required by the fork to decrease the amplitude of its vibration by a known quantity, the coefficient of damping was calculated. The forks were then taken out of doors and the amplitude observed at the instant a distant listener indicated that the sound ceased, the object being to determine how much energy was needed to cause sensation; *i. e.*, how much energy passed through one square centimeter at the limit of hearing. For the Ut_3 fork this was found to be, at 200 feet, 280×10^{-8}, and at 300 feet, 310×10^{-8}; for the Sol_3 fork at 200 feet, 260×10^{-8}; for the Ut_4 fork, 110×10^{-8}; and for the Ut_5 fork, 710×10^{-8}. The energy of a fork is dissipated (1) in heating itself and the resonance box (2) in causing its support to vibrate and (3) in producing a sound wave. Some experiments to determine the relative energy so distributed showed that only about one-fifteenth of the total energy is used for the sound wave. (*Am. J. Sci.*, September, 1883, III, XXVI, 177.)

Dvorak has continued his investigations upon the attractions and repulsions produced in the vicinity of vibrating bodies. He shows from theory that the mean pressure in the vicinity of the nodes is superior to that at the loops, a result which he has confirmed by experiment. By this excess of pressure on the base of the resonnators the author explains the repulsion of these by sonorous bodies. He has described some new rotation apparatus, more perfect than that used hitherto. For obtaining the best result it is necessary that the vibrations should be energetic, and to secure this the walls of the resonance box should vibrate in unison with the fork mounted upon it. A form of torsion balance, with bifilar suspension, by which, on this principle, the intensity of the air vibrations may be measured, is described in the paper. (*J. Phys.*, October, 1883, II, II, 465.)

Neyreneuf, by means of a special apparatus, has studied the capability of various gases for transmitting sound. A tube of iron, 2 meters long and 5 centimeters diameter, the ends closed by suitable membranes, is passed through the wall separating two rooms. In one of these is the sonorous body and in the other the sensitive flame. The gas is introduced by lateral tubulures. The sensitive flame remains fixed in position and the tube is moved until the effect on the flame is zero. The results show that air and carbon monoxide have appreciably the same power of transmitting sound. With coal gas the results were quite variable. With carbon dioxide the experiments show that it possesses a much more considerable transmitting power for sound than air, the ratio of distances of the flame being in the two cases 1.32 : 1. The mean of the intensities is 1.7459, which is $(1.529)^{\frac{4}{3}}$. (*Comptes Rendus*, April, 1883, XCVI, 1314.)

Blaikley has presented a paper to the London Physical Society on the velocity of sound in air, using for his measurements a modification of Dulong's method by means of the wave-length in a lengthened organ pipe. The author allows for the harmonics of the pipe, which are an important factor. With four tubes he obtained the following mean results: 1st, diameter 54.1 mm., velocity 329.73 meters per second; 2d, diameter 32.5 mm., velocity 328.78 meters; 3d, 19.5 mm., 326.9 meters; and 4th, 11.7 mm., 324.56 meters. The mean velocity for all his experiments was about 320 meters. (*Nature*, November, 1883, XXIX, 71.)

Griveaux has contrived a differential apparatus for determining the relative velocity of sound in solids and in gases. It consists of a tube of glass and a rod of wood of the same length, whose ends, by means of lightly balanced levers, are adjusted to keep closed the two circuits of a differential galvanometer, the currents in which are equal and the needle, therefore, at zero. If, now, a drum be struck opposite the free ends of this rod and tube, the sound will be unequally transmitted, and the galvanometer needle will be displaced in the same direction as when the circuit is opened at the end of the wooden rod. By using the Wheatstone bridge arrangement a galvanometer with a single wire may be used in this experiment. (*J. Phys.*, May, 1883, II, II, 228.)

Boltzmann has succeeded in photographing sonorous vibrations directly. A thin plate of iron, covering a capsule containing air, is the vibrating body. To its center is attached a very thin strip of platinum, perpendicular to its plane and vibrating with it. This strip is strongly illuminated by sunlight, and its image may be formed on the screen by a microscopic objective. The linear image falling on a cylindrical lens is transformed into a point, which is allowed to fall on a revolving cylinder covered with sensitive photographic paper. On speaking before the vibrating plate the shadow is displaced and a sinuous line is produced on the paper. The vowels give either a simple sinusoid or a combination of two sinusoids. The consonant curves resemble somewhat Koenig's figures, given by the letter *r*. (*Ber. Ak. Wien*, 1882, 242; *J. Phys.*, April, 1883, II, II, 195.)

An improved apparatus for projecting acoustic vibrations has been described by Rigollot and Chavanon, under the name of a palmoptic capsule. It consists of a hollow paraboloid, over the mouth of which a collodion membrane is stretched. In front of this membrane is a platinum wire, serving as an axis, on which is a mirror, its plane parallel to that of the membrane. This mirror rests on the end of a small rubber prism attached to the membrane, so that when the latter vibrates the mirror oscillates about the wire as a diameter. By means of a rubber tube the interior of the paraboloid is put in communication with any sounding mass of air, and the vibration of the mirror causes a beam of sunlight reflected from it to describe a line on the screen, which may be drawn out into curves by a second mirror vibrating perpendicularly. (*J. Phys.*, December, 1883, II, II, 553.)

Michelson has described a method of ascertaining with any desired accuracy the rate of a tuning-fork. The method consists, first, in determining the rate in terms of an electrically vibrated fork, and, second, in fixing the absolute rate of this second fork. The electric fork carries a mirror on one prong, in which the reflection of a Geissler tube is seen when illuminated once a second by means of a pendulum. If the fork makes an exact number of vibrations per second the illumination of the tube, finding the fork always in the same place, will appear always in the same position. But if the fork makes more or less than this by any fraction, the position of the flash will successively change, passing through all its phases in one complete period. If a flashes take place in one period in the case of an Ut_2 fork, it makes obviously $128 \pm \frac{1}{a}$ vibrations per second. By using the fork to be rated with a microscope, with cross-hairs focused on one edge of the fork, the Geissler tube being behind it, the use of an electrical fork may be dispensed with. (*Am. J. Sci.*, January, 1883, III, XXV, 61; *Phil. Mag.*, February, 1883, V, XV, 84.)

The attention of the Berlin Physical Society has been called by Christiani to certain peculiarities observed with Koenig tuning-forks injured by the fire in the Physiological Institute. When the rust had been removed, and new resonance boxes provided, one of the Mi_3 forks showed, after tuning and sounding, a maximum of tone when one side of it was turned toward the closed end of the case. Another Mi_3 fork, though in unison with the first, did not present the phenomenon, though when the cases were exchanged it appeared, showing that the new case produced the effect. Another experiment was made to show total absorption of tone. A singing flame tuned approximately to Mi_3 was unaffected when the resonance case bearing the Mi_3 fork was held near it with its open end horizontal. When, however, the same case without its fork was brought to the same position the sound immediately ceased. (*Nature*, January, 1883, XXVII, 236.)

Francis Galton has improved the whistles which he contrived in 1876 for testing the upper limits of the power of hearing very shrill notes by different men and animals, by using hydrogen in place of air to produce the sound. Since this gas is about thirteen times as light as air, the number of vibrations per second would thus be increased nearly four times. The whistles were made with a movable piston, by which the pitch could be varied; but since to give its proper note the depth of the cylinder should be 1.5 times its diameter, it follows that the diameter of a whistle giving 24,000 vibrations, and whose depth is only 0.14 inch, must be very small. The first experiments were made with coal gas. A whistle whose bore was 0.04 inch in diameter was attached to a gas-jet by a rubber tube, and the piston adjusted. When its length was 0.13 inch no sound could be perceived. On suddenly squeezing the tube filled with air at 0.14, a faint musical note could be heard, which became purely musical at 0.25 inch. When the gas was allowed to fill the tube, and it was again squeezed, it gave the same barely perceptible sound as with air at 0.14. By the use of hydrogen this little whistle would give at 0.14 about 83,000 vibrations per second. (*Nature*, March, 1883, XXVII, 491.)

Pauchon has experimented to determine whether the upper limit of the perceptibility of sounds varies for the same ear with the intensity of the sound. A powerful Caignard-Latour siren, driven by steam, was used to produce the sound. He finds that when the pressure varies from 0.5 to 1.5 atmospheres the limit of perceptibility varies from 48,000 to 60,000 simple vibrations. With a pressure of 2.5 atmospheres the disk rotates 600 times a second, giving 72,000 vibrations, the maximum limit reached. These experiments were repeated, using metal rods made to vibrate longitudinally by friction with a resined cloth; but the minute variations of length could not be measured with sufficient accuracy. When the sound ceases to the ear it still acts on a sensitive flame. (*C. R.*, April, 1883, XCVI, 1041; *Phil. Mag.*, May, 1883, V, XV, 371.)

Krebs has studied the laws of the reciprocal excitation of elastic bodies tuned to nearly the same pitch. When the pitch of two forks or of two wires is exactly the same, one of these, as is well known, can excite the other. The author finds that if the pitch is not exactly the same in the two cases, the one having the lower tone can excite the other, but not the reverse, provided the difference is at least two or three vibrations, at most three or four. This result is well shown on a sonometer. In the case of tuning-forks the deeper-toned one can excite the other only if the difference in the number of vibrations does not exceed one. The experiment, however, is easily repeated. (*Wied. Ann.*, XIX, 935; *Phil. Mag.*, October, 1883, V, XVI, 318.)

Clarke has replied to the assertion of Chappell that those who propose to divide the octave into twelve equal semitones instead of equally tempered semitones, are deficient in musical ear, by showing that the term equally tempered semitone is inaccurate, since no one of the equal semitones on a piano thus tuned can be altered without making them unequal; that the moving of the note E ever so little from the value $2\frac{1}{3}$ introduces a greater error somewhere else; that unequal tempering is in use because all keys are not used equally often, the keys C, G, A, and F being fair, E, B flat, E flat tolerable, and the others very much worse than on an equal semitone piano. He concludes that the best plan of tuning a piano for vulgar music and vulgar players is that now in ordinary use by tuners and recommended by Chappell, but if the piano is to be used equally in all keys (or even frequently in four or five flats, five or six sharps) the best plan is to tune it in twelve mathematically equal semitones. (*Nature*, January, 1883, XXVII, 240.)

Huggins has communicated to the Royal Society a paper on the function of the sound-post of the violin, in which he comes to the conclusion that this sound-post is more than a prop, and that besides its other functions it does transmit vibrations to the back in addition to those which are conveyed through the sides. He has also investigated the proportional thickness of the strings in use as compared with that required by theory. (*Nature*, July, 1883, XXVIII, 259.)

HEAT.

1. *Production of Heat; Thermometry.*

Ancelin has patented the use of sodium acetate as a heating agent, the object being to use its latent heat of fusion, which is very high, for the purpose of giving out heat in the interior of railway carriages, etc. He finds that the heat given out by sodium acetate is four times greater than that given out by water. A railway warming pan, containing eleven liters of water, in passing from 80° C. to 40° evolves 440 calories, while the same pan, containing about 50 kilograms of sodium acetate, evolves in passing from 80° to 40° 1,731 calories. Moreover, the expenditure of heat required to reverse the operation is much less in the case of the acetate. To heat the pan of water, containing 11 liters, from 10° to 90° four times, 3,520 calories are required; while for the same volume of acetate only 1,987 calories are needed, a saving of 1,500 calories. Again, in the case of water at 90°, four heatings return only 1,760 calories, or 50 per cent., while in the case of the acetate the unutilized heat amounts only to 256 calories, or 12 per cent. of the quantity stored. The water cools much more rapidly. (*Nature*, February, 1883, XXVII, 344.)

Fischer has given the following values for the amounts of heat (calories) of water vapor (kilograms) and of carbon dioxide (cubic meters) given off in the various illuminating processes in ordinary use. These amounts are all calculated for a light of one hundred candles burning for one hour.

Illuminating processes.	Water vapor.	Carbon dioxide.	Heat.
Electric lamp (arc)	0	0	57–158
Electric lamp (incandescent)	0	0	290–536
Gas (Argand burner)	0.86	0.46	4860
Lamp, petroleum (flat flame)	0.80	0.95	7200
Lamp, colza oil	0.85	1.00	6800
Candle (paraffine)	0.99	1.22	9200
Candle (tallow)	1.05	1.45	9700

The hygienic superiority of the electric light is clearly shown by these figures. (*J. Soc. Tel. Eng.*, XII, 625; *Nature*, July, 1883, XXVIII, 281.)

Laurie has shown that if the atomic weights of the elements are taken as abscissas and their atomic heats of combination with chlorine as ordinates of a curve, the heats of combination will be seen to be a periodic function of the atomic weights. (*Phil. Mag.*, January, 1883, V, xv, 42.)

Crafts has made use of hydrogen in his thermometers, because of the facility of flowing most rapidly through capillary tubes. The volume of the reservoir is small, only from one to ten cubic centimeters. The instrument is used at constant volume, an electric contact between the mercury of the manometer and a platinum point being established when the gas reaches the fixed volume, thus exciting an electro-magnet and closing the manometer cock. (*J. Phys.*, September, 1883, II, II, 435.)

Dufour has contrived an ingenious form of differential thermometer, which is especially useful for purposes of demonstration. Two bulbs of 15 or 20 millimeters in diameter close the ends of a glass tube forming the segment of a circle. The tube contains a drop of mercury, and the whole is supported upon a knife edge, slightly above its center of gravity, the position of which may be altered by a counter-weight. An index passes vertically upward and moves over a graduated arc. When the two bulbs are of the same temperature, the system is horizontal and the index vertical. But if the temperature of one of the bulbs rises, the expansion of the air drives the mercury to one side and the tube inclines to one side. If one of the bulbs is blackened and the other gilded, the apparatus serves well for experiments on radiant heat, especially if a cone be employed to concentrate the heat upon the blackened bulb (*Jour. Phys.*, July, 1883, II, II, 321.)

Negretta and Zambra have adapted their inverting thermometer for recording variations of atmospheric temperature at any desired interval of time. Twelve such thermometers are arranged on a suitable frame, in connection with a clock, a galvanic battery, and a series of small electro-magnets, in such a way that at every hour the circuit is completed by the clock, thus releasing a detent and allowing one of the thermometers to reverse and record the temperature at that moment. In the present form of the apparatus, the twelve thermometers have been mounted to record hourly temperatures; but the period can obviously be lengthened or shortened indefinitely. The advantages claimed for the system are: 1st, the thermometers contain only mercury, without any alcohol or other liquid; 2d, they have neither indices nor springs, the column of mercury itself effecting the registrations; 3d, they may be carried in any position, and cannot be disarranged except by actual breakage; and, 4th, they will record exact temperature at any hour of the day or night. (*Nature*, July, 1883, XXVIII, 306.)

Nicol has described a form of constant-temperature bath, in which the extreme variation of temperature does not exceed 0.05°. The water in the bath is heated by the circulation of other water in a copper tube, which passes through the flame of a Bunsen burner, the supply of gas being controlled by a suitable thermometer placed in the liquid, being shut off by the rise of the mercury as the temperature rises. (*Phil. Mag.*, May, 1883, V, xv, 339.)

2. *Expansion and Change of State.*

Kapoustine has devised a simple method of showing the expansion of a solid bar. It is supported at its two ends, one end resting against a fixed point, and the other upon a sewing needle placed upon a horizontal plate of ground glass. When the bar expands by heat the needle rolls upon the glass, and a light wooden index fixed upon its point renders this rotation visible. Greater precision can be given by the use of a mirror. (*J. Soc. Phys. Chem. Russe*, XIV, 64; *J. Phys*, December, 1883, II, II, 576.)

In order to throw some light on the question whether a given bar can have differing lengths at the same temperature, Woodward, Wheeler, Flint, and Voigt have made a series of experiments with bars of various metals, measuring them at the temperature of melting ice. Seven bars were used—two meter bars of steel, two of glass, one of zinc, one of copper, and one of brass. The comparisons were made by means of micrometer-microscopes, magnifying about thirty diameters and reading to 92.1 and 95.3 microns, respectively, for each turn of the screw. They were mounted on an oak beam one meter apart, the whole being supported on stone piers. The bar to be compared is placed in a wooden box 1.1 by 0.1 by 0.1 meter, supported at one-fourth and three-fourths the length of the bar from either end. The box is filled with finely pounded ice, spaces being left near the graduations. Taking one of the steel bars as standard, several sets of comparisons are made with another bar. This latter is placed in water, which is gradually raised to boiling. It is then cooled gradually to the melting point of ice and a second set of comparisons made. The same bar is then cooled to $-6°$ or $-8°$ F., returned to the melting point of ice, and again compared. The zinc bar, raised to 208° F. and then cooled to the temperature of melting ice, was found to be 139 microns longer than before. Kept in melting ice for four days, it shortened 39 microns, leaving the final length still 90 microns shorter than the initial length. It was then cooled to $-8°$ F. in the open air and again brought to the temperature of melting ice. Its length had now diminished by 30 microns below that originally given. Kept in melting ice for a day and a half produced no change; but exposure to the temperature of the comparing room for one day increased its length permanently by 15 microns, leaving it still 15 microns too short at the temperature of melting ice. Exposed to an air temperature of 70° F. for four hours increased its length when cooled to the temperature of melting ice 26 microns, leaving its final length 11 microns greater than the initial. The zinc bar then having been subjected to a total range of 216° F. varied in its length at the temperature of melting ice 169 microns. No similar set was observed in the copper bar as compared with the steel, although the brass bar showed a difference of 3.8 microns and the glass ones 3.6 and 2.8 microns, respectively. The authors conclude, first, that zinc is not a reliable metal for one of the components of a metallic thermometer, much less for a standard of length; and, second, that bars of steel, copper, and brass are not likely to vary in length appreciably at any temperature within the range to which standards are ordinarily subjected. (*Am. J. Sci.*, June, 1883, III, XXV, 448.)

Wiedemann has measured the changes of volume which hydrated salts undergo by the action of heat, using for this purpose a dilatometer consisting of a bulb, in which is placed a known weight of the salt, terminated by a capillary tube. The bulb is exhausted of air and is then filled either with oil or with mercury, by the oscillations of which in the capillary tube the changes of volume are measured. The alums melt about 90°, remain surfused down to 60°, then undergo a modification, accompanied, in the case of potassium-aluminum and ammonium-iron alums, with a change of volume. Magnesium sulphate deposits at 93° crystals of $Mg\ SO_4\ (H_2O)_3$; zinc sulphate at 69° deposits $Zn\ SO_4\ (H_2O)_3$; iron sulphate gives at 65° $Fe\ SO_4\ (H_2O)_3$—all accompanied by a change in volume. (*Wied. Ann.*, XVII, 561; *J. Phys.*, August, 1883, II, II, 374.)

Mallard has made an elaborate study on the action of heat on crystals of boracite and of potassium sulphate. He has observed that the former, which are doubly refractive at ordinary temperatures and even when heated to 260°, becomes suddenly singly refractive at or about 261°, remaining so at higher temperatures. Crystals of potassium sulphate which are biaxial below 380° pass through intermediate stages and become uniaxial negative at 600° and above. Boracite crystallizes in rhombic dodecahedrons rigorously cubic; its double refraction is therefore anomalous. The author distinguishes between the crystalline form which is due to the symmetry of the molecules themselves and that which results from their arrangement in space, the reticular system. Hence he maintains that, while the reticular system of boracite is cubic, the molecular symmetry is orthorhombic. The results given above he regards as proof of his position. The reticular system of boracite is unaltered by the heat, being cubic at all temperatures. But the molecular symmetry changes from the orthorhombic at ordinary temperatures to the cubic at 261°; a change accompanied by an absorption of 5.74 calories for each unit of weight. So potassium sulphate, which is orthorhombic at the ordinary temperature, is hexagonal at 600° and above. The dimorphism here noted has a parallel in the well-known cases of niter and of sulphur. The former is orthorhombic and hexagonal, biaxial in the former, uniaxial in the latter, the former being the stable form below 339°, the latter above this point. Sulphur is orthorhombic and monoclinic. Toward 110° the former variety passes into the latter. The author concludes as follows: 1st, a perfectly cubic reticular system may be accompanied by an energetic double refraction;

consequently the double refraction depends, certainly in some cases and perhaps in all, on the modifications which the light undergoes in traversing the molecule. 2d, the action of heat on crystals may produce three distinct classes of phenomena: (1) the axis of the ellipsoid of elasticity may vary considerably in magnitude, these variations being due, as in the case of boracite, to a change in the form of the molecule; (2) the orientation of the molecules may vary suddenly, they being able to turn about their centers of gravity so as to take various positions compatible with their crystalline arrangement, which remains sensibly constant, or is altered only by the very secondary phenomena of expansion; (3) the action of heat may change suddenly either the symmetry of the molecule alone (boracite, potassium sulphate) or both this and the reticular system. In case (1) one form passes into the other suddenly at the same temperature, the two not coexisting together. In case (2) the change takes place at a fixed temperature only when the temperature is rising; when it falls a sort of crystalline surfusion takes place, the form belonging to the higher temperature existing at a lower but in an unstable condition. (*J. Phys.*, May, 1883, II, II, 201.)

Vieille has investigated the influence of cooling on the value of the maximum pressures developed in a closed vessel by exploding gases. If the results are plotted in a curve, using $\frac{S}{V}$, or the ratio of the surface of cooling to the volume of the gaseous mass, as abscissas and the corresponding pressures as ordinates, this curve will be independent of the nature of the walls of the vessel and of its capacity, and the point of intersection of this curve with the axis of ordinates will give the value of the pressure which the exploding gas would develop in an inclosure impermeable to heat. The curves obtained are divisible into two classes. The first, obtained with dissociable mixtures (CO and O, H and O), are concave toward the axis of abscissas and tend to cut the axis of ordinates at right angles. Extrapolation gives, then, a small correction and the limiting pressure is accurately determinable. The second, obtained by burning cyanogen and oxygen mixed with an inert gas, are convex toward the axis of abscissas, and rise sensibly toward the axis of ordinates. Hence the influence exerted by the unit of cooling surface upon the diminution of pressure increases with rise of temperature. The point at which the curve cuts the axis of ordinates is less well defined in this case. (*Comptes Rendus*, January, 1883, XCVI, 116.)

Guthrie has described to the London Physical Society an experiment which he had made on the theory of regelation. He modified Bottomley's well-known experiment of cutting through a block of ice with a metallic wire weighted at the ends, without separation of the fragments, by using a cord of silk of the same size as the wire and equally weighted. While the wire cut through the block the cord did not.

The explanation is that the ice in the former case was melted by the heat conducted from the air. (*Nature*, May, 1883, XXVIII, 47.)

Forel has sought to explain the granulation of glaciers by the alternate action of heat and cold to which they are annually subjected, without the intervention of any exterior pressure whatever. Hagenbach, on the contrary, suggests that if it is legitimate to suppose that the pressure required to lower the temperature of fusion by a definite amount, say 0.01°, is a function of its direction relative to the crystalline axis, *i. e.*, that it is less perpendicular to the optic axis than parallel to it, then it follows that two crystals of ice with their axes perpendicular would undergo fusion by pressure in different degrees, the water from the fusion of the one serving to increase the volume of the other. Hence he believes that pressure exerts the preponderating influence on the phenomenon, the variations of temperature playing only a secondary part. (*Arch. Genève*, VII, 329; VIII, 343; *J. Phys.*, August, 1883, II, II, 377.)

Crova has devised an improved form of condensation hygrometer, consisting of a thin brass tube, nickel-plated and carefully polished in its interior, closed at one end by a plate of ground glass and at the other by a lens of long focus. This tube is fixed in a closed rectangular metal box, furnished with two stop-cocks. This box is two-thirds filled with carbon disulphide and air is blown through it, producing cold by its evaporation. A gentle current of the air to be tested is drawn through the tube, and when dew appears on the polished surface the temperature is noted on a thermometer in contact with the tube. The cooling current is then stopped and the temperature again noted at the instant when the dew disappears. The author claims that the dew point may be determined to 0°.1. (*J. Phys.*, April, 1883, II, II, 166.)

In a subsequent paper, Crova gives the results of his experiments made to compare the accuracy of the above interior condensing hygrometer with the ordinary exterior condensing instrument and with the psychrometer. The maximum differences between the two former instruments were obtained when the relative humidity was low and the wind from north to northwest. The minimum differences were observed when the relative humidity was high and the wind from the south and slight. The psychrometer differed notably and in most cases arbitrarily from the other instruments. (*J. Phys.*, October, 1883, II, II, 450.)

According to Hutton's theory, rain is produced by the mixture of two masses of saturated air at different temperatures. Pernter has sought to test the theory by calculating the quantity of rain produced by mixing two given masses of air at given temperatures. He finds that to produce upon one square meter a rainfall of 1 millimeter it is necessary to mix in a very short time 685 cubic meters of saturated air, one-half of which is at 0° and the other at 25°, the pressure being 760^{mm} throughout the mass. If, therefore, any rain can be produced on Hutton's theory, such rainfall is very small. (*Jour. Phys.*, December, 1883, II, II, 561.)

Schwarz has improved Meyer's vapor density method by using an ordinary combustion furnace in place of the special furnace of the former. The substance is introduced into the heated combustion tube, which is slightly inclined backward for this purpose, and which has been previously filled with nitrogen. The vapor expels the nitrogen, which is collected over water and measured. As in Meyer's method, it is not necessary to know the temperature of the furnace. (*Ber. Berl. Chem. Ges.*, XVI, 1051; *Am. J. Sci.*, September, 1883, III, XXVI, 234.)

Pacinnotti has constructed a barometer containing water thoroughly deprived of air above the mercury. This water retains the liquid state even under a negative pressure. The mercury column stands at 903 millimeters above that in the reservoir, although the Fortin barometer shows a pressure of 760 millimeters only. The author gives several experiments which show the necessity of a free surface in order for evaporation to take place. (*J. Phys.*, November, 1883, II, II, 524.)

Wroblewski and Olzewski have succeeded in liquefying oxygen, nitrogen, and carbon monoxide gases, by using a modified Cailletet's apparatus, and employing the evaporation of liquefied ethylene to cool the gas to be condensed, by which a temperature of −136° C. was obtained. At this temperature a pressure of 20 atmospheres suffices to completely liquefy oxygen. It forms a colorless, transparent, very mobile liquid, with a well defined meniscus. Nitrogen and carbon monoxide are more difficult to liquefy. At the temperature of −136° and under a pressure of 150 atmospheres, the capillary tube shows no trace of liquid. If, however, the pressure be rapidly though progressively diminished, not allowing it to fall below 50 atmospheres, both gases liquefy, the meniscus being sharp and the liquids colorless and transparent. They evaporate readily at this pressure and temperature, so that to preserve them permanently a lower temperature is necessary. The temperatures were observed with a hydrogen thermometer, as this gas showed at −136° and under a pressure of 150 atmospheres no mist on sudden expansion. Carbon disulphide became solid at −116°, and liquefied again at −110°. Alcohol was viscous at −129°, and solidified at −130.5. (*Wied. Ann.*, XX, 243; *C. R.*, XCVI, 1140, 1225; *Phil. Mag.*, V, XVI, 75; *J. Phys.*, November, 1883, II, II, 485.)

Jamin has published some criticisms upon the ordinarily received interpretation of the "critical point" of gaseous liquefaction. The facts he concedes; but they have been inaccurately interpreted. He maintains that gases are liquefiable at any temperature whatever when the pressure is sufficient, but a circumstance hitherto overlooked has prevented the liquefaction from being seen. In Cagniard-Latour's experiment, where a thick glass tube is one-half or two-thirds filled with water, sealed, and heated to 300° or 400°, the vapor increases indefinitely in density and the liquid undergoes an increasing expansion, until a limiting temperature is finally reached, at which both the liquid and the vapor have the same weight in the same volume. At this moment they cannot be separated; the vapor cannot escape to the top, the liquid cannot sink to the bottom. The meniscus first disappears, the surface of separation ceases to be distinct, then the entire mass is mingled together, showing undulating and moving streaks, evidence of a mixture of different densities, and finally the whole assumes a homogeneous state which is supposed to be gaseous. The "critical point" is reached and it may be defined as the temperature at which a liquid and its saturated vapor have the same density. In a subsequent paper Jamin discusses the laws of compressibility and condensibility of gases as illustrating this view. (*C. R.*, XCVI, 1448; *J. Phys.*, II, II, 389, 393; *Phil. Mag.*, July, 1883, V, XVI, 71.)

Gerard-Ansdell has studied the critical point of mixed gases, using for the purpose a mixture of carbon dioxide and hydrogen chloride. The experiments were made in a graduated Cailletet tube 50 cubic centimeters in capacity, the capillary portion having a diameter of 2 millimeters. After determining the critical point, the maximum tensions of the vapor at different temperatures, and the volumes of the liquid and gaseous portions, the apparatus was opened in distilled water, and the hydrogen chloride, which dissolved, was determined by analysis. The critical point of the carbon dioxide was 31°, and of the hydrogen chloride, 51.25°. But the critical point of the various mixtures was not found to vary proportionally to the percentage, but departed therefrom by as much as 3.6°. (*Proc. Roy. Soc.*, XXXIV, 113; *J. Phys.*, January, 1883, II, II, 45.)

3. *Conduction and Radiation.*

To demonstrate to an audience the relative conductibility of copper and iron, Petrouchewski uses two air-thermoscopes of identical dimensions, the reservoir of the one being a vertical tube of copper and of the other a similar tube of iron. The heat from a gas flame is conducted to the thermoscopes by means of large wires of copper and of iron, respectively. A few minutes after the lamp has been lighted the level of the liquid in the copper thermoscope has fallen 25 to 35 centimeters, while that in the other has fallen only 7 or 8. A similar apparatus for showing the low conductibility of water in comparison with mercury has been devised by the same experimenter. (*J. Soc. Phys. Chim. Russe*, XIV, 154; *J. Phys.*, December, 1883, II, II, 576.)

Violle has measured the radiation from silver at its melting point, as preliminary to measuring that of platinum, proposed by him as a photo metric standard. A bath of melted silver was placed below a thermo-electric battery connected with a mirror galvanometer, so that the radiation from the metal fell normally on the face of the battery through an opening one square centimeter in area made in the double walls of a suitable screen and closed with a plate of quartz. The screen was cooled by a current of water. As the metal cooled the radiation at first decreased;

but as soon as solidification began at the edges of the mass, the radiation from the liquid portion at the center remained constant until the solidification was complete. The author recommends this constant radiation of silver as a spectro-photometric standard. (*J. Phys.*, August, 1883, II, II, 366; *C. R.*, XCVI, 1033.)

Baur has investigated by means of the bolometer the radiation of rock salt at different temperatures. He concludes that rock salt absorbs its own radiations more strongly than it does those of other bodies; and that the absorption increases as the difference of temperature between the radiating and absorbing rock-salt plates diminishes; reaching its full value when this difference is zero. He does not believe that the radiations emitted by rock-salt are homogeneous; but concludes that long waves are accompanied by more or less longer and shorter waves, just as a yellow glowing solid emits beside the yellow radiations of a greater wave-length in addition. (*Wied. Ann.*, XXIII, 17; *Am. J. Sci.*, June, 1883, III, XXV, 469.)

Lecher has calculated the absolute emissive and absorbing powers of a body as a function of the diffuse reflecting power and of the emissive power of surrounding bodies. Conceding the former to be constant at all temperatures, he concludes: (1) That a body emits radiations of all refrangibilities whatever the temperature; and (2) that the distribution in the spectrum of the emitted radiations, is independent of the temperature. Placing, for example, between two thermo-batteries differentially arranged an incandescent plate of platinum, he finds that certain bodies interposed between the platinum and either battery maintain nearly the same absorbing power however the temperature of the plate be varied. Incandescent electric lamps give spectra of the same quality, whatever may be the temperature of the carbon filament. He maintains therefore that the emissive power of any body whatever is for any temperature the same fraction of the function which expresses the emissive power of a black body. (*Ber. Ak. Wien*, 1882, 57; *J. Phys.*, April, 1883, II, II, 195.)

Abney and Festing have published an investigation into the relations between radiation, energy, and temperature, using for the purpose the incandescent lamps of Edison, Lane Fox, British Electric Company, and Maxim. They express their results as follows: (1) the current can be expressed as a function of the potential; (2) the radiation, after a certain temperature of the filament has been reached, bears a simple proportion to the energy expended in the lamp; (3) the resistance can be formulated as a function of the energy and therefore of the radiation; and (4) the temperature appears to be nearly a simple function of the resistance. These results are given also in the form of curves. (*Phil. Mag.*, September, 1883, V, XVI, 224.)

Van Assche has proposed a thin plate of selenium as a medium of isolating heat radiation from other radiations. The light which it transmits is monochromatic, of a reddish tint, its spectrum being comprised between A and C. All radiations are interrupted by the selenium when the source has a temperature between 720° and 2000°; those radiations at comparatively low temperatures, 525° to 720°, alone penetrating the selenium. A thin plate of selenium heated to 250° converts all radiations into obscure ones. (*C. R.*, XCV, 838; *Am. J. Sci.*, December, 1883, III, XXVI, 476.)

Pringsheim has made a careful study of the radiometer, considering particularly the influence of the glass-containing vessel, of the inclosed gas and of the constitution of the vane. His apparatus consisted of a single vane hung by a long bifilar suspension, and carrying a mirror which reflected a beam of light on a scale. He concludes that a pressure emanates from the heated side of the vessel, and that it increases with the temperature and is independent of the nature of the material of which the vessel is made. He finds that the absorption by the rarefied medium is extremely small, and may be neglected. The action of the vane is due to the rate of absorption and conduction on its two sides. The theory of currents in the rarefied medium he considers untenable, and believes that the kinetic theory of the radiometer is the most reasonable one. The form of the vanes is without influence *per se*, affecting the result only indirectly by their proximity to the sides of the vessel. Hence his use of a single vane bifilarly suspended. (*Wied. Ann.*, XXVIII, 1; *Phil. Mag.*, February, 1883, V, XV, 101; *Am. J. Sci.*, March, 1883, III, XXV, 229.)

Rovelli has suggested various lecture experiments with the radiometer. He places the instrument in the focus of a parabolic mirror, while a mass of snow is put in the focus of a like mirror at a little distance, facing the first. He puts the instrument under a bell jar containing ether, on an air-pump. On exhausting, the motion is reversed on admitting the air. He exposes the radiometer in the focus of a parabolic mirror turned toward the weak light reflected from snow on a cloudy day, and then turns the mirror away from the snow. He finds that eight degrees of dark heat neutralizes the effect of the light emitted by an ordinary candle at a distance of 45 centimeters. (*Nature*, March, 1883, XXVII, 144.)

4. *Specific Heat.*

Cantoni and Gerosa have undertaken to determine the value of the calory by measuring the rise of temperature in a mass of mercury allowed to fall from a known height. The height selected was 2.225 meters, and the extreme values obtained in fifty-six experiments was 0.140° and 0.172°. The mean of the first series (twenty-two experiments) was 0.1537°, of the second (twenty-two experiments), 0.1546°, and of the third (twelve experiments), 0.1687°, the general mean being 0.1573°. The authors found for the specific heat of mercury, 0.033375 as the mean of three experiments; whence the mechanical equivalent of the calory is $2.225 \div (0.033375 \times 0.1573°) = 423.82$ kilogrammeters. The probable error, however, is in the second significant number, the determinations differing from each other by 20 per cent. (*J. Phys.*, December, 1883 II, II, 562.)

In Kopp's specific heat method, the solid is introduced into a tube, together with a liquid of known specific heat, and this tube is heated to a known temperature in a bath of mercury, and then immersed to a fixed level in the calorimeter. Pagliani has modified this method by using for heating the tube, in place of the mercury bath, the vapor of any suitable liquid. The results, obtained with various solid organic salts, agree well with those calculated from their solutions. (*J. Phys.*, December, 1883, II, II, 565.)

Liebig has studied in the laboratory of the Johns Hopkins University the variation in the specific heat of water, using the same method as that which Rowland employed in his research on the mechanical equivalent of heat and the same apparatus. The result which he has obtained agree entirely with the statement of Rowland that the specific heat of water decreases regularly from 0°, but differ as to the point of minimum, that of Rowland being about 30°, while that of Liebig being near 23°. No obvious explanation of the discrepancy appears. (*Am. J. Sci.*, July, 1883, III, XXVI, 57.)

Vieille has investigated the specific heat of certain gases at elevated temperatures. Assuming the constancy of the coefficient of expansion at constant volume and the correctness of Marriotte's law for high temperatures, he finds that the mean specific heat at constant volume of the gases CO, N, H, and O, does not vary at most by more than two-thirds its value between 0° and 4400°. (*C. R.*, April, May, 1883, XCVI, 1218, 1358.)

Strecker has continued his determination of specific heats by Kundt's acoustic method. Representing the energy of the translatory movement of the molecules by *k* and the total energy by H, the author finds that the ratio of *k* to H divides the diatomic gases into two groups, in the first of which this ratio has the value 0.6, and in the second from 0.44 to 0.50. In the first group are the gases O, N, H, CO_2, N_2O_2, HCl, HBr, HI. In the second, Cl, Br, I, ICl, IBr, Cl(?). (*Wied. Ann.*, XVII, 85; *J. Phys.*, January, 1883, II, II, 46.)

Berthelot and Ogier have determined the specific heat of nitrogen tetroxide at various temperatures. Calling the molecular weight 46, corresponding to the formula NO_4 (O=8), the molecular specific heat is found to decrease rapidly as the temperature rises, being 74.7 calories from 27° to 67°, 51.3 from 27° to 150°, and 29.8 from 27° to 280°. These authors have also determined, by the same method, the specific heat of the vapor of acetic acid, and have found it to diminish as the temperature rises, like nitrogen tetroxide. The molecular specific heat (the molecular weight being 60) is 90.1 calories at 129°, 76.2 at 160°, 57 at 200°, 38.2 at 240°, and 28.5 at 280°. Berthelot and Ogier have also determined the heat of vaporation of bromine, and find it to be 6991 calories referred to Br_2, molecular weight, 160. (*Ann. Chim. Phys.*, November, 1883, V, XXX, 382, 400, 410.)

Frankland has contrived an instrument for registering the relative thermal intensity of the sun. It consists of two bulbs at the ends of a tube bent twice at right angles, resembling the differential thermometer of Leslie. These bulbs have the same diameter, and one of them is blackened and surrounded by a glass envelope, which is exhausted. The other bulb is placed beneath a zinc roof painted with zinc-white on both faces. The apparatus contains air, and the tube is partially filled with mercury. The blackened bulb receives the solar radiation, the other preserves the temperature of the surrounding air. The reading of the two mercury columns on a suitable scale gives the difference of the temperatures. (*Proc. Roy. Soc.*, XXXIII, 331; *J. Phys.*, February, 1883, II, II, 93.)

LIGHT.

1. *Production and Velocity.*

Lodge has given an interesting lecture at the London Institution on the ether and its functions. Light vibrations, he says, can be transmitted only by a body possessing rigidity; and rigidity is active resistance to shearing stress, to alteration of form. Elasticity of figure is possessed by solids alone; the elasticity of fluids is volume elasticity only. Hence, fluids can transmit longitudinal vibrations only, while solids alone can transmit transverse vibrations like those of light. Water and air, therefore, cannot transmit light vibrations; it is the ether in them which conveys the motion. At 4,000 miles above the earth's surface the density of the air is represented by a number with 127 ciphers before it and after the decimal point. But according to Sir William Thomson's calculation the density of the ether is represented by a number with only 17 ciphers between it and the decimal point. The rigidity being the product of the square of the velocity by the density, is therefore 900, while that of steel is 8×10^{11}. Glass itself can transmit vibrations with a velocity of only half a million centimeters per second, but the ether in the glass transmits them 40,000 times as quick, or 20,000,000,000 centimeters per second. Outside the glass they are transmitted 30,000,000,000 centimeters per second. Fresnel assumed the ether to be really denser within ordinary matter, being condensed around the molecules, while the rigidity is unchanged. Hence it follows that in water, for example, seven-sixteenths of the ether within it is bound to the molecules and moves with it, while the remaining nine-sixteenths is free and blows freely through the mass. The electric relations of the ether are discussed and the suggestion made that, since a given electromotive force produces a greater electric displacement in some kinds of matter than in others, *i. e.*, that the electricity is denser in some kinds of matter, the ether is sheared by electromotive forces into positive and negative electrification. The density of electricity in space being 1, that inside matter is called K, the specific inductive capacity, while in optics it was measured by the square of the refractive index. These appear to be the same values. The vortex atom theory of Thomson is discussed, and the lecture closes as follows: "One continuous substance filling all space, which can vibrate as light, which can be sheared into positive and negative electricity, which in whirls constitutes matter, and which transmits by continuity and not by impact every action and reaction of which matter is capable. This is the modern view of the ether and its functions." (*Nature*, January and February, 1883, XXVII, 304, 328.)

Preece has proposed to the Royal Society the use as a reference photometric standard a small surface illuminated to a given intensity. In practice the light given by a small incandescent lamp, which can be varied by varying the current, is used for the comparison. The amount of illumination is proportional to the current flowing, and is read in amperes. The standard surface is that illuminated by a British candle at 12.7 inches, the same as is given by the French carcel at 1 meter distance. The theory of the method is simple. (*Nature*, June, 1883, XXVIII, 206.)

Sabine has described a wedge and diaphragm photometer which consists of a horizontal brass tube on a stand having an eye-piece at one end and a paraffin lamp at the other. A disk of opal glass near the middle of the tube is constantly illuminated by the flame. The tube itself is cut away laterally near its center, the opening being covered by a collar carrying a slit containing a strip of opal glass, before which slides a frame carrying a wedge of neutral-tint glass, the thicker end of which absorbs eight times as much light as the thin end. The light to be measured is placed on the right side of the photometer, and its rays pass through the wedge and slit, falling on a narrow mirror at 45°, which reflects them to the eye. When the light from the paraffin lamp and that from the source under examination are balanced the mirror becomes invisible. Diaphragms, with various openings, placed at the lamp end of the tube, permit the range to be varied. (*Phil. Mag.*, January, 1883, V, XV, 22.)

Conroy has suggested a modification of Ritchie's photometer in which two surfaces of white paper are so placed that the light is incident upon them at 30°, and the line of sight makes an angle of 60° with the normal, one of the papers being made to overlap the other slightly. (*Phil. Mag.*, June, 1883, V, XV, 423.)

Sir William Thomson has made some approximate photometric measurements of natural as compared with artificial lights. From Pouillet's data he estimates the solar radiation to be 7,000 horse-powers per square foot of the sun's surface, or 50 horse-powers to the square inch. The radiation from a Swan incandescent lamp he finds to be three-fourths of a horse-power per square inch of surface, and hence the sun's radiation is 67 times that of the lamp. From measurements taken at York in 1881 he estimates moonlight to be equal to the light of a candle 230 centimeters distant. The light of a cloudy sky through an aperture one square inch in area was found to be equal to one candle, and the intensity of the light from the sun's disk was equal to 5,300 candles. (*Lond. Elec. Rev.*, XI, 490; *Am. J. Sci.*, February, 1883, III, XXV, 149.)

Crova has introduced a correction into the value of the solar luminous intensity, previously given by him, and now concludes that the sun's illuminating power in a clear sky is very near 8,500 carcels. Allowing 9.5 candles to a carcel, this gives over 80,000 candles as the value of the sun's light, a number considerably greater than Sir William Thomson's estimate. (*C. R.*, XCV, 1272; XCVI, 124, January, 1883.)

McLeod has made a series of experiments to test the action of light on india-rubber. He comes to the conclusion that caoutchouc alters under the combined influence of light and oxygen, but either alone produces no effect. (*Nature*, February, XXVII, 312; July, XXVIII, 226.)

Huggins has succeeded in reproducing the solar corona by photography, using a solution of potassium permanganate to absorb all rays different from those emitted by the corona itself. Compared with the photographs obtained during the eclipse of the 17th of May, Abney considers their essential identity established. (*J. Phys.*, April, 1883, II, II, 173.)

Cros and Vergeraud have succeeded in producing direct positives by the following process: Any suitable paper is covered with a solution of 2 grams ammonium bichromate, 15 grams glucose, and 100 of water, and dried. It is then exposed to the light under a positive. When the uncovered parts of the paper have become gray it is placed in a bath containing 1 gram of silver nitrate, 10 grams of acetic acid, and 100 grams of water. The image appears at once in red, drying to a dark brown. By treatment with a sulphide it becomes black. (*J. Phys.*, March, 1883, II, II, 123.)

Hare and Dale have constructed a multiplex camera back by which thirteen plates in two tiers may be exposed, in any order without opening the box. (*Nature*, September, 1883, XXVIII, 470.)

2. *Reflection and Refraction.*

Lermantoff proposes to select thin disks of microscopic cover glass to serve as light mirrors, by means of Newton's rings. Using a lens of long focus, placed successively on the disks illuminated with sodium light, those are selected which show regular rings not altered in size when the disk is turned over. (*Jour. Soc. Phys. Chim. Russe*, XIV, 480; *Jour. Phys.*, December, 1883, II, II, 583.)

Laurent has communicated to the French Academy a description of some new pieces of apparatus devised for the purpose of testing optical surfaces. Among these are, (1) an apparatus for verifying the flatness of a plane surface; (2) one for controlling parallel surfaces; (3) one for fixing the construction of prisms of any determined angle; and (4) one for controlling perpendicular surfaces. Most of these devices may be used during the working of the surfaces. (*C. R.*, XCVI, 1035; *J. Phys.*, September, 1883, II, II, 411.)

Soret has modified the total reflection refractometer of Kohlrausch so that it may be used with white light. The new apparatus is illuminated with a strictly parallel beam of solar light, which, after reflection at the contact-surface of the given substance and carbon disulphide, is received on the slit of a spectroscope. For any convenient incident angle a dark well-defined shadow moves from the red to the violet with an increasing incidence, limiting the totally reflected rays. The index of the given substance for the part of the spectrum with which the edge of the shadow coincides is obtained by multiplying the index of carbon disulphide by the sine of the incident angle. (*J. Phys.*, March, 1883, II, II, 138.)

Wiedemann has determined the density and refractive index at 19° for the three lines of lithium, sodium, and thallium of ethyl-carbonic ether and the five corresponding ethyl sulphocarbonates. From these values he calculates, by Lorenz's formula, the atomic refraction of sulphur, and finds it to be 7.94 in the case where only one atom of sulphur is united to the same atom of carbon, and 9.28 where two atoms are thus united. (*Wied. Ann.*, XVII, 577; *J. Phys.*, March, 1883, II, II, 139.)

Dufet has investigated the influence of temperature on the index of refraction of water and quartz. When a parallel beam passes through a rectangular trough filled with water and containing a quartz plate with parallel sides, one-half of the beam passing above this plate, Talbot's bands are perceived on passing the light through a prism. By the displacement of these bands the temperature may be determined to within 0°.02. The variation of the ordinary index of quartz for D and one degree is −0.0000050. (*C. R.*, XCVI, 1221, April, 1883.)

Quincke has studied the changes which the volume and the refractive index of liquids undergo under hydrostatic pressure. The compressibility was measured in glass vessels provided with capillary tubes, while the indices were measured by observing with an interferential refractometer the number of bands in homogeneous light. The ratio of these changes exhibits a definite relation, and the results go to confirm Dale and Gladstone's formula for the constant of refraction, *i. e.*, the index, less unity, divided by the density. Or, in other words, the excess of the index above one increases proportionally to the density. (*Ber. Ak. Berl.*, April, 1883; *Nature*, XXVIII, 308; *J. Phys.*, June, 1883, II, II, 279.)

Chappuis and Rivière have measured the refractive indices of gases at high pressures, employing the interference method of Jamin. The gas was compressed in a prismatic cavity in a block of steel 20 centimeters long, closed at the ends by glass plates a centimeter thick. One of the interfering rays traverses this cavity, the other passes outside of it and one centimeter distant. They are united by the second mirror, and the fringes are observed with a telescope. The results obtained between 24 and 36 atmospheres are now given. For the number of the fringes which would pass under the reticule for a variation of pressure of 1 millimeter in a tube 1 meter long, the author obtained 0.550, 0.510, and 0.555 in three experiments, the number calculated on adopting the index for air at 22° the value 0.000271, being 556. (*C. R.*, March, 1883, XCVI, 699; *Phil. Mag.*, April, 1883, V, XV, 299.)

Sarazin has determined with great care the ordinary and extraordinary indices of Iceland spar for the leading Fraunhofer lines as well as for twenty-six of the leading lines of cadmium. He used two prisms, one by Hofmann, the other by Laurent. (*J. Phys.*, August, 1883, II, II, 369.)

Loewy has given a detailed description of the novel telescopic mounting devised by him for the new equatorial of the Paris Observatory, and constructed by Eichens and Gautier. (*J. Phys.*, August, 1883, II, II, 349.)

Thollon has constructed a modified form of collimating telescope for use with his liquid prisms, which must be kept in a horizontal position. If a total reflection prism be placed behind the slit of a collimator, so that its hypotenuse is at the same time parallel to the axis of the telescope and to the slit, an image of the slit will be formed inverted, as in Zöllner's reversion prism. If the slit be turned through any angle, and the prism through half this angle, an image of the slit will be given which will coincide in direction with the first image. This device works well in practice. (*C. R.*, March, 1883, XCVI, 642.)

Tait has discussed that state of the atmosphere which produces the forms of mirage observed by Vince and by Scoresby. From theoretical considerations he concludes that the conditions requisite for the production of Vince's phenomenon, at least in the way conjectured by him, are a stratum in which the refractive index diminishes upward to a nearly stationary state, and below it a stratum, in which the upward diminution is either less or vanishes all together. The former condition secures the upper erect image, the latter the inverted image and the lower direct image. In proof of the correctness of this theory, the author constructed a tank with parallel glass ends, about 4 feet long, and filled it one-half with a weak brine carefully filtered. Pure water was then cautiously introduced above it till the tank was nearly full. After a few hours the whole had settled down into a state of slow and steady diffusion, and Vince's phenomenon was beautifully shown. (*Nature*, May, 1883, XXVIII, 84.)

3. *Dispersion and Color.*

Zenger has produced a direct vision prism of great dispersive power by joining to a dispersion parallelopiped a prism of light crown. He claims that by this combination he gets a dispersion of 150° between the A and the H lines. Since ordinary direct vision prisms give a separation of these lines of only 20°, this result is remarkable and exceeded only by the Thollon spectroscope. But in this instrument the loss of light from the absorptions and reflections is far less. (*C. R.*, April, 1883, XCVI, 1039.)

Crova has described an improved form of spectrophotometer which consists essentially of a direct vision spectroscope having an adjustable slit in the eye-piece and a double rectangular prism covering one-half the ordinary slit. One beam passes to the prism directly; the other enters from a perpendicular direction passing into the collimator through the total reflection prisms. In the path of this rectangular beam two nicols are placed with a graduated circle by the position of which the movable one may be read off. The two lights to be compared are placed at equal distances, the brighter in front of the nicols, and the analyzer is turned until the intensity is the same in any given portion of the two superposed spectra. (*Ann. Chim. Phys.*, August, 1883, V, XXIX, 556.)

It is often desirable to place the slit of a spectroscope at an angle with the axis of the prism. Garbe has shown that this may be done by placing immediately behind the slit an ordinary reversing prism, with its axis in that of the collimator. Under these circumstances the virtual image of the slit will not be displaced by its rotation. The device is similar to that used by Thollon. (*J. Phys.*, July, 1883, II, II, 318; *C. R.*, March, 1883, XCVI, 836.)

Cornu has suggested a new form of spectroscope, which gives a high dispersion. A right-angled prism throws the light from the slit along the axis of the collimating lens, whence it passes through the prism and is incident upon a reflecting surface at 45°, by which it is thrown vertically upward upon a second mirror at 45°, which returns it to the prism. After traversing this a second time it is incident normally upon a mirror, which returns it over its course to the eye-piece of the collimator. The ray thus passes four times through the prism; and since this is of carbon disulphide the dispersion obtained is very considerable. (*J. Phys.*, February, 1883, II, II, 53.)

Rohrbach has produced a liquid possessing extraordinary high refractive and dispersive power. One hundred parts of barium iodide and 130 parts of mercuric iodide are heated in a test-tube with 20^{cc} of distilled water, the whole placed in an oil bath at 150° to 200° C., and well stirred. A liquid double iodide of mercury and barium is formed, which is poured into a shallow porcelain dish and evaporated down until its density is so great that an epidote crystal no longer sinks in it. Even topaz will float in it when cold. It is then filtered through glass wool. It has a density of 3.575–3.588, boils at about 145°, and is yellow in color. Its refractive index is 1.7755 for the C line and 1.8265 for the E line of the spectrum. For the two D lines of sodium are 1.7931 and 1.7933, respectively. When a hollow prism of 60° filled with this liquid is used in the spectroscope the separation of the D lines is almost exactly 2′. (*Nature*, November, 1883, XXIX, 63; *Wied. Ann.*, XVII, 169; *Am. J. Sci.*, November, 1883, III, XXVI, 406.)

Lagarde has measured, by means of the spectrophotometer of Crova, the intensity of the hydrogen spectrum lines under various conditions of temperature and pressure. Using the carcel lamp as a standard, and calling the intensity of the corresponding regions of the spectrum 1,000, the intensity of the red line was 3.6 under a pressure of $6^{mm}.5$, 8.8 under a pressure of $0^{mm}.542$, and 12.6 under a pressure of $0^{mm}.010$, the current intensity being the same. The blue line had an intensity of 5.5, 25.8, and 39.3 under these conditions, and the violet line 17.2, 65.8, and 110.9. For a pressure of $6^{mm}.5$ the curve of the red line becomes a straight line. (*C. R.*, December, 1882, XCV, 1350; *Phil. Mag.*, March, 1883, V, XV, 226.)

Liveing and Dewar have presented to the Royal Society a paper on the origin of the hydrocarbon flame spectrum. (*Nature*, January, 1883, XXVII, 257.)

Thalén has measured the wave-lengths of the brilliant spectra of samarium and didymium. (*J. Phys.*, October, 1883, II, II, 446.)

The same physicist has mapped the emission spectra of scandium, ytterbium, and thulium, as well as the absorption spectrum of thulium. (*J. Phys.*, January, 1883, II, II, 35.)

Cornu has compared together the telluric lines of the spectrum and the lines of the metals as a means of determining the absorbing power of the atmosphere. (*J. Phys.*, February, 1883, II, II, 58.)

Liveing and Dewar have studied the conditions under which the spectrum lines of the metals are reversed. (*J. Phys.*, September, 1883, II, II, 434.)

Hartley has submitted to the British Association the report of the committee on the comparison of the spark spectra of the elements with spectra of solutions of their compounds. (*Nature*, November, 1883, XXIX, 89.)

Abney has communicated to the Royal Society the results of his measurements of the wave-lengths of A, of *a*, and of some prominent lines in the infra-red of the visible spectrum. (*Nature*, December, 1883, XXIX, 190.)

Pringsheim has measured the ultra-red wave-lengths of the solar spectrum, using a Chapman grating and silvered mirrors, the rays being received on an extra sensitive radiometer. The visible spectrum of the second order was absorbed by a solution of iodine or a plate of ebonite. He concludes that rays exist in the spectrum of wave-length 0.00152, or double the length of the extreme red. He finds a cold band between the limits $\lambda = 0.00139$ and $\lambda = 0.001366$. This band has also been observed by Langley. (*Wied. Ann.*, XVIII, 32; *J. Phys.*, September, 1883, II, II, 424.)

H. Becquerel has published three papers on the infra-red region of the spectrum. The first is on a phosphorograph of the infra-red region of the solar spectrum and the wave-length of the principal lines. The second is on the study of the infra-red radiation by means of the phenomena of fluorescence. And the third is on the maxima and minima of extinction of phosphorescence under the influence of the ultra-red rays. (*C. R.*, January, April, June, 1883, XCVI, 121, 1215, 1853; *Ann. Chim. Phys.*, V, XXX, 5; *Phil. Mag.*, March, 1883, V, XV, 223; *Am. J. Sci.*, March, 1883, III, XXV, 230.)

Egoroff has shown that the A and B lines of the solar spectrum are due to the oxygen in the earth's atmosphere. He used a tube 20 meters long, closed by glass plates, filled with dry oxygen under a pressure of 15 atmospheres, and observed the calcium light through it. The lines of absorption produced by the oxygen were identical with the A and B of the solar spectrum. (*C. R.*, August, 1883, XCVII, 555; *Am. J. Sci.*, December, 1883, III, XXVI, 477.)

Langley has published *in extenso* his valuable memoir on the selective absorption of solar energy, giving the results of his measurements at Allegheny and on Mount Whitney. He has explored the ultra-red region to a wave-length of 2.8 microns, the extreme value obtained hitherto being only 1.2. The charts accompanying this memoir are of great interest. (*Am. J. Sci.*, March, 1883, III, XXV, 169; *Ann. Chim. Phys.*, V, XXIX, 497; *J. Phys.*, II, II, 371.)

Rayleigh has pointed out the fact that the curve of energy of the diffraction spectrum has no special claim to the title of "normal." A curve plotted with wave-frequencies, or reciprocals of wave-length, as abscissas would have quite as much claim to be considered normal and would give an energy curve more like that obtained with the prismatic spectrum. If the logarithm of the wave-length or the wave-frequency be used as abscissa, a curve will be obtained in which every octave occupies the same space. (*Nature*, April, 1883, XXVII, 559.)

4. *Interference and Polarization.*

Egoroff, in experimenting with a Chapman grating of 17290 lines to the inch, finds that for every grating and every wave-length there is an angle of incidence such that the reflected diffracted ray coincides with the incident ray. In this case the focus of the grating is infinitely distant. Considering the image of the source of light formed by the reflecting surface of the grating as the source of light for a transparent grating, it will be seen that the case of the coincidence of the diffracted ray with the incident ray corresponds to the case of minimum deviation for this transparent imaginary grating, the angles of incidence and emergence being equal. (*J. Soc. Phys. Chenv. Russe*, XIV, 253; *J. Phys.*, December, 1883, II, II, 580.)

Rowland has published a complete investigation of the theory of the concave grating and has compared the results with those obtained by experiment. He finds that since the radius of curvature of concave gratings is usually great, the distance through which the spectrum remains practically normal is also very great. In his instrument this radius is about 21 feet 4 inches, the width of the ruling being about 5.5

inches; hence the spectrum thrown by it on a flat plate is normal within about 1 part in 1.000,000 for 6 inches, and less than 1 part in 35,000 for 18 inches. In photographing the spectrum on a flat plate the definition is excellent for 12 inches, and by the use of a plate bent to 11 feet radius a plate of 20 inches in length is in perfect focus, the spectrum being so nearly normal that for most purposes its error may be neglected. Another important property of the concave grating is that all the superimposed spectra are in focus at the same point; so that the relative wave-lengths are readily determined by micrometric measurement. Knowing, therefore, the absolute wave-length of one line, the entire spectrum can be measured. This method is the most accurate known, as by simple inspection the relative wave-length can be judged of to 1 part in 20,000, and with a micrometer to 1 part in 1,000,000. This method is especially valuable in obtaining the focus in the invisible parts of the spectrum. Examining the question whether the ruling actually performed, in which equal spaces are ruled along the chord, could be replaced to advantage by any other kind of ruling, the author finds that the departure of the ruling from theoretical perfection is of little consequence until lines twenty times as fine as the 1474 line can be divided; the components of this line being one forty-thousandth of the wave-length apart. Considering, finally, the question of the limit of the resolving power of the spectroscope, he shows that all lines have some physical width and that we are limited by that width in the resolving power of the spectroscope. All the methods of determining the limits seem to point to about the 150,000th of the wave-length as the smallest distance at which the two lines can be separated in the solar spectrum by a spectroscope of even an infinite power. Practically he has been able to photograph lines which do not differ in wave-length more than one part in 80,000, and he believes he can resolve lines whose components are only one 100,000th of the wave-length apart. So that the idea of a limit has not yet been proved. (*Am. J. Sci.*, August, 1883, III, XXVI, 87.)

Similar investigations on the theory of concave gratings have been made by Mascart (*J. Phys.*, January, 1883, II, II, 5), by Baily (*Phil. Mag.*, March, 1883, V, XV, 183), and by Glazebrook (*Phil. Mag.*, June, 1883, V, XV, 414). In a note, subsequent to his last paper, Rowland has called attention to certain errors in the latter paper, intimating that some of the methods suggested were identical with those he had himself presented to the London Physical Society six months before. Indeed, in a foot-note to his previous paper, he had expressed his surprise at this invasion of his field by others, saying that he had expected to be allowed a little time to work up the subject himself. (*Am. J. Sci.*, September, 1883, III, XXVI, 214.)

Glazebrook has suggested a new form of polarizing prism, free from the defect of the Nicol, of displacing laterally the object seen through it. It is made by cutting a rectangular parallelopiped from a piece of spar so that two of its faces are at right angles to the optic axis, while the other four are parallel to it, its length being three times its width. Cut it by a plane inclined 20° to its length, polish, and re-cement these faces with Canada balsam. Such a prism has the following advantages: (1) An object seen through it is not displaced laterally; (2) a conical pencil whose axis passes directly through it is more nearly plane polarized than in other prisms, and (3) if the direction of the wave normal within the prism does not quite coincide with the axis of rotation, the average error in the position of the plane of polarization isless than for any other method of cutting. The angular aperture of the field is 10°. (*Phil. Mag.*, May, 1833, V, xv, 352.)

Gouy has devised an apparatus for the synthetic production of circular double refraction. It is formed of a collection of parallel plates cut from a uniaxial crystal parallel to the axis. These all have the same thickness, which corresponds to a difference of path of either one semi-undulation or of an uneven number of semi undulations between the ordinary and extraordinary rays for sodium light at a normal incidence. These plates are cut into equal rectangular bands, long and narrow, and then these are placed side by side, like the boards in a floor, and cemented together between two parallel glass plates with Canada balsam. In the first strip the principal section of the crystal has an arbitrary direction; in the following ones the principal section of each strip makes with that which precedes a constant angle in magnitude and direction, upon which depends the properties of the apparatus. Upon the whole is superposed a half-wave plate without regard to direction. (*J. Phys.*, August, 1883, II, II, 360.)

Some time ago Righi demonstrated that if two rays were made to interfere when their vibration numbers were slightly different, there appeared on the screen, instead of the ordinary fringes, fringes which had a uniform movement in a direction perpendicular to their length, with a velocity such that there would pass a given point in one second a number of luminous fringes equal to the difference of the vibration numbers. The phenomenon was identical with that of beats produced by sonorous air vibrations. He has now succeeded in realizing the condition experimentally, and has described the apparatus necessary as well as the conditions of success. (*J. Phys.*, October, 1883, II, II, 437.)

Gouy has examined the condition of diffracted light as regards its polarization. He finds that if the incident light is natural, the diffracted light is polarized, very strongly if the diffraction angle exceeds 50°, and always in a plane parallel to the edge of the screen or perpendicular to the diffraction plane. If the incident light is plane polarized, the diffracted light is also plane polarized, but in a plane making a greater angle with the plane of diffraction. With reference to the light diffracted away from the shadow, the polarization phenomena are contrary. With ordinary light the diffracted beam is now polarized in the plane of diffraction; the polarization being almost complete if the diffraction angle is small. The same edge produces complementary polarizations. (*C. R.*, March, 1883, XCVI, 697.)

ELECTRICITY.

1. *Magnetism.*

Hughes has presented to the Royal Society a theory of magnetism based on new experimental researches. He maintains (1) that each molecule of a piece of iron, steel or other magnetic metal is a separate and independent magnet, having its two poles and distribution of magnetic polarity exactly the same as its total evident magnetism when noticed upon a steel bar magnet; (2) that each molecule or its polarity can be rotated in either direction upon its axis by torsion, stress, or by physical forces such as magnetism and electricity; (3) that the inherent polarity or magnetism of each molecule is a constant quantity like gravity, and can neither be increased or destroyed; (4) that when we have external neutrality or no apparent magnetism, the molecules or their polarities arrange themselves so as to satisfy their mutual attraction by the shortest path, and thus form a complete closed circuit of attraction; (5) that when magnetism becomes evident, the molecules or their polarities have all rotated symmetrically in a given direction, producing a north pole in the piece of steel if rotated in one direction, and a south pole if rotated in the other. The arrangement here is still symmetrical, but the circles of attraction are completed only through an external armature joining both poles. (*Nature*, February, 1883, XXVII, 354.)

Wassmuth has shown that the moment of a milligram of iron submitted to a magnetic force, depends upon its temperature and the pressure to which it is exposed. A diminution of pressure, a rise of temperature affect the moment oppositely. Compression evolves nearly the same amount of heat whether the iron be magnetized or not. Iron, therefore, subjected in a vacuum to a feeble magnetic force should be cooled. It would heat, on the contrary, under the atmospheric pressure and the action of a more powerful magnetization. (*J. Phys.*, April, 1883, II, II, 194.)

Bosanquet has proposed the term "magnetomotive force" as the analogue of electromotive force; a difference of magnetic potential. He concludes that the magnetic induction of a permanent magnet may be supposed to be produced by a magnetomotive force derived from permanent amperian currents acting through the resistance of the steel. (*Phil. Mag.*, March, 1883, V, XV, 205.)

Stefan has observed that if a magnet oscillating under the action of the earth be inclosed within a hollow cylinder of iron, and the diminution which the horizontal component undergoes under these circumstances be measured, it will be found to equal nine-tenths of the whole value. If a solenoid be placed in a magnetic field, currents may be induced in it by covering it with a tube of iron. (*J. Phys.*, April, 1883, II, II, 192.)

Meyer has given his results upon the magnetic permeability of the magnetic metals obtained with weak magnetizing forces. A cylinder of the metal was made the core of an earth inductor, the earth's field being used. He concludes, (1) the magnetizing function has a positive value for a diminishing magnetizing force; (2) it increases at first with the magnetizing force; and (3) it increases for weak magnetizing forces with the temperature. The value 2.24 for pure nickel, with a magnetizing force 3.096 was obtained. (*Am. J. Sci.*, April, 1883, III, XXV, 309.)

In a paper read at the meeting of the British Association, Ewing has given the results of an extended investigation of magnetic susceptibility and retentiveness in iron and steel. He finds that soft iron retains 90, and even 93 per cent. of the induced magnetism, after the magnetizing force is removed. Pieces of soft iron held an amount of magnetism per unit of volume greatly exceeding that retained by the best-tempered steel. But the condition is highly unstable, the slightest mechanical disturbance, such as gentle tapping, removed the residual magnetism completely. (*Nature*, October, 1883, XXVIII, 625.)

Borgman has succeeded in establishing the fact that iron is heated by being rapidly magnetized and demagnetized. Similar tubes of iron and of copper were placed in reservoirs of glass which served as the bulbs of air thermometers. The magnetizing currents surrounded these reservoirs and were reversed from five to twenty times a second. No heating of the copper was observed. (*Soc. Phys. Chim. Russe*, XIV, 67; *J. Phys.*, December, 1883, II, II, 574.)

Wassmuth has calculated, from the fact observed by Stefan in 1874, that the specific heat of iron is greater when it is magnetized than in its natural state, what the temperature should be in order that the magnetic moment may be zero. He finds, for the difference of the two specific heats, 2.7×10^{-6}, and for the temperature, 1,346°. (*Ber. Ak. Wien*, 1882, 112; *J. Phys.*, April, 1883, II, II, 194.)

Himstedt has studied the damping effect exerted by a plate of iron upon a magnetic needle vibrating above it. Comparing the results with those given by copper plates of the same dimensions, he finds that while for copper plates the logarithmic decrement of the oscillations is proportional to the duration of the oscillation, for iron plates the logarithmic decrement is independent of this duration. From this it follows that the damping effect due to ordinary induction currents is only a very small fraction of the total damping effect which was observed. (*J. Phys.*, March, 1883, II, II, 135.)

Barrett has described some experiments made under the direction of a committee of the Society for Psychical Research, to test the accuracy of Reichenbach's assertion that the magnetic field is luminous to certain persons. Two persons were subjected to the most careful tests, and the author regards the result as a remarkable verification of the fact that to certain eyes a faint luminosity accompanies the creation of a powerful magnetic field. (*Phil. Mag.*, April, 1883, V, XV, 270.)

2. *Electromotors.*

Bichat and Blondlot have made a series of experiments to determine the influence of pressure on the contact-potential between a metal and the liquid in which it is immersed. Two electrodes of different metals were used, immersed in a solution of a salt of one of them. The results obtained put beyond question the influence of pressure on the electrical difference between a liquid and a metal, amounting to as much as a thousandth of a volt for one hundred atmospheres. (*J. Phys.*, November, 1883, II, II, 503.)

The same authors have extended their investigations and have subsequently measured the difference of potential between two liquids in contact. This difference was measured by means of a Thomson-Mascart electrometer, an apparatus similar to Thomson's water-dropping collector being employed to equalize the potentials of the layers of air which covered the liquids in the two vessels. Between water acidulated with ten per cent. sulphuric acid and nitric acid, the difference was 0.48 Daniell. (*J. Phys.*, December, 1883, II, II, 533.)

Blake has experimentally examined, in Helmholtz's laboratory, the two evaporation hypotheses for the production of atmospheric electricity. The first of these supposes the electricity to be produced simply by the evaporation of the liquid; the second that a convection of the electricity occurs by means of the vapor arising from the surface when the liquid is electrified. The results of his experiments are conclusive apparently in showing that no electrification whatever is produced, directly or indirectly, from the evaporation of liquids. (*Phil. Mag.*, September, 1883, V, XVI, 211.)

The phenomenon of Hall, discovered in 1880, has been the subject of numerous investigations. He observed that if a thin leaf of metal conveying a current be placed on the pole of a powerful electro-magnet perpendicular to the lines of force, a new electromotive force is developed normal to the lines of force and to the direction of the current through the metal, tending to produce a transverse current, which, for most of the metals, is in a contrary direction to the displacement which a movable conductor would experience under the same conditions, but for the strongly magnetic metals, as iron, cobalt, and zinc, is in the same direction. He gives the name "rotational coefficient" to the quotient of E by V, in which E is the difference of potential per centimeter of width, produced in the film, and V the current intensity per unit section traversed. Righi has modified the form of the film, using three electrodes instead of four. He has also found that the effect is more marked with bismuth than with any other metal, so much so that he believes he can show the phenomenon with the earth's magnetism.

Roiti has not succeeded in reproducing these phenomena in solutions, either of zinc sulphate or ferric chloride, or even in a thin layer of mercury. He suggests that the results may be due to the fact that the conductor under the action of the magnet ceases to be electrically isotropic, and has a different resistance in different directions. (*Phil. Mag.*, V, XII, 157; XV, 341; *Atti Accad. Lincei*, III, XII, 397; *J. Phys.*, November, 1883, II, II, 509, 512, 513.)

Hamantoff has measured the electromotive force developed by the contact of silver, silver nitrate, and the various developing agents. Ferrous sulphate gives 0.04 Daniell, pyrogallic acid, 0.08; while the rapid developers suggested by Boissonas for instantaneous plates give 0.12 to 0.16. This supports Lermantoff's view that development is a galvanoplastic process, each molecule of metallic silver set free by the light on the sensitive surface forming a voltaic couple with the silver nitrate molecule and the ferrous sulphate molecule, resulting in a deposit of metallic silver. In order to demonstrate the currents produced by the action of light on a silver plate coated with silver iodide, Borgmann has combined seven cells together and obtained, even with diffused light, a notable deflection on Wiedemann's mirror galvanometer. (*J. Phys.*, December, 1883, II, II, 580, 581.)

Preece has studied the effect of temperature on the electromotive force and resistance of batteries, and concludes (1) that the electromotive force is not materially affected by changes of temperature, (2) that the internal resistance is affected materially according to a law special for each form of cell, and (3) that the resistance of a liquid is greater on a cooling than on a rising temperature. (*Proc. Roy. Soc.*, XXXV, 48; *J. Phys.*, October, 1883, II, II, 475; *Nature*, March, 1883, XXVII, 426.)

Trowbridge and Stevens have measured the electromotive force of alloys, using mixtures of lead and tin and of copper and zinc. The composition was determined by analysis and the electromotive force in dilute sulphuric acid with a platinum plate for the positive pole. (*Proc. Am. Acad.*, XVIII; *Phil. Mag.*, December, 1883, V, XVI, 435.)

Haga has concluded from his experiments that the currents produced in amalgamation of metals are thermoelectric currents due only to the heat of combination. (*Wied. Ann.*, XVII, 897; *J. Phys.*, May, 1883, II, II, 232.)

If two electrodes of the same metal be plunged in a liquid, the movement of either within the liquid produces a current. Krouchkoll has investigated this phenomenon and has shown that currents are also produced at the instant of immersion and of emersion, and that the former is opposite to, and the latter in the same direction as, the current which movement in the liquid produces. (*J. Phys.*, November, 1883, II, II, 505.)

Bartoli and Papasogli have constructed a battery consisting of gold or platinum for one plate and gas carbon for the other, immersed in an alkaline solution. The carbon is here negative and the electromotive force, with a saturated solution of potassium or sodium carbonate, on open circuit, is 0.10 to 0.17 Daniell. With saturated solution sodium hypochlorite, it rises to 0.4 to 0.5 Daniell. With graphite or wood charcoal, the electromotive force is less. The circuit being closed, the carbon disintegrates and produces oxidation compounds, the formation of which is attended with an evolution of heat. (*Il Nuovo Cimento*, III, XII, 141; *J. Phys.*, December, 1883, II, II, 570.)

Two new forms of influence-machines have been produced, the one by Voss, the other by Wimshurst. In the former there is a fixed disk with quadrantal armatures, and a revolving disk with six or eight equidistant metallic buttons on the face, to act as carriers. In the latter there are two revolving disks moving oppositely, each armed with 12 radial sectors. Both machines are self-charging. (*Nature*, May, 1883, XXVIII, 12.)

Elster and Geitel have proposed to string the disks of a dry pile upon a silk thread in place of putting them in a glass tube. They find that these dry piles may act as accumulators, and on charging a pile of 11,000 pairs of plates of a square centimeter surface with a Holtz machine it gave sparks a millimeter long. A form of pile was made consisting of 7,000 plates of thin lead coated on both sides with tissue paper made to adhere by water-glass to which a little lead peroxide was added. After charging, this pile gave sparks one millimeter long for ten minutes, and after twenty-four hours it still showed electrification. (*Wied. Ann.*, XVII, 489; *Phil. Mag.*, V, XVI, 159; *Nature*, July, 1883, XXVIII, 234.)

Reynier has published some figures concerning the work done by a Leclanché battery when used on a telephone exchange. Two batteries of three cells each were used for thirty days of seven hours' duration. The loss of weight of zinc during that time was 64.5 grams, which represents 63,235 coulombs. This is equal to a current of 0.084 amperes during the month. Taking the electromotive force of a Leclanché cell as one volt, the total work done is 189,705 watts, which is equivalent to a horse-power every fifty-two minutes. (*Nature*, July, 1883, XXVIII, 309.)

Wright and Thompson have investigated the Clark standard cell, determining its electromotive force, the influence exerted upon this by dissolved air, by contamination of the mercurous with mercuric sulphate, by time and by temperature changes. They conclude that Clark's valuation for the electromotive force is exact, viz, 1.457 volts at 15°.5 C. These authors have also determined experimentally the work done in the electrolysis of various solutions. (*Phil. Mag.*, July, 1883, V, XVI, 25.)

Trouvé has experimented on the use of the bichromate battery for incandescent lighting, and finds that 12 of his cells in two series of six each maintained ten 16-volt lamps at 10 candles for two hours, the electromotive force being 12.6 volts and the current 65 amperes. After 3 hours the current fell to 31.50 amperes, only 8 lamps being in circuit.

In 4 hours only 6 and in 4½ hours only 4 lamps were maintained. The 12 cells consumed 0.912 kilogram of zinc or 0.076 per cell for the five hours. (*C. R.*, March, April, 1883, XCVI, 787, 1048; *J. Soc. Tel. Eng.*, XII, 616.)

Hallock has investigated the conditions of variation in the electromotive force of the Smee battery, especially that due to polarization. He concludes, first, the accepted view that the variations in E. M. F. of the Smee battery are due to variations of hydrogen polarization on the platinum plate is correct; second, the electromotive force of polarization is by no means independent of the substance of the electrodes; third, we cannot calculate the polarization from the thermo-chemical equivalents; and, fourth, the electromotive force of polarization can be raised considerably above that necessary to produce a visible evolution of gas. (*Am. J. Sci.*, April, 1883, III, XXV, 268.)

Kittler has given the name "normal element" to a cell composed of amalgamated pure zinc in dilute sulphuric acid of specific gravity 1.075 at 18° C., and of pure copper in concentrated copper sulphate solution of specific gravity 1.190 to 1.200. (*Nature*, February, 1883, XXVII, 325.)

Barker has devised a new form of Daniell cell to be used as a standard. It consists of two bottles having tubulures at the side near the bottom, closed by rubber corks through which the ends of a glass stopcock pass. One of these bottles contains the zinc rod passing through a cork in the neck and immersed in a saturated solution of zinc sulphate. The other bottle contains the copper rod immersed in saturated copper-sulphate solution. The advantages claimed for the cell are its uniformity, no evaporation taking place, and no change in the liquids by the action of the battery or by diffusion. When not in use the cock communicating between the bottles is kept closed. (*Proc. Am. Phil. Soc.*, January, 1883, XX, 649.)

Von Waltenhofen has claimed for Pfaundler, of Innsbruck, priority in producing continuous-current machines. In 1867 Kravogl showed at the Paris Exposition his electric motor. This consisted of a series of coils forming a hollow ring which rotated about a horizontal axis. Within it is inclosed a curved cylindrical rod, which, by its weight, tends to take the lowest position, but is kept suspended in a raised position by currents in the coils. The reaction of the attraction rotates the ring. Pfaundler the same year proposed to apply Siemens' principle to it and get electric currents from mechanical work. This he tried and successfully effected three years later, as he states in a letter dated February 11, 1870. (*Nature*, March, 1883, XXVII, 517.)

3. *Electrical Measurements.*

Mercadier and Vaschy have published a paper on the dimensions of electric and magnetic magnitudes, in which, among other questions, they consider the influence of the surrounding medium upon electrodynamic induction, and conclude from their own experimental investigations that this influence is non-existent, at least so far as the media studied by them are concerned. Hence they consider that Ampère's coefficient k' in his electrodynamic formulæ is probably independent of the surrounding medium. Borgmann has called attention to the fact that he had investigated this question six or seven years ago, using Poggendorff's compensation method to determine the induced electromotive force. He concluded that the dielectric medium had no influence, but that the magnetic medium had an appreciable influence, the electromotive force of induction being proportional to the coefficient of magnetic permeability. Hence Ampère's coefficients depend on the same quantity. (*J. Phys.*, June, December, 1883, II, II, 245, 551.)

Dorn, using a modification of Weber's second method, the same that Kohlrausch employed, has obtained for the value in absolute measure of one Siemens unit 0.9482×10^{10} millimeter-seconds. (*Wied. Ann.*, XVII, 773; *Am. J. Sci.*, February, 1883, III, XXV, 148.)

Pending the decision of the International Electric Congress, called to meet in Paris in April, 1884, many methods have been suggested for the determination of the value of the ohm. Carey Foster has called the attention of the London Physical Society to the results, recently obtained, of a method suggested by him in 1874. The method consists in balancing the electromotive force set up in a coil spinning in the earth's magnetic field, by means of an opposing electromotive force from a given battery. The two opposing circuits through the same wire, R, are composed, the first of the spinning coil and a zero galvanoscope and the second of a battery and an absolute galvanometer, these two circuits meeting at the end of the wire R. In two preliminary trials the values 1.003 and 0.999 were obtained, warranting further experiments. Glazebrook has obtained the value 0.9866 for the ohm, or the exact mean of Lord Rayleigh's results, 0.9893, 0.9865, and 0.9868. Lippmann has suggested an electrodynamic method, resembling that of Lorenz. A coil is spun inside a long coil, through which a known current is passing. The resistance to be determined is placed in the circuit of the latter coil. The electromotive force produced by the rotation of the inner coil is balanced along the given resistance by the electromotive force in the outer coil. Gray has proposed a method nearly the converse of that of Weber. It is to hang a coil, the constants of which are known, in a sufficiently intense and uniform magnetic field and find the decrement of the oscillatory motion produced by the induction. Roiti has described a method analogous to that employed by Rowland in 1878. He uses a closed solenoid, in which a primary current flows, and a galvanoscope so arranged that into it can be thrown at will either a branch of the primary current or induced currents resulting from a certain number of interruptions of the principal circuit. The resistances are so chosen that the deflection of the galvanoscope is the same in both cases. Frölich has discussed the question whether electrodynamic actions alone can serve to measure the ohm. Two circuits, the one inducing, containing a constant battery, and the other induced, are placed near each other. Whenever the former circuit is opened or closed, or is shunted, an instantaneous current is produced in the second which is measured by an electro-dynamometer. If the battery be constant and no other variation occurs, the theory is easily confirmed. This distinguishes these methods from the corresponding galvanometric method, the electrodynamic actions depending on the law of variation of the inducing current, while the magnetic action of the induced circuit depends only on the final state of the inductor. The two bobbins may be placed both on the inductor or both on the induced coil, or one on each. Theory shows that the last is the only arrangement which permits the coefficients of self-induction to be eliminated. The experimental methods of doing this are described. Brillouin has described two methods based on the fact that in the electromagnetic system the ratio of a coefficient of induction to a resistance is a time. To determine absolutely a resistance, therefore, the essential measurements are (1) the measures of length necessary to calculate the absolute value of a mutual coefficient of induction, and (2) the measure of a time. (*Nature*, XXVII, 354; *Am. J. Sci.*, III, XXV, 309, 321; *Phil. Mag.*, V, XV, 149; XVI, 144; *C. R.*, XCV, 1348; *J. Phys.*, April, II, II, 149; July 325; December, 566; *Wied. Ann.*, XIX, 106.)

Bidwell has modified the proportions of the Wheatstone bridge so as to insure the constancy of the current used for measuring resistances by its means. This is important in those cases where the resistance measured is a function of the strength of current. (*Phil. Mag.*, V, XV, 316, May, 1883.)

Chevet has devised a modification of the capillary electrometer of Lippmann, which is easily constructed and which will show a difference of potential of 0.001 to 0.0001 volt. Through lateral orifices two bottles are connected by means of a piece of thermometer tube. One of these bottles contains mercury, the other dilute sulphuric acid with a little mercury at the bottom, the mercury in each having an insulated platinum wire leading to it. These wires being connected together, the level of the mercury and water in the bottles is adjusted so that the surface of separation in the tube is near the end which is in the mercury. (*C. R.*, XXVII, 669; *Am. J. Sci.*, December, 1883, III, XXVI, 477.)

Claverie has also described a capillary electrometer with a horizontal tube, and has given a theoretical discussion of the conditions of sensibility in it. It has a displacement of fifteen centimeters for an electromotive force of one volt, and the zero is fixed. (*J. Phys.*, September, 1883, II, II, 420.)

Debrun has devised a capillary relay, in which the capillary tube being horizontal the motion of the mercury to and fro causes a beam to which it is attached to oscillate on its knife-edges, and so to open or close a secondary local circuit. Since the oscillations are very slow, only about forty-eight a minute, it cannot be used in telegraphy, but the author thinks it useful in automatically registering instruments, such as barometers, thermometers, and galvanometers. (*J. Phys.*, April, 1883, II, II, 169.)

Ducretet has constructed a universal galvanometer which is capable of measuring from 0.1 to 400 amperes when used as an ammeter, and from 0.1 to 700 volts when used as a voltmeter. The needle is immersed in liquid to damp its vibrations and is controlled by a steel magnet beneath it. It is placed at one end of a graduated rule on which slides the coil, movable by a rack and pinion. The coil is wound in a groove in a metal ring, and has a resistance of 5,490 ohms. For measuring current the metal ring itself is used. The instrument is empirically calibrated. (*J. Phys.*, December, 1883, II, II, 556.)

Siemens and Halske have brought out a torsion galvanometer for strong currents. It consists of a magnet suspended between two coils, suspended by a torsion spring so arranged that the amount of torsion required to return it to zero after deflection can be read off directly. Two forms are made, the vertical and the horizontal. In the former the needle is suspended by a silk fiber, the reading being taken from above. In the latter the needle is balanced on a knife-edge and carries a pointer at one end, moving over a scale. The amount of torsion necessary to return the needle to zero is indicated by a second pointer, which is attached to a handle, and which also moves in front of the scale. These instruments may be used either in the main circuit or in a shunt circuit. (*Nature*, October, 1883, XXVIII, 571.)

Obach has improved his movable coil tangent galvanometer by making the coil compound, the ring itself being used for current, and the coil, which is of high resistance, for electromotive force. The coil revolves about a horizontal axis, and can be fixed at any angle. The needle is suspended and can be rendered dead beat. The coils are so balanced that the same deflection is produced by one volt with the high resistance coil which is produced by one ampere with the low one. (*Phil. Mag.*, August, 1883, V, XVI, 77; *Nature*, July, 1883, XXVIII, 257.)

Gray has examined the influence of temperature, density, and chemical composition upon the electric conductivity of glass. He finds that with the varieties of glass having lime as their basis the poorest conductors are those which have a composition most nearly approaching a trisilicate, either of potassium and calcium or sodium and calcium. He finds also that among various specimens of lead glass the poorest conductors have a composition nearest to a trisilicate of potassium and lead. These latter insulate better, as they are more dense. (*Proc. Roy. Soc.*, XXXIII, 256; *J. Phys.*, February, 1883, II, II, 95.)

Foussereau has experimented to determine the effect of hardening upon the electric resistance of glass. He concludes 1st, that hardening diminishes considerably the electric resistance of many kinds of glass; a specimen of lime glass hardened, and then annealed for six hours at 500°, and observed between 35° and 80° showed 2.30 times the original resistance; with flint-glass the difference is still more striking; 2d, moderate annealing, causing the elasticity due to hardening to partially disappear, destroys only in part the action of this hardening on the resistance; and 3d, the resistance of a glass recently annealed continues to increase slowly for some time. (*C. R.*, March, 1883, xcvi, 785.)

The rapidity with which light modifies the resistance of selenium is well shown by an experiment of Bellati and Romanese. A Breguet photophonic receiver received the light of a petroleum lamp after passing a solution of alum. This receiver and a rheostat, in the circuit of ten Bunsen cells, were placed on the two circuits of a differential galvanometer. Between the light and the receiver a disk, pierced with holes, rotated. Though the speed of rotation was widely varied no appreciable change was observed in the mean resistance of the selenium, which could hardly have been the case unless the effect of the light on the selenium was instantaneous. (*Il Nuovo Cimento*, III, xi, 5; *J. Phys.*, November, 1883, II, ii, 518.)

Bidwell has submitted selenium cells to direct examination in order to test the truth of Moser's hypothesis that their change of resistance was an effect of heat. He finds the very reverse to be the fact; that with a single exception all the cells in his possession rise in their resistance as their temperature rises; reaching a maximum and then decreasing. Exposed to sunlight a selenium cell does not become perceptibly warm to the touch; but the amount of dark heat required to effect the same reduction in its resistance would certainly render it too hot to handle. (*Phil. Mag.*, January, 1883, V, xv, 31.)

Fritts has described a new form of selenium cell in which he has succeeded in diminishing materially the resistance, and in which the light is made to strike the cell in the same direction as that in which the current passes. These cells are far more sensitive to light than any before made, falling in resistance from twenty to forty-four times when placed in sunlight. He has also observed a change in resistance on reversing the current, and on varying the strength of the battery. To make these sensitive cells it is necessary to use selenium which has been very carefully purified. (*Am. J. Sci.*, December, 1883, III, xxvi, 465.)

Gray has published a valuable paper on the size of conductors required for the distribution of electric energy, considering the questions of economy, safety, and regulation. (*Phil. Mag.*, September, 1883, V, xvi, 187.)

Thompson has given an ingenious method for representing graphically the law of efficiency of an electric motor. (*Phil. Mag.*, February, 1883, V, xv, 124; *J. Phys.*, March, 1883, II, ii, 131.)

The complete report upon the experiments made at the Paris Electrical Exhibition by the special committee appointed for the purpose, consisting of Allard, Le Blanc, Joubert, Potier, and Tresca, has been published. An abstract of it has been made by Potier. (*Ann. Chim. Phys.*, May, 1883, V, XXIX, 5; *J. Phys.*, January, 1883, II, II, 11.)

Sprague has published the results of his tests made upon the new form of Edison-Hopkinson dynamo, the peculiarity of which is its shortened field magnets. The resistance of the armature cold was 0.026, and hot 0.0325 ohm. The mean of three experiments gave a total efficiency of 94.8 per cent., and a commercial efficiency of 86 per cent. (*Nature*, August, 1883, XXVIII, 405.)

4. *Electric Spark and Electric Light.*

Villari has experimented upon the sparks from a condenser, and upon the modifications which they undergo when various resistances are inserted in the circuit. When a condenser is discharged so as to produce at first a single spark, and then two in series, it is observed that the former is not equal to the sum of the latter in length, nor is it constant in value. The author finds that with his apparatus (which he calls a spintherometer) if one of the sparks is zero the other has its minimum value, 26^{mm}. When it becomes 2^{mm} or less, the sum becomes 40^{mm}, a maximum. Between 3 and 30^{mm} the sum is constant at about 32^{mm}. Hence it appears that a very small spark produced in the circuit of a condenser has the singular property of lengthening a second spark produced simultaneously in the same circuit. The effect of introducing various kinds of resistance in the path of the short spark is given. (*J. Phys.*, June, 1883, II, II, 272.)

Wachter has discovered that the electric spark is produced always by only one of the two electricities, and hence that the carrying of solid particles, which constitutes this spark, is effected sometimes by positive, sometimes by negative, electricity, and therefore always in one definite direction. He finds that positive electricity can give a spark only when the pressure of the air is above 10^{mm} of mercury. Negative electricity can give a spark under pressures included between 63 and 5^{mm}, according to the distance of the electrode from the wall of the tube. As the air becomes more rarefied, the matter transported decreases from the positive and increases from the negative electrode. Positive electricity transports the particles much farther than negative. Under a pressure of 63^{mm}, the positive spark can cross a space of $2,040^{mm}$; the negative one only of 0.6^{mm}, or 3,400 times less. The positive particles follow the line of least resistance, and hence may describe a curvilinear trajectory; the negative particles are thrown off normally, and move in straight lines. A powerful magnet acts on the former as on diamagnetic bodies; on the latter as on paramagnetic substances. The positive particles sometimes become incandescent, and are measurable under the microscope; the negative particles are never incandescent, and are too tenuous to measure. (*Wied. Ann.*, XVII, 903; *J. Phys.*, June, 1883, II, II, 283.)

Edlund has given the results of his experiments in favor of the hypothesis advanced by him, that a vacuum opposes a very feeble resistance to the passage of electricity, maintaining that the resistance experienced is due to a counter electromotive force, increasing with the rarefaction and connected with the electrodes. In exhausted tubes, without electrodes, simple friction produces an electrical glow. (*Phil. Mag.*, January, 1883, V, xv, 1.)

Naccari has examined the heating produced in the electrodes by the induction spark. (*J. Phys.*, II, II, 521.) Hertz has communicated to the Berlin Physical Society some curious results observed by him in the case of electric discharges in air and other gases under a pressure of from 20 to 30^{mm} of mercury. (*Nature*, XXVII, 403.) Goldstein has studied the electric discharge in rarefied gases, especially the so-called reflection of electric rays. (*J. Phys.*, II, II, 179.) Worthington has succeeded in showing that the phenomena of induction take place across a discharge-resisting vacuum. Hence this vacuum cannot be a conductor, at least in the ordinary sense. (*Nature*, March, 1883, XXVII, 434.) De la Rue and Müller have communicated to the Royal Society a paper on the electric discharge produced with the chloride of silver battery of 11,000 cells. (*Nature*, August, 1883, XXVIII, 381.)

Dewar has made a series of manometric observations upon the electric arc. The two carbons used were hollow, and had an interior diameter of 3^{mm}. Their porosity had been destroyed by heating them to a white heat in a porcelain tube, through which benzene vapor was passed, thus depositing compact carbon on their surfaces. The carbons were connected to the interior of two closed flasks, at the bottom of which was ether or other mobile liquid, into which also passed the recurved end of a long horizontal tube serving as a manometer, and showing a variation of 0.004^{mm} pressure. When the arc is well formed, being sharply limited by an almost spherical surface, enveloping the extremity of the positive carbon and just touching the end of the negative, an increase of pressure of one to two millimeters of water is seen at the positive electrode, and a slight decrease at the negative. When the arc hisses, the positive pressure diminishes. When the negative pole throws off incandescent particles, the pressure increases. (*Proc. Roy. Soc.*, XXXIII, 262; *J. Phys.*, January, 1883, II, II, 42.)

Siemens and Huntington have described the modified form of electric furnace lately employed by them. Its novelty consists in the fact that the negative electrode, which passes through the cover of the crucible, is suspended to one end of a lever, to the other end of which is a hollow cylinder of iron moving within a coil, and adjustable by a counterweight. Since the coil, which is placed in shunt circuit, has a high resistance, its attractive force on the cylinder is proportional to the electromotive force between the carbon points, *i. e.*, to the resistance of the arc, the length of which is thus automatically regulated. The advantages of this furnace are, 1st, the temperature is limited only by the refractory resistance of the crucible; and, 2d, the heat is applied directly to the substance to be melted. (*Ann. Chem. Phys.*, December, 1883, V, xxx, 465; *J. Phys.*, March, 1883, II, II, 124.)

Dobrohoff-Maikoff has devised a form of arc-lamp, in which a coil of coarse wire surrounds an iron tube, within which is a rod of iron. When the current passes the two are similarly magnetized, and the rod is repelled from the tube. By means of articulated levers this motion is made to regulate the distance of the carbons. (*J. Phys.*, December, 1883, II, II, 574.)

Lever has invented a simplified form of clutch arc-lamp, in which the upper carbon is clamped in a brass holder sliding freely vertically. A brass washer or collar fits accurately but loosely to it, supported on one side by an adjustable screw, and on the other by a metal piece attached to the framework. This framework is supported by a spiral spring, which keeps the washer tilted against the carbon-holder. This spring is antagonized by an electromagnet in shunt circuit, so that when the current is turned on, the carbon is allowed to fall until contact takes place. Then the shunt magnet loses its force and the spring separates the carbons to form the arc. (*Nature*, January, 1883, XXVII, 274.)

Williams has claimed for an American, Starr, the invention of the incandescent lamp, which was patented after his death by King, in 1845. It consisted of "a short stick of gas retort carbon" in a barometric vacuum. "The light was far more brilliant and the carbon stick more durable than the flimsy threads of the incandescent lamps now in use." It was abandoned solely on account of the cost of supplying the power. (*Nature*, January, 1883, XXVII, 241.)

Fleming has called attention to a phenomenon of molecular radiation in the Edison lamp. When a loose contact occurs so that an arc is formed and the copper projected on the walls of the glass, there is a shadow of one side of the loop on the glass where this side of the filament has protected the glass from the copper bombardment. (*Phil. Mag.*, July, 1883, V, XVI, 48.)

Hopkinson has delivered a lecture at the Institution of Civil Engineers on "some points in electric lighting." The building was lighted by about 230 Edison lamps, each of 16 candles, and each requiring 75 watts of power. To produce the same 16-candles light in ordinary good flat flame gas-burners would require between 7 and 8 cubic feet of gas per hour, contributing heat to the atmosphere at the rate of 3,400,000 foot-pounds per hour, equivalent to 1,250 watts, or nearly seventeen times as much heat as the incandescent lamp of equal power. The direction of progress was in the improvement of the lamp. (*Nature*, April, 1883, XXVII, 592.)

Geraldy has published some valuable statistics comparing the cost of the electric arc-light with gas, both as to its actual cost and its cost per candle power. (*Nature*, October, 1883, XXVIII, 625.)

Tommasi has contrived an electric-light regulator in which the varying resistance which selenium has when exposed to light is made use of.

Thus far it has been applied only to the Jablochkoff candle. (*Nature*, July, 1883, XXVIII, 309.)

Incandescent lighting is steadily working its way into public favor. The Savoy theater, in London, has been lighted with 1,194 Swan lamps for a year and a half with entire success. At the coronation in Moscow, the tower of Ivan the Great, and its side galleries, were lighted with 3,500 Edison lamps. The Edison station in the first district of New York City has run uninterruptedly since September, 1882, constantly increasing the amount of light furnished. In December, 1883, 10,297 lamps were in use in that district, the bills rendered during November exceeding $10,000 for the month's lighting. The capacity of the station has proved totally insufficient for the light required, and is to be largely increased. Hence no electricity has yet been available for power, notwithstanding the demand. At the Vienna Exhibition various forms of incandescent lamps were exhibited, but none showing marked improvement in durability. (*Nature*, March, 1883, XXVII, 418; June, XXVIII, 207; September, XXVIII, 466; November, XXIX, 42.)

5. *Electromagnetism.*

Wassmuth has experimented on the portative force of electromagnets, using semicircular magnets in contact at their polar surfaces. He observed that if a very thin sheet of mica be placed between the magnet and its contact, provided the magnetization is not too strong, the portative force increased from 4.7 to 9 kilograms. (*J. Phys.*, April, 1883, II, II, 193.)

Ayrton and Perry have experimented to determine the effect of different methods of winding upon the strength of electromagnets, the current strength being constant. In the first case the wire was wound uniformly over the entire length; in the second it was "coned" toward each end; in the third it was wound uniformly over one-half the bar only; and in the fourth it was "coned" on one-half only. They conclude that with a definite iron core, a definite length of wire to be coiled on it, and a definite current, the mode of coiling to produce the maximum field depends entirely on the distance from the end of the electromagnet at which this field is to be produced. With the magnet used, they found that at distances very small compared with the length of the core, the fourth method is best. When the field is to be produced at a distance of one-third the length of the magnet, the third method is preferable. While for distances equal to or greater than $\frac{4}{9}$ of the length of the core the first method gives the best results. (*Phil. Mag.*, June, 1883, V, XV, 397.)

At the Montreal meeting of the American Association Graham Bell read a paper upon the electrical experiments made to determine the location of the bullet in the body of the late President Garfield, and upon a successful form of induction balance for the painless detection of metallic masses in the human body. (*Proc. Am. Assoc. Adv. Sci.*, XXXI, 151; *Am. J. Sci.*, January, 1883, III, XXV, 22.)

Du Moncel, in a paper presented to the French Academy, has shown that if one of the poles of a permanent magnet be passed longitudinally along a straight electromagnet, the coil of which is connected to a galvanometer, three induced currents are successively developed; a first, which results from the approach of the inducing pole, and which is an inverse current; a second, which results from the motion of the magnet from one end of the coil to the other, and which is direct; and a third, produced by withdrawing the inducing magnet, which is also direct, though the current flows in the same direction as the first, since the magnet acts on the opposite end of the coil. A conclusion drawn from his experiments is that the induced currents due to an approach of the inductor to the polarized core are the same in direction as the currents which produce the magnetization of the latter when the opposed poles at the instant of approach are of the same name. (*C. R.*, January, 1883, XCVI, 214.)

Munro has experimented upon the action of a metal microphone in vacuo, using two square pieces of fine iron-wire gauze—one fixed, the other suspended so as to swing against the other, the whole inclosed in glass. The pressure of the gauze could be regulated by means of an external magnet. The sensitiveness of the instrument was found to be greatly increased when exhausted. (*Phil. Mag*, July, 1883, V, XVI, 23.)

Several contributions to the theory of the microphone have appeared Bidwell thinks the heat at the point of contact plays an important part in the action; Heaviside finds that the apparent resistance of a contact varies inversely as the square root of the current strength, and hence argues against the use of multiple contacts; but their advantages in practice have been found very considerable. Munro and Warwick regard the action of the microphone as due to the existence of a silent discharge of electricity through the thin stratum of air at the point of contact; a view which is sustained by Mr. Stroh's observation that an actual separation of the contact points may be observed in the microscope while the current continues to flow and the instrument to act. Moreover, he has observed that when in action there is a minute repulsion observable between the two carbons, their motion being 0.0005^{mm}. (*Nature*, April, 1883, XXVII, 588.)

On the history of the telephone Thompson has translated some remarkable passages from Philipp Reis's papers, published in 1860–'61. He proposed at that time the name telephone, and says the instrument can reproduce to a certain degree the human voice, the consonants being, for the most part tolerably distinct, but the vowels not equally so. One of the forms of his telephone was in the form of the human ear, carved in oak wood, the tympanic membrane and apparatus of transmission being made so as to resemble closely the similar parts in the natural organ. (*Nature*, June, 1883, XXVIII, 130.)

Carhart has observed that an iron plate with a hole in it held in front of the pole of a magnet acts magnetically as a screen just as it would act optically, the shadow being sharply defined. By rotating a perforated iron disk between a magnet and a coil with an iron core, a sound was heard in a telephone in circuit corresponding in pitch to the number of perforations which passed per second. When the disk had two rows of holes, one of thirty-two, the other of sixty-four, the interval heard was the octave. He calls the instrument the magnetophone. (*Nature*, October, XXVIII, 626.)

Bosanquet has given a valuable discussion of the theory of the compound dynamo-machine, *i. e.*, one that has its field wound with two coils, one in the main and the other in the shunt circuit. His Gramme dynamo, with field coils in main circuit, failed whenever more than ten ohms was put in the external circuit. Consequently, he wound 2,000 turns of a small wire on pasteboard cylinders, fitting over the main coils, the resistance of these auxiliary coils being about 27 ohms. The ends of this coil are attached to the armature brushes, and even when the main circuit is open an electromotive force of 70 to 80 volts is produced by the machine. The advantages of this alteration are obvious. (*Phil. Mag.*, April, 1883, V, XV, 275.)

The question of the transmission of power electrically has absorbed a large share of attention. On March 15, Siemens gave a lecture on this subject at the Institution of Civil Engineers, giving an interesting résumé of the progress of scientific thought on the subject and a historical sketch of the development of electric railways. (*Nature*, March, 1883, XXVII, 518.) Tresca has made a report to the French Academy upon the transmission of power from Paris to Bourget by the system of Deprez. The distance from one station to the other and back was 17 kilometers. The electric energy was transmitted over an ordinary telegraph wire 4^{mm}. in diameter, having a resistance of 160 ohms. The motive power absorbed by the generator was 6.21 horse-power; that yielded to the brake by the motor was 2.03 horse-power, or 32.7 per cent. The generator made 588 revolutions a minute, and gave an electromotive force of 1,290.5 volts. (*C. R.*, February, 1883, XCVI, 457.) In a second set of experiments the generator made 814 revolutions; the electromotive force developed was about 2,000 volts, the power consumed 10.395 horse-power, and recovered 3.304; giving an efficiency for the system of 31.7 per cent. (*C. R.*, XCVI, 530.) The Academy then appointed a commission, with Cornu as secretary, to repeat the experiments. With a speed of 850 turns, 9.514 horse-power was absorbed by the generator, and 3.582 returned by the motor; a yield of 37.5 per cent. The electromotive force was 1,937 volts. (*Ann. Chim. Phys.*, October, 1883, V, XXX, 214.)

The production of power from accumulators has also made some progress. An electrical tram-car was tried at Kew in March. The battery is placed under the seats, and consists of fifty Faure-Sellon-Volckmar cells, each 13 by 11 by 7 inches, and weighing 80 pounds. It is capable of driving the full car for seven hours. (*Nature*, March, 1883, XXVII, 470.)

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Ueber die Messung elektrischer Kräfte mittelst des elektrischen Flugrads. D. Kaempfer. 8vo. pp. 36. Berlin, 1883. (Friedländer.) Inaug. Diss.

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Die Anwendung der Elektricität für militärische Zwecke. F. Waechter. 8vo. pp. 256. Wien, 1883.

Ueber den Einfluss der galvanischen Polarization auf die Aenderung der Reibung. K. Waitz. 8vo. pp. 39. Tübingen, 1883. (Fues.)

Il telefono; con prefazione del Pietro Blaserna. E. Bottero & C. Magistrelli. 8vo. pp. 82. Torino, 1883. (Loescher.)

Exposition d'électricité, Paris. Expériences faites par Allard, Le Blanc, Potier, et Tresca. Méthodes d'observation; machines et lampes à courant continu, à courants alternatifs; lampe à incandescence; accumulateur; transport électrique du travail; machines diverses. 12mo. Paris, 1883.

Die Elektro-Technik in der praktischen Heilkunde. R. Lewandowski. 8vo. pp. 400. Wien, 1883.

Electricity in Theory and Practice; or the elements of electrical engineering. B. A. Fiske. 8vo. pp. 270. New York, 1883. (Van Nostrand.)

Des progrès récents réalisés dans la construction des lignes télégraphiques et téléphoniques. H. Vivarez. 8vo. pp. 71. Paris, 1883. (Chaix.)

Conférence sur la transmission du travail mécanique par les courants électriques, faite à la Société d'encouragement pour l'industrie nationale. H. Tresca. 4to. pp. 28. Paris, 1883. (Tremblay.)

Manuel d'électrométrie industrielle. R. V. Picou. Paris, 1882. (G. Masson.)

Electricity. R. M. Ferguson. New edition, revised and extended by James Blyth. London and Edinburgh, 1882. (Chambers.)

Electric Illumination. Conrad Cook, James Dredge, M. F. O'Reilly, S. P. Thompson, and H. Vivarez. Edited by Jas. Dredge. Vol. I. London, 1882. (Engineering Office.)

Il potentiale elettrico nell' insegnamento elementare della elettrostatica. A. Serpieri. Milan, 1882.

Electric Lighting Act, 1882. London, 1883. (W. Clowes & Sons.)

Die Lehre von der Electricität. Gustav Wiedemann. Vol. I, pp. xi, 795; Vol. II, pp. vii, 1002. Braunschweig, 1882–3. (Vieweg.)

NECROLOGY OF PHYSICISTS, 1883.

CARL WINTER, electrician, Vienna. Died December 7, 1882.

J. B. LISTING, professor of physiology, Königsberg. Died December, 1882.

C. V. WALKER, president Society Telegraph Engineers. Died at Tunbridge Wells, December 24, 1882, aged 70 years.

General Sir EDWARD SABINE, ex-president Royal Society. Died at Richmond, Eng., June 26, 1883, aged 94 years.

WILLIAM SPOTTISWOODE, president Royal Society. Died in London, June 27, 1883, aged 58 years.

C. F. VARLEY, telegraphic engineer. Died at Bexley Heath, Kent, September 2, 1883, aged 55 years.

J. A. F. PLATEAU, professor emeritus in the University of Ghent. Died September 15, 1883, aged 81 years.

WILLIAM. A. NORTON, professor of civil engineering in Yale College. Died September 21, 1883, aged 72 years.

RICHARD WERDERMANN, electrician. Died in London, September, 1883.

LOUIS BREGUET, electrician, member of the Institute. Died in Paris, October 27, 1883.

P. T. RIESS, professor University Berlin. Died in Berlin, November, 1883.

Sir C. W. SIEMENS, electrical engineer. Died in London, November 19, 1883, aged 60 years.

CHEMISTRY.

By H. Carrington Bolton,
Professor of Chemistry, Trinity College, Hartford.

GENERAL AND PHYSICAL.

Possible Variability of the Law of Definite Proportions.—One of the most interesting subjects discussed during the year (1883) concerns the fundamental conceptions of chemical philosophy. The whole superstructure of modern chemistry rests upon the atomic theory and on the absolute character of that function of an element which we call atomic weight; hence, any proposition to throw discredit on these conceptions may well be regarded as revolutionary. The discussion was introduced by Prof. Adolphe Wurtz, who presented to the *Société chimique de Paris* a summary of the views of Boutlerow; these were emphatically indorsed by Schützenberger, and have since elicited a communication from Prof. Josiah P. Cooke, jr., of Harvard College.

Schützenberger announced in 1880 or 1881 that in analyzing some hydrocarbons the sum of the carbon and hydrogen was 101 for 100 parts of material, the result under other conditions being normal. Boutlerow has called attention to this anomaly as illustrating views he has held for three years. He expresses the opinion that the chemical value of a constant weight (or rather mass) of a substance may vary, and that the so-called atomic weight of an element may be simply the carrier of a certain amount of chemical energy which is variable within narrow limits. He further asks the question whether Prout's hypothesis may not be a true law which, like that of Mariotte, admits of a limited variation. Numerous facts are cited, chiefly the results of quantitative analyses, which seem to confirm these views. If such views prevail, chemical combination can no longer be regarded as the juxtaposition of the definite invariable masses we call atoms, but must be considered as the reciprocal saturation or interpenetration of masses which may vary with the relative strength of their chemical energy acting at the time. Schützenberger, who took part in the discussion, enumerated many facts which led him to the conclusion that the law of definite proportions is not so absolute as generally supposed. We have space but for a single example: When water is synthesized by reduction of a known weight of CuO, by weighing the reduced copper and the water formed, it is found that the ratio of O to H is not constant, but varies with the state of division and of saturation of the oxide, the duration of contact of the water formed with the oxide and with the temperature, from 7.95 to 8.15. The latter value is obtained with a saturated and divided oxide filling the tube; the former, with oxide in lumps filling the tube for a space of 25 centimeters. With a larger empty space the ratio has fallen to 7.90.

Prof. Josiah P. Cooke, jr., calls attention to the fact that he expressed similar views and fully worked them out more than twenty-five years ago. He quotes from his paper on "Two new crystalline compounds of zinc and antimony, and on the cause of the variation of composition observed in their crystals," published in the Memoirs of the American Academy of Arts and Sciences in 1855 (new series, vol. v., p. 337). He also refers to a paper published in the American Journal of Science (second series, xx, 1855) entitled "On an apparent perturbation of the law of definite proportions observed in the compounds of zinc and antimony." In these papers the opinions now under discussion were brought forward, not simply as speculations, but as a legitimate theory advanced to explain the facts observed in his investigations. Professor Cooke shows that as long since as 1855 he questioned the absolute character of the law of definite proportions; he then suggested that the variation is due to the very weak affinity between elements manifesting a fluctuating composition; and he wrote at that time, "To what extent this perturbation of the law of definite proportions prevails among chemical compounds future investigation must determine. There are, however, a number of facts which tend to prove that it is very general whenever chemical affinity is weak." Professor Cooke fully substantiates his claim to priority, and then proceeds to consider whether the progress of chemistry since 1855 has tended to confirm or to invalidate these views. He says, in conclusion, that he "feels that the weight of evidence is at present in favor of the atomic theory, and of that absolute definiteness of combining proportions which this theory involves;" yet at the same time he "is very glad that the whole question" is again open to discussion. "But, although it must be admitted that the atomic theory is the only basis on which a consistent philosophy of chemistry can at present be built," Professor Cooke confesses that "he is rather drawn to that view of nature which refers all differences between substances to dynamical causes, and which regards the atomic theory as only a temporary expedient for representing the facts of chemistry to the mind." (*Am. J. Sci.* (3), XXVI, 63 and 310.)

Atomic Weight Determinations.

Didymium.—Owing to the discrepancies in the existing figures for the atomic weight of didymium, B. Brauner has re-examined the subject. Cleve had previously assigned the figures 147.2, and Brauner himself had found 146.58. The latter undertook experiments to decide which of the numbers represents, or more nearly approaches, the true atomic weight, and to ascertain whether pure didymium is a homogeneous body, or whether it can be split up into heterogeneous constituents, as has been proved to be the case with several metals of the rare earths. Brauner found by his new experiments Di = 145.42. This number differs much from that previously obtained by Brauner, who believes the discrepancy due to the elimination of an element of a higher atomic weight and of a less basic nature than didymium. This proved to be samarium, *q. v.* (*J. Chem. Soc.*, 1883, 278.)

P. T. Cleve has also examined this question, and having eliminated foreign bodies by fractional precipitation he obtained the value Di = 142.33, when O = 16. He had previously obtained (in 1874) Di = 147.2, but he attributes the discrepancy to the presence of the then unknown element samarium. (*Bull. soc. chem.*, XXXIX, 289.)

Samarium.—Brauner, in the course of his researches into the atomic weight of didymium, investigated the atomic weight of samarium, and assigns to it the value 150.7. (*J. Chem. Soc.*, 1883, 278.)

P. T. Cleve has also determined the atomic weight of samarium by converting the pure oxide Sm_2O_3 into the sulphate, and obtained from six closely agreeing experiments the value 150.021, or, in round numbers, 150. Cleve thinks samarium entitled to fill the eighth line, eighth group of Mendelejeff's Periodic System. (*J. Chem. Soc.*, 1883, 362.)

Lanthanum.—In 1874 P. T. Cleve found the atomic weight of La=139., figures which agreed well with determinations by Marignac and Brauner. More recent investigations by Brauner led to the value 138.28, and his researches seemed to denote the existence of a foreign oxide accompanying the lanthanum. Cleve himself was at one time inclined to admit the existence of such a substance by the observation of a blue ray ($\lambda = 4333.5$) in the spectrum of the fractions intermediate between lanthanum and didymium; but this ray proved to belong to lanthanum. To decide the question of the existence of this hypothetical body between La and Dd, Cleve submitted mixtures to several series of partial precipitations by dilute ammonia. His results give for La 138.019 (O = 15.9633). They also show that La is not split up, but is a homogeneous body. (*Bull. soc. chem.*, XXXIX, 151.)

Yttrium has again been examined by P. T. Cleve, who effected a more complete separation from terbium by precipitating the acid solution of the nitrate by means of oxalic acid. In the successive fractions thus obtained Cleve determined the atomic weight, which he places at 89.02 for Y^{III}, when O=16. Determinations by the same author in 1872 gave him 89.485. (*Comptes rendus*, December 11, 1882.)

Thorium has been re-examined by L. F. Nilson, who determined its specific heat, and thence estimates the atomic weight at 232.4 for Th^{IV}. (*Comptes rendus*, XCVI, p. 346.)

Dithium.—D. Tommasi, on purely theoretical grounds, thinks the atomic weight of Lithium in its compounds is double that which it possesses in a free state. He proposes for lithium chloride the formula $LiCl_2$, bringing the metal into the family group Ba, Sr, and Ca, with which, in its compounds, it certainly bears many analogies. (*Cosmos, les mondes*, No. 2, 1883.)

Glucinum.—By determining anew the specific heat of metallic glucinum, Dr. T. S. Humpidge obtained the figures 0.4455, and this gives an atomic weight=13.65 instead of 9.1, as usually assigned. (*Chem. News*, XLVII, 181.)

Humpidge's results have been questioned by Dr. J. Emerson Reynolds, who shows that the material used by Humpidge was less pure than that used by Messrs. Nilson and Petterson. He thinks that the weight of evidence is in favor of the value 9.2 for the atomic weight, the metal being a dyad. To this criticism, however, Dr. Humpidge replies in a third article, maintaining the purity of the material used and rejecting Reynolds' views as to the valence of the element. (*Chem. News*, XLVII, p. 297.)

Titanium.—The atomic weight of titanium has been carefully revised by Prof. T. E. Thorpe, who obtained as a mean of nineteen determinations Ti=48.00. (*Chem. News*, XLVIII, 251.)

Manganese.—Professors James Dewar and Alexander Scott, of Cambridge, England, have redetermined the atomic weight of manganese, and obtain as a mean of eight experiments the value 55.038 when O = 16 and Ag = 107.93. The methods employed were the reduction of silver permanganate by hydrogen (which, however, was unsatisfactory), and the reduction of the same salt by sulphurous acid, sodium formate, or potassium nitrite, and subsequent titration of the silver with dilute potassium bromide. (*Chem. News*, XLVII, 98.)

Marignac has also redetermined this constant, obtaining Mn = 55.07. (*Archives des sci. phys. nat.* (3), X, 5.)

Antimony.—Bongartz has recently estimated anew the atomic weight of antimony by the method proposed by Classen. The average of twelve experiments was 120.193, which very closely approximates the results of Schneider and of Cooke. (*Ber. d. chem. Ges.*, XVI, 1942.)

Additional Redeterminations of Atomic Weights.

Nickel: Ni=58.75 by Baubigny. (*Comptes rendus*, XCVII, 951.)

Copper: Cu=63.46, by Baubigny. (*Comptes rendus*, XCVII, 906.)

Tellurium: Te=125.0 by Brauner. (*Ber. d. chem. Ges.*, XVI, 3055.)

Bismuth: Bi=208.16 by Marignac. (*Archives des sci. phys. nat.* (3), X, 5.) Also by Lowe, who obtained Bi=207.33. (*Zeitschr. anal. Chem.*, XXII, 489.)

Zinc: Zn=65.29 by Marignac. (*Archives des sci. phys. nat.* (3), X, 5.)

Magnesium: Mg=24.37 by Marignac. (*Archives des sci. phys. nat.* (3), X, 5.)

Atomic Weights of the Elements.

Lothar Meyer and K. Seubert have published a recalculation of the atomic weights of the elements from the original numbers. The values obtained differ but little from those previously published by F. W. Clarke (*Constants of Nature*, Part V), though they are not all identical. The following table may be usefully reprinted here, since it contains most reliable figures. All values whose possible error lies between 0.01 and 0.5 H are denoted by (*a*).

Name.	Symbol.	Atomic weight.	Name.	Symbol.	Atomic weight.
Aluminium	Al	(*a*) 27.04	Niobium or Columbium	Nb	93.7
Antimony	Sb	119.6	Nitrogen	N	(*a*) 14.01
Arsenic	As	(*a*) 74.9	Norwegium	Ng	?
Barium	Ba	(*a*) 136.86	Osmium	Os	195
Beryllium	Be	(*a*) 9.08	Oxygen	O	(*a*) 15.96
Bismuth	Bi	207.5	Palladium	Pd	106.2
Boron	B	(*a*) 10.9	Phosphorus	P	(*a*) 30.96
Bromine	Br	(*a*) 79.76	Platinum	Pt	(*a*) 194.3
Cadmium	Cd	(*a*) 111.7	Potassium	K	(*a*) 39.03
Caesium	Cs	(*a*) 132.7	Rhodium	Rh	104.1
Calcium	Ca	(*a*) 39.91	Rubidium	Rb	(*a*) 85.2
Carbon	C	(*a*) 11.97	Ruthenium	Ru	103.5
Cerium	Ce	141.2	Samarium	Sa	* ?
Chlorine	Cl	(*a*) 35.37	Scandium	Sc	(*a*) 43.97
Chromium	Cr	52.45	Selenium	Se	78.87
Cobalt	Co	58.6	Silicon	Si	28.0
Copper	Cu	(*a*) 63.18	Silver	Ag	(*a*) 107.66
Decipium	Dp	?	Sodium	Na	(*a*) 22.995
Didymium	Di	146.0	Strontium	Sr	(*a*) 87.3
Erbium	E	166	Sulphur	S	(*a*) 31.98
Fluorine	F	(*a*) 19.06	Tantalum	Ta	182
Gallium	Ga	69.9	Tellurium	Te	† 127.7
Gold	Au	196.2	Terbium	Tb	?
Hydrogen	H	(*a*) 1.00	Thallium	Tl	203.7
Indium	In	(*a*) 113.4	Thorium	Th	231.96
Iodine	I	(*a*) 126.54	Thulium	Tm	?
Iridium	Ir	(*a*) 192.5	Tin	Sn	117.35
Iron	Fe	(*a*) 55.88	Titanium	Ti	50.25
Lanthanum	La	138.5	Uranium	U	239.8
Lead	Pb	(*a*) 206.39	Vanadium	V	(*a*) 51.1
Lithium	Li	(*a*) 7.01	Wolfram (Tungsten)	W	(*a*) 183.6
Magnesium	Mg	23.94	Yα and Yβ		?
Manganese	Mn	54.8	Ytterbium	Yb	172.6
Mercury	Hg	(*a*) 199.8	Yttrium	Y	89.6
Molybdenum	Mo	(*a*) 95.9	Zinc	Zn	64.88
Mosandrium	Ms	?	Zirconium	Zr	90.4
Nickel	Ni	(*a*) 58.6			

* See determination in preceding pages. † Perhaps Te = 126.3.

Experiments at remarkably low Temperatures; Solidification of Alcohol and of Nitrogen.—The long-recognized distinction between condensible vapors and permanent gases was forever abolished in December, 1877, by the memorable experiments of Messrs. Cailletet and Raoul Pictet. These gentlemen, working independently and with different appliances, succeeded, it will be remembered, in liquefying oxygen, nitrogen, and even hydrogen, in glass tubes. Since that date S. Wroblewski and K. Olszewski have taken up the study of the liquefaction of gases with great success. In 1882 Cailletet had recommended liquefied ethylene as a means of producing intense cold; this liquid at the normal pressure boils at —105° C. Having compressed oxygen in a tube, and cooled it by means of liquid ethylene to —105°, Cailletet observed, when some of the gas was allowed to escape, "a tumultuous ebullition which lasted for an appreciable time and resembled the projection of a liquid into the cooled portion of the tube," but the liquid and gas could not be separated. By means of a new apparatus, the Austrian chemists subjected comparatively large amounts of gas to a pressure of several hundred atmospheres, and thereby obtained some remarkably low temperatures; carbon disulphide and alcohol were solidified, and oxygen was easily and completely liquefied. By allowing the liquefied ethylene to boil in a vacuum a temperature of —136° was obtained, as determined by the hydrogen thermometer. Oxygen begins to liquefy at a pressure of 26.5 atmospheres and a temperature of —131.6°, and forms a colorless transparent liquid, very mobile, and yielding a sharp meniscus. Carbon disulphide freezes at about —116°; alcohol becomes viscous like oil at about —129°, and solidifies to a white mass at —130.5°.

These results were communicated to the French Academy of Sciences early in the year 1883, and on the last day of the same year Wroblewski announced the following additional results.

Having succeeded in obtaining liquefied oxygen in large quantity he employed it as a refrigerating agent. When liquid oxygen is suddenly allowed to evaporate by release of the pressure it does not solidify like carbon dioxide, but it leaves a crystalline residue on the bottom of the apparatus. Whether this is crystallized oxygen or not, Wroblewski was unable to determine. In attempting to measure the temperature of oxygen in a state of ebullition he made use of a thermo-electric method which admits of the registration of all the sudden changes of temperature of the medium and is also very sensitive. Wroblewski gives the temperature of —186° C. "as the first approximation to the temperature produced by the sudden release from pressure of liquefied oxygen." By submitting nitrogen to this low temperature, the compressed gas allowed to expand a little solidifies and "falls like snow in crystals of remarkable size."

Experiments of this character demand great resources and are not devoid of danger. Wroblewski states that since the apparatus is partly constructed of glass great inconvenience is caused by the constant danger of serious explosions, and having experienced several accidents he and his assistants always work with masks before their faces. (*Comptes rendus*, XCVI, 1140 *et seq.* Also, abstracts in *Am. Chem. Journ.*, V, 146, and *Chem. News*, XLIX, 13.)

Radiant Matter Spectroscopy, a new Method of Spectrum Analysis.—William Crookes gave the Bakerian Lecture before the Royal Society on May 31, 1883, under the above title, and presented a novel and remarkable extension of investigations into the phenomena of radiant matter with which his name is identified.

Many substances when struck by the molecular discharge from the negative pole in a highly exhausted tube emit phosphorescent light, some faintly and others with great intensity. On examining the emitted light in the spectroscope most bodies gave a faint continuous spectrum, and more rarely the spectrum of the phosphorescent light is discontinuous. Especial attention has been directed to the latter phenomenon. After a long and laborious search for an unknown substance which gave under the above conditions a bright citron-colored band or line, Crookes found it belonged to yttrium. In the course of his investigations he worked up 10 pounds of North Carolina zircons, 2 pounds of orangite and thorite and about 15 pounds of North Carolina samarskite, reviewing the characteristics of all the rare earths known to exist in these minerals and those awaiting confirmation. Crookes finally narrowed the elusive substance down to yttrium, the spectrum of which in a radiant matter tube is very beautiful, consisting of an intensely brilliant citron band and two bright green bands together with fainter lines not characteristic. The best results are obtained with the sulphate; pure yttria precipitated by ammonia does not phosphoresce in the slightest degree.

The extraordinary delicacy of this new test for yttrium is such that the element was detected when present in one-millionth part. Crookes found in pink coral 1 part of yttrium in 200 parts; strontianite contains 1 in 500; calcite 1 in 10,000; ox bone 1 in 10,000; an earthy meteorite 1 in 100,000; and tobacco ash 1 part in 1,000,000. The wide distribution of yttrium is notable. (*Chem. News*, XLVII, 261.)

Relation between the Composition and Absorption Spectra of Organic Bodies.—Gerhard Krüss and S. Œconomides have examined the absorption spectra of indigo and its methyl, ethyl, nitro- and amido-derivatives, with a view to determining the relation between chemical composition and absorption spectra. They conclude that the introduction of methyl, oxymethyl, ethyl, and bromine in the place of an atom of hydrogen moves the absorption bands to the less refrangible end of the spectrum, and the introduction of the nitro and amido groups has an opposite effect. The apparatus employed was the universal spectroscope, by A. Krüss of Hanover, having fine adjustments. (*Ber. d. chem. Ges.*, XVI, 2051.)

INORGANIC.

Boron.—The substances obtained by the action of aluminium on boric acid at a very high temperature have been variously described by chemists; Deville and Wöhler obtained yellowish or reddish regular octahedra, containing variable proportions of carbon and of aluminium, together with lustrous black scales or plates containing 2.4 per cent. carbon. On the other hand, Hampe assigned to the black crystalline plates the formula $Al\ B_6$ and to the yellow octahedra the formula $C_2Al_2B_{24}$. These discrepancies have led to an examination of the subject by A. Joly, who states that at the elevated temperature used by Deville and Wöhler only very small quantities of the large black plates were obtained, but at a lower temperature, with small quantities of material, smaller black crystals united to the yellow ones are formed. It is this substance that Deville and Wöhler probably analyzed, while Hampe reduced boric acid in clay crucibles at a much lower temperature and obtained large black crystals containing but little carbon. Joly also finds that the yellow crystals AlB_6 dissolve readily in boiling nitric acid without a residue, but the brown or black crystals obtained at a high temperature leave a carbonaceous residue when treated with the same oxidizing agent. The products of the reduction of boric acid by aluminium therefore embrace:

(1) AlB, yellow hexagonal plates.

(2) AlB_6, large black crystalline scales.

(3) Yellow cubical crystals containing Al and C.

(4) Several compounds of carbon and boron not further characterized. (*Comptes rendus*, XCVII, 456.)

Hydrated Carbon Disulphide.—All who have worked with carbon disulphide are familiar with the peculiar cauliflower-like growth of a snow-white substance which forms when the volatile liquid is filtered or otherwise exposed to rapid evaporation. Berthelot, Wartha, Ballo, and others, have studied this substance, and the latter has recorded some experiments to prove that the white excrescence is a hydrate and not solid carbon disulphide. Prof. F. P. Venable, of the University of North Carolina, has studied anew this body and obtained evidence that the amount of moisture in the air has a decided effect upon the ease and rapidity of its production. No fixed law, however, could be deduced. The following experiment is conclusive and confirms Ballo's results: An open-necked bell-jar, ground, greased, and tightly fitting to a ground-glass plate was provided with a large rubber stopper pierced with two holes. Through one of these openings a calcium chloride tube 250 mm. long was inserted, and through the other a glass tube with a glass rod working tightly in it and rendered air tight by rubber tubing. Inside the bell-jar was placed a watch glass containing purified carbon disulphide supported above a vessel of fresh concentrated sulphuric acid. A small strip of previously dried filter paper was attached to the end of the glass rod within the bell-jar, and when this was lowered it dipped into the volatile liquid; the liquid rose rapidly in the pores of the paper, but even after some minutes no sign of a solid incrustation was visible. When, however, the sulphuric acid was replaced by water the solid began to form immediately after the lowering of the paper. By drawing air through the jar until it was filled with aqueous vapor the solid hydrate suddenly and completely melted away. During the evaporation of the carbon disulphide in an open shallow dish the liquid reached a temperature of —6° C. By forcing air over it the thermometer fell to —19.5° C. (*Am. Chem. Journ.*, v, 15.)

Blue Chloride of Sodium.—This mineralogical curiosity occurs in small quantity in the salt mines of Stassfurt and the cause of the blue coloration has been studied by B. Wittjen and H. Precht. As already noticed by F. Bischof, the blue salt imparts no color to its aqueous solution; and the authors of this paper find that no coloring matter can be extracted by ether or by carbon disulphide. S. W. Johnson has suggested that the blue color is due to sodium subchloride, but these authors find that the color is not at all affected by heating the salt at 100° C. in chlorine gas. They therefore conclude that the blue color is an optical phenomenon. Pulverization and heating to 280° C. destroys the color, probably owing to the liberation of confined gases. (*Ber. d. chem. Ges.*, XVI, 1454.)

The *Fluorine compounds of Uranium* were made the subject of investigation in 1866 by H. Carrington Bolton. Ditte (*Comptes rendus*, 91) afterwards prepared the same bodies and gave analytical data differing widely from those of Bolton. Arthur Smithells has now gone over the same ground and confirms the results previously obtained by Bolton, and shows that the compounds claimed by Ditte have no existence. (*J. Chem. Soc.*, March, 1883.)

Nitrogen Selenide has been prepared by M. Verneuil, by acting on a mixture of selenium perchloride and carbon dichloride with dry ammonia gas. Its composition is Se_2N, and it forms a light orange amorphous powder, insoluble in water, ether, and alcohol, slightly soluble in benzene and carbon disulphide. When dry it detonates if struck with a hard body, and explodes if heated to 230° C. (*Bull. soc. chim.*, XXXVIII, 548.)

Occurrence of Thallium in Sylvite and Carnallite.—Julian Schramm gives the following analysis of sylvite from Kalusz:

Potassium chloride	99.250
Sodium chloride	0.594
Calcium chloride	0.012
Calcium sulphate	0.143
Thallium chloride	traces.
	99.999

The author found thallium in carnallite and in kainite; in the former it is associated with rubidium, but the latter contains neither rubidium nor cæsium. He thinks this association gives additional grounds for classifying thallium with the alkali-metals: sodium, lithium and cæsium occur together on one hand, and potassium, rubidium, and thallium on the other. (Liebig's *Annalen*, CCXIX, 374.)

Researches on the Compounds of Gold.—P. Schottländer has published an extended research on gold and its salts, in which he describes several new bodies and examines with care reactions already known. Auro-potassium bromide forms a very stable salt, neither deliquescent nor efflorescent and obtained in large crystals. The action of manganous acetate on neutral gold chloride yields a mixture of metallic gold and hydrated oxide of manganese of varied composition. Hydrated gold monoxide $Au^{11}{}_3O_2(OH)_2$ forms a light crystalline powder of a pure black color. Hydrochloric acid decomposes it with formation of the metal, trioxide and water. Nitrate of goldtrioxinitrate, aurylnitrate, acid aurylsulphate and its potassium compound and gold monoxysulphate $Au^{11}SO_4$ are further described in this paper. Schottländer regards gold as divalent. (Liebig's *Annalen*, CCXVIII, 312.)

Manufacture of Aluminium.—Secular papers and scientific journals contain notices of improved methods in the industrial preparation of aluminium, some of which were patented in the year 1882, and great claims are advanced as respects the economy of the processes. Aluminium, it will be remembered, was first obtained in its metallic state by Friedrich Wöhler in 1826, who decomposed the chloride by sodium, and although (with one exception) aluminium is the most abundant metal known, thirty years elapsed before its industrial preparation was successfully accomplished. This was done by Henri Sainte Claire Deville, who improved greatly the preparation of sodium, the most expensive ingredient used. Still the metal has sold at the relatively high price of $20 per pound, and its physical properties are such that its production at cheaper rates is most desirable. James Webster, an English chemist and metallurgist, has devised the following method for the preparation of alumina for the purpose of manufacturing the metal: Three parts of alum are mixed with one part of coal pitch, and the mixture heated to 200° to 260° for about three hours. The mass is cooled, broken into pieces, and hydrochloric acid of 20 to 25 per cent. is poured over them, giving rise to the evolution of sulphuretted hydrogen. When this gas ceases to come off about 5 per cent. of charcoal powder or lamp-black is added and enough water to make a thick mass. This mass is thoroughly broken up and mixed in a mill, and then worked into balls weighing about one-half kilogram each. These balls are perforated to facilitate drying, and dried first in a chamber heated to 40° and then in a furnace at 95° to 150°. The balls are then placed in retorts and heated to low redness for about three hours, while a mixture of two parts of water vapor and one of air is passed through, so that sulphur and charcoal are converted into sulphur dioxide and carbon dioxide and thus escape. The dry residue, consisting of aluminium, oxide and potassium sulphate, is removed from the retorts, cooled, ground to powder in a mill, and treated with about seven times its weight of water, and after boiling by means of steam, the solution containing potassium sulphate is run off and evaporated to dryness. The residue, consisting of aluminium oxide, is washed and dried. At the *Aluminium Crown Metal Works*, in Hollywood, under the direction of Mr. Webster, another method is said to be employed. The mineral beauxite, an aluminium-ferric hydrate, is ignited with sodium carbonate, and the sodium aluminate formed is decomposed with carbonic anhydride, yielding pure alumina; this is then heated with charcoal in a current of chlorine, forming a double chloride of sodium and aluminium, which is finally decomposed by sodium, furnishing aluminium. It is said that a ton of the metal costs by this process only $500, whereas it formerly cost $5,000. At Webster's works, it is said that the output of metal amounts to 20 (!) tons per week, a manifest exaggeration.

J. Norris, of Uddington, near Glasgow, has obtained a patent for manufacturing aluminium by treating an intimate mixture of alumina and charcoal with carbonic anhydride at a low red heat, a reaction which is regarded as doubtful by many chemists. Morris claims that the carbonic anhydride is reduced to carbon monoxide by the charcoal, and that in turn reduces the alumina. The metal is obtained by this process as a porous, spongy mass which is melted and poured into molds.

At Salindres, France, about 2,400 kilogrammes of aluminium are manufactured annually. The process is the old one of decomposing the double chloride of aluminium and sodium by metallic sodium, some cryolite being added as a flux.

The chief value of aluminium at present is in tempering or giving strength and a surface or body to alloys, bronzes, or metals so they will not corrode. In the bronze $\frac{1}{1700}$ part of aluminium tends to soften the brittle and hard nature of the baser metal. The tensile strength of aluminium bronze is great; it bears a strain of 42 tons to the square inch, or 12 tons more than the best Bessemer steel. It is said to be unequaled for pianos and telegraph wires. Dr. Gegring, of Land street, is reported to have invented an inexpensive process for coating ordinary iron with aluminium, and the coating can be given any color desired. (Dingler's *polytechnisches Journal*, and other sources.)

Present Condition of the Soda Industry in Europe.—Mr. Walter Weldon read an important paper on the above subject before the London section of the Society of Chemical Industry, on January 8, 1883. He stated that in recent years manufacturers of soda by the Leblanc process had failed to reap satisfactory profits and in some cases had met with financial ruin. Of twenty-five alkali works which were in operation in the neighborhood of Newcastle-on-Tyne a very few years ago only thirteen are in operation now, and of the other twelve, not fewer than eight have been actually dismantled, in utter despair of its ever again being possible to manufacture soda in them by the Leblanc process except at an absolute loss. In Belgium the industry has entirely ceased; in France, Germany, and Austria the industry still exists, being protected by impost duties. Aided by manufacturers in all parts of the world Mr. Weldon has compiled the following table of the present soda production in various countries:

Present soda production of the world.

Countries.	Leblanc soda.	Ammonia soda.	Totals.	Ammonia soda per cent. of total soda.
Great Britain	380,000	52,000	432,000	12.0
France	70,000	57,125	127,125	44.9
Germany	56,500	44,000	100,500	43.8
Austria	39,000	1,000	40,000	2.5
Belgium	....	8,000	8,000	100.0
United States	....	1,100	1,100	100.0
Tons	545,500	163,225	708,725	23.0

From this it is evident that the total quantity of soda now being manufactured annually is nearly 709,000 tons, of which more than 163,000 tons are made by the ammonia process.

Although the ammonia process was first proposed by Dyer & Hemming more than forty-seven years ago, it is less than seventeen years since it has been carried on industrially. In 1866 Ernest Solvay, of Brussels, began to produce soda by the ammonia process at his works near Charleroi; in 1866–'67 he manufactured 179 tons; this increased to 11,580 tons in 1876–'77, and 53,400 tons in 1881–'82. Mr. Weldon estimates that about 40 per cent. of the total soda now made on the continent is produced by the ammonia process. In England, also, the competition of the ammonia process has attained a magnitude which is alarming the makers of Leblanc soda.

Another circumstance is injuriously affecting the Leblanc system, viz, the loss of profits on the by-products. Originally, soda was the only commercial product of the process, the hydrochloric acid being turned to no account. In time a demand grew up for chlorine, and the hydrochloric acid began to be utilized profitably; then the soda ceased to be profitable, and became a by-product in the manufacture of chlorine; next, this source of profit failed and recourse was had to the "burnt ore" or "pyrites cinders" obtained as a secondary product by roasting pyrites for sulphuric acid, and which is treated for copper, silver, and to some extent for gold. The Rio Tinto Company, of Spain, owning enormous deposits of pyrites, intend establishing in France and elsewhere works for manufacturing Leblanc soda, and expect to derive their profits neither from the soda nor from the chlorine, but from the copper and the residual oxide of iron.

The extension of the ammonia process of manufacturing soda has led to devising plans for obtaining ammonia itself more cheaply, and it is now collected from coke ovens in France and in England, and from blast furnaces in Scotland. From the latter source alone Mr. Weldon estimates the amount of ammonium sulphate produced at 20,000 tons per annum.

To maintain the Leblanc industry in England, Mr. Weldon thinks the manufacturers must have cheaper pyrites, and must perfect methods for the recovery of sulphur from the alkali waste. He regards favorably the Schaffner and Helbig process for sulphur recovery, which consists of two operations indicated by the following equations:

First operation.

$$Ca\,S + Mg\,Cl_2 + 2H_2O = H_2S + Ca\,Cl_2 + Mg\,H_2O_2.$$

Second operation.

$$Ca\,Cl_2 + Mg\,H_2O_2 + CO_2 = Mg\,Cl_2 + Ca\,CO_3 + H_2O.$$

In closing his interesting paper, of which we have given but a brief summary, Mr. Weldon states that the immediate future of the English Leblanc soda industry is somewhat gloomy, but suggests the motto *nil desperandum.* (*Chem. News*, XLVII, 67 *et seq.*)

Phosphides of Platinum.—Prof. F. W. Clarke and Mr. O. T. Joslin have examined the bodies resulting from the fusion of platinum and phosphorus, a process suggested by the discovery of Mr. Holland, recorded in our previous report. Professor Clarke finds proof of the existence of three simple phosphides, PtP_2, PtP, and Pt_2P, and of a double phosphide, Pt_3P_5. The monophosphide by virtue of its insolubility in aqua regia, is the most noteworthy. The compound Pt_2P is malleable and is analogous to Pt_2P previously described, and called in the patent of Mr. Holland "fused iridium." The compound PtP_2 is probably identical with the phosphide described by Schrötter and obtained by heating the finely divided metal in phosphorus vapor. (*Am. Chem. Jour.*, V, 231.)

Researches on the Complex Inorganic Acids.—Dr. Wolcott Gibbs, in two additional papers, continues his investigations in the remarkable field mentioned in our report for 1882. He describes the preparation and properties, and discusses the structural formula of hypophospho-molybdates, hypophospho-tungstates, phosphoroso-molybdates, vanadio-molybdates, vanadio-tungstates, phospho-vanadio-molybdates, vanadio-vanadico-molybdates, vanadio-vanadico-tungstates, phospho-vanadio-vanadico-tungstates.

It is impossible in the brief space at our command to give an adequate idea of these remarkable researches. The evident beauty of many of the well crystallizing complex salts, the exceedingly difficult problems in analytical chemistry which are involved, and the admirable theoretical discussions conjoined, make these papers masterpieces in the science. (*Am. Chem. J.*, V, 361 and 391.)

Manufacture of Potash Alum from Feldspar.—In 1882 Mr. John Spiller published an article proposing to manufacture potash alum by treating feldspar with sulphuric acid and a fluoride, the latter being either fluorspar or cryolite. Both these minerals can be had very cheaply, but Mr. Henry Pemberton, jr., undertakes to show that the difficulties of the process are such as to leave little or no margin for profit. The weak point in the process is the quantity of acid required, and in the production of three tons of bulky, insoluble, comparatively useless calcium sulphate for every ton of alum made. Cryolite is shown to be too expensive, and moreover yields the wrong alkali, soda in place of potash. And if the necessary potash were added, enormous quantities of Glauber's-salt would be left upon the manufacturer's hands. (*Journ. Frankl. Inst.*, 1883.)

Analyses of the Geyser Waters and Deposits of the Yellowstone National Park.

Dr. Henry Leffmann has published analyses of the waters of several of the Yellowstone Geysers and of the incrustations forming in their vicinity. From these we select the following:

I.—*Pearl Geyser.*

	Grains in imp. gallon.
Calcium sulphate	1.40
Sodium sulphate	1.89
Sodium chloride	61.39
Silica	7.84
	72.52

At the bottom of the bottle containing this water impure gelatinous silica was found yielding after drying over strong sulphuric acid:

	Per cent.
Water	4.9
Silica	79.1
Alumina	traces
Ferric oxide	traces
Calcium oxide	traces

II.—*Opal Spring.*

The water of this spring is opalescent and on evaporation gelatinizes before becoming dry:

	Grains in imp. gallon.
Sodium chloride	72.18
Calcium sulphate	3.22
Calcium chloride	4.06
Silica	53.76
	143.22

III.—*Water of Mammoth Hot Springs.*

	Grains in imp. gallon.
Sodium sulphate	34.44
Sodium chloride	18.90
Calcium carbonate	17.92
Magnesium carbonate	8.68
Silica	3.36
	83.30

IV.—*Deposit from Mammoth Hot Springs.*

Calcium carbonate	96.80
Magnesium carbonate	1.36
Alumina and iron	0.45
Silica	0.25
Water	0.50
	99.36

(*Am. J. Sci.*, CXXV, 104 and 351.)

Decomposition of Minerals by Citric Acid.

H. Carrington Bolton has continued his investigations as to the action of organic acids on minerals, and publishes the following results. The acid employed was citric acid, which, as the author has shown, has a power of decomposing minerals little less than that of hydrochloric acid; the effect of prolonged action at ordinary temperatures was especially considered. Of the sulphides, chalcocite showed signs of decomposition at the end of ten days, and after several months a partial solution of a green color was obtained; pyrite was attacked in eight days, and a month later a solution of a reddish yellow color was obtained; chalcopyrite acted similarly; one gram lost 11 per cent. after fourteen months' contact with the citric acid solution. Of the oxides magnetite and limonite were strongly attacked in eight days, hematite yielding more slowly. Of the silicates datolite was the most quickly decomposed, yielding gelatinous silica after twenty-four hours; hornblende, pyroxene, almandite, epidote, and serpentine were decidedly decomposed in eight days, and after fourteen months the last named yielded a dry, gelatinous mass. The feldspars are unequally attacked under like conditions; labradorite yielded most easily. Muscovite and biotite yielded very slowly, the latter showing signs of decomposition the sooner, minute scales and slimy silica separating after two years' subjection to the acid solution.

Dr. Bolton gives the following:

Table showing approximate relative disintegration of rock-forming (and associated) minerals by citric acid in solution.

Quickly decomposed.	Slowly decomposed.	Very slowly decomposed.	Not decomposed.
Carbonates.	Serpentine.	Orthoclase.	Quartz.
Phosphates.	Pyroxene.	Oligoclase.	Corundum.
Prochlorite.	Hornblende.	Albite. (?)	Spinel.
Chrysolite.	Labradorite.	Biotite.	Beryl.
Nephelite.	Garnet.	Muscovite.	Barite.
	Epidote.	Tourmaline.	Talc. (?)
	Vesuvianite.	Staurolite.	Kyanite.
	Pyrite.	Hematite.	
	Limonite.		
	Magnetite.		
	Gypsum. (?)		

(*Proceedings Am. Assoc. Adv. Science*, XXXI, 271.)

New Explosives.—Pyronome is the name given by M. Sandoy to a new explosive mixture consisting of 69 parts saltpeter, 9 of sulphur, 10 of charcoal, 8 of metallic antimony, 5 of potassium chlorate, 4 of rye flour, and a few centigrams of potassium chromate. These are to be mixed in an equal volume of boiling water, and the mass evaporated down to a paste, dried and powdered as wanted. This mixture is said to be cheaper than dynamite, but its manufacture and use must be attended with considerable danger.

S. H. Hinde proposes a new explosive mixture composed of 64 parts of nitro-glycerine, 12 of ammonium citrate, 0.25 of ethyl palmitate, 0.25 of calcium carbonate, 23 of coal, and 0.50 of sodium carbonate. The special advantages of this complex mixture do not appear.

A new explosive has just been patented in England by Dr. C. W. Siemens. The compound is a mixture of saltpeter, chlorate of potash, and a solid hydrocarbon, and is suitable both for mining purposes and fire-arms, while, if ignited in the open air, the combustion takes place slowly and imperfectly, and, therefore, without danger. The new compound, which has about the same density as ordinary gunpowder, and is very hard, possesses with equal volume more than double the explosive force of the latter. The intensity of explosion can be regulated at will by varying the proportions of the ingredients and the size of the granules. (Munroe's *Notes on the Literature of Explosives.*)

Use of Limed Coal in Gas-making.—Prof. J. Alfred Wanklyn read a paper on the above subject before the British Association for the Advancement of Science at the Southport meeting in August, 1883.

As the gas manufacture is usually carried on, only a small part of the nitrogen contained in the coal is recovered in the form of ammonia;

whereas the coal might furnish 25 to 50 pounds of ammonia per ton of coal, only 5 or 6 pounds are actually obtained. By mixing a little lime with the coal before introducing it into the retort, the yield of ammonia is greatly increased, and at the same time the gas formed loses its fetid odor. The invention is patented, and is known as Cooper's liming process.

At the Beckton gas-works, where a series of experiments were carried on, the addition of lime produced a gain of 36 per cent. of ammonia. Besides this, there is a gain in tar and a diminution in the sulphuretted hydrogen and carbon disulphide. So marked is the latter feature that the lime purifier proves to be superfluous where the process is used, and gas-works, being no longer offensive, cease to be a public nuisance. (*Chem. News*, XLVIII, 174.)

ORGANIC.

New Substances from Plants.—Jamaica dogwood (*Piscidia erythrina*) has been examined by Prof. Edward Hart, of Lafayette College, who obtained therefrom the active principle, *piscidia*, $C_{29}H_{24}O_8$. This body is insoluble in water, but crystallizes from alcohol in small colorless four or six sided prisms, which have a melting point of 192° C. It is easily soluble in benzene and in chloroform. Its physiological effects are that of a direct sedative, narcotic but refreshing. (*Am. Chem. Journ.*, V, 39.)

Algin is the name given by Edward C. C. Stanford to a new substance obtained from some of the commoner species of marine algæ, and which possess valuable properties as a gelatizer. It has characteristic reactions distinguishing it from gelatin, from starch, from dextrin, pectin, gum arabic, and other gummy bodies. Dilute mineral acids generally coagulate it when in solution. Mr. Stanford thinks it can be used in the soluble form as a stiffener of fabrics; although not so rigid as starch, it is tougher, more elastic, and more transparent. It may also have some value as a food on account of its nitrogenous character. Its agglutinating power enables one to convert non-coherent bodies, such as silica, lime, magnesia, alumina, chalk, graphite, and charcoal, into solid hard blocks. A new "carbon cement" for covering steam-boilers consists of 97 per cent. charcoal and 3 per cent. algin. In its insoluble form algin resembles horn, and may be used as a substitute for it. Algin is an excellent non-conductor of electricity, and can be used also in emulsifying oils and fining wines and spirits. (*Chem. News*, XLVII, 254.)

A *new acid* has been obtained by Von Lippmann from the juice of the beet root. The incrustations formed on the pans in which beet juice is evaporated contains, besides citric, aconitic, tricarballylic, and malonic acids, a new acid which appears to be identical with the oxycitric described by Pawolleck. The new acid forms needle shaped crystals, soluble in water, alcohol, and ether, having the formula $C_6H_8O_8$. It is tribasic, its barium salt having the formula $(C_6H_5O_8)_2\,Ba_3\,5\,H_2O$. (*Ber. d. chem. Ges.*, XVI, 1078.)

Saponin was discovered in 1809 by Schrader in the root of *Saponaria rubra.* Stütz prepares it from the bark of *Quillaja saponaria* as follows: 10 kilograms are extracted with water, the evaporated liquid is dried, pulverized and extracted with hot alcohol, which on cooling yields flocks of saponin; these are purified by re-solution in hot alcohol. In this way 10 kilograms of bark yielded 200 grams of saponin. It is a white, amorphous powder, neutral and tasteless. It is soluble in water in all proportions, and even when dilute the solutions froth like a soap solution. It has the composition expressed in the formula $C_{19}H_{30}O_{10}$, but contains also 2.4 per cent. ash, consisting of the carbonates of magnesium, calcium, and potassium. Experiments lead the author to conclude that the constitution is expressed in the formula $C_{19}H_{25}(OH)_5O_2O_3$. (Liebig's *Annalen*, CCXVIII, 231.)

A New Source of Mannite.—L. Lindet has found this sugar quite abundant in the pineapple of Brazil, amounting, he claims, to 1 per cent. of the fresh fruit. The mannite is extracted from the fermented pulp by neutralization with sodium carbonate and evapoation to the consistence of molasses. On cooling small needle-shaped crystals, having a slightly sweet taste, are obtained; purified by solution in boiling alcohol they give the true characters of mannite. He intends to prosecute the study with a view to ascertaining whether the mannite was formed during the fermentation or whether it exists already formed in the fruit itself. (*Bull. soc. chem.*, XL, 65.)

Saccharone and Saccharine.—By the action of calcium hydrate on dextrose and on levulose Péligot obtained in 1880 a body having great stability and crystallizing with facility, which he called saccharine. Heinrich Kiliani, by acting on this body with concentrated nitric acid, has obtained a new substance, which he names saccharone, and which is both a lactone and a monobasic acid. Consequently both saccharone potassium C_6H_7OK and saccharonate of potassium $C_6H_8O_7K_2$ are obtained when saccharone is treated with potassium, the latter at a boiling temperature. By the action of hydriodic acid on saccharone, saccharinic acid, a dibasic acid is obtained, having the formula $C_6H_{12}O_6$. (Liebig's *Annalen*, CCXVIII, 361.)

Borneol from Camphor.—Professors C. Loring Jackson and A. E. Menke recommend the following process for preparing borneol from camphor on account of its simplicity, rapidity, and economy. The camphor is dissolved in about ten times its weight of common alcohol, and an excess of sodium is added in pieces of somewhat less than a gram at a time. By working with quantities not over ten grams the action can be carried on in an open flask without cooling. As soon as all the sodium has disappeared, part of the alcohol is distilled off and water added, which precipitates crude borneol. This is freed from sodium hydroxide by washing with water, and crystallized from hota lcohol.

Borneol melts at 197°; 10 grams of camphor yield 9.5 grams of borneol being 94 per cent. of the theory. (*Am. Chem. Journ.*, v, 270.)

Researches on Atropine.—In 1863, Kraut decomposed atropine by a boiling barium hydrate solution into atropic acid $C_9H_8O_2$, and tropine $C_8H_{17}NO_2$; the formula for the latter base was corrected by Lossen, who found $C_8H_{15}NO$, and showed that atropic acid was only a secondary product of the decomposition, the primary being tropic acid $C_9H_{10}O_3$. Ladenburg in late researches has affected the synthesis of atropine by the dehydration of tropate of tropine. The best results were obtained by the action of dilute hydrochloric acid. The identity of the artificial atropine with that extracted from atropa belladonna was fully established by chemical and physiological experiments. Tropate of tropine exerts no action whatever on the eye, even in a 10 per cent. solution. (Liebig's *Annalen*, CCXVII, 74.)

The Oxidation of Substitution Products of the Aromatic Hydrocarbons.—Dr. Ira Remsen is pursuing his investigations grouped under the above title, and publishes two additional contributions on the oxidation of betacymenesulphamide and of paradipropylbenzenesulphamide in which he has been assisted by Mr. W. C. Day and Dr. E. H. Keiser, respectively.

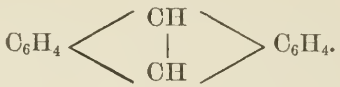
By treating betacymenesulphamide with potassium pyrochromate and sulphuric acid a body was obtained which proved to be sulphamine-parapropylbenzoic acid having the formula—

$$C_6H_3 \begin{cases} C_3H_7 \\ SO_2NH_2\ (o) \\ CO_2H\ (p) \end{cases}$$

Under similar treatment paradipropylbenzenesulphamide yielded as a principal product alphasulphaminepropyllbenzoic acid, the formation of which under the conditions given proves that the sulphamide group exerts a partial protective action upon one of the propyl groups. The protection, however, is not perfect, because sulpho-terephthalic acid is formed at the same time. These results are in perfect harmony with the views advanced some time ago by Dr. Remsen as to the law of protection. (*Am. Chem. Journ.*, v, p. 149.)

Synthesis of Salicin.—Prof. Arthur Michael, of Tufts College, has the honor of accomplishing the first synthesis of a glucoside occurring in nature. Having obtained helicin synthetically by the action of sodium salicylaldehyde on acetochlorhydrose, he submitted the helicin to the action of sodium amalgam, as suggested by Lisenko, and obtained a body the properties and composition of which agree perfectly with natural salicin. (*Am. Chem. Journ.*, v, p. 171.)

A new Synthesis of Anthracene.—With the expectation of obtaining an isomeric tetraphenylethane, Anchütz and Eltzbacker examined the action of aluminium chloride upon a benzene solution of acetylene tetrabromide. The resulting hydrocarbon was easily isolated and proved to be anthracene. This synthesis establishes the fact that the middle carbon atoms in anthracene are directly united, a supposition generally held but not previously determined by experiment. The formula of anthracene is accordingly represented thus:



(*Ber. d. chem. Ges.*, XVI, 623.)

Pyridine and Quinoline Bases.—The close connection which has been established between several important alkaloids and the derivatives of pyridine and quinoline is being confirmed by numerous researches. All the evidence accumulated thus far is in harmony with the view that many of the important alkaloids are derivatives of pyridine, a constituent of bone-oil and of coal-tar, which, moreover, has been obtained by the dry distillation of nicotine. The relation between these alkaloids and pyridine is somewhat analogous to that between the aromatic compounds and benzene. According to Körner pyridine is benzene in which one of the six CH groups is replaced by N, and this view has recently found additional support.

The investigations of Königs, Skraup, and others go to establish a close connection between quinoline (and its homologues lepidine, dispoline, and tetrabiroline) and such alkaloids as quinine, cinchonine, and their isomers. (E. H. K. in *Am. Chem. Journ.*, V, 60.)

Constituents of the Petroleum of Galicia.—According to Lachowicz, the petroleum of Galicia contains a large number of hydrocarbons of the marsh-gas series, isopentane, normal pentane, hexane, both normal and secondary, and heptane, together with several of the aromatic series, benzene (benzol) toluol, isoxylol mesitylene, and the so-called Vreden's hydrocarbons. Members of the ethylene series are entirely wanting. (Liebig's *Annalen*, CCXX, 168.)

Products of the Dry Distillation of Wood at low Temperatures.—Prof. C. F. Mabery has examined the more volatile products of the dry distillation of wood in the manufacture of acetic acid. The greater part of the product consists of methyl alcohol and methyl acetate; besides these are found acetic aldehyde, acetic acid, acetone, acetal, dimethylacetal, methylethylketone, and allyl alcohol, together with traces of the higher ketones. A new constituent is methyl formiate. The higher boiling oils contained furfurol, and by the action of alkalies upon it a small quantity of pyroxanthin. The proportion of acetone was small. (*Am. Chem. Journ.*, V, 256.)

The Constituents of Ozokerite.—Ozokerite from the island Tscheleken, in the Caspian Sea, has been examined by F. Beilstein and E. Wiegand.

The raw material formed a brownish-black, sticky mass, almost wholly soluble in boiling benzine. On adding alcohol to the filtered solution most of the paraffine precipitates and the oils remain in solution. By treating the powdered ozokerite with ether nearly all the oily matters and coloring matters are removed from the paraffine, and this may be further purified by solution in benzine, boiling with animal charcoal and precipitation by alcohol. By repeating this process, shining white crystals, having a definite melting point, were obtained, which the authors name Lekene, from the island above referred to. Lekene has the following properties: Melting point, 79°; sp. gr., 0.93917. Soluble in 124.3 parts of benzine at 15°, 1334.8 parts of chloroform at 16°, 9534 parts of alcohol at 16°, and 15257 parts of absolute acetic ether at 16° C. It distills unaltered in vacuo, and hence may be obtained by this process on a commercial scale. Nitric acid diluted with two volumes of water scarcely attacks lekene at all; fuming sulphuric acid converts it quickly into a black, pulverulent mass. The analysis made gave following figures: C=85.23 per cent., H=14.72 per cent. It does not appear whether lekene belongs to the series $C_n H_{2n}$, or $C_n H_{2n+2}$. The oil extracted by ether from the ozokerite was purified by distillation in vacuo and gave 86.13 per cent. C. and 13.70 per cent. H. Its sp. gr.= 0.8450 at 18.5°. (*Ber. d. chem. Ges.*, XVI, 1547).

Researches into the Nature of Resins.—Prof. Arthur Michael has instituted an investigation into the action of aldehydes on phenols, and arrives at the following conclusions: (1) Mixtures of aromatic aldehydes and phenols are converted by mere traces of acids, more or less rapidly, according to the acids used, into white resins; (2) the resorcin-benzaldehyde resin is converted by the further action of dilute acids into two crystalline compounds, one of which is isomeric with the resin when the latter is dried at 100° C.; (3) fixed alkalies and potassium carbonate convert a mixture of resorcin and benzoic aldehyde into a resin; (4) the properties of the crystalline compound $C_{26}H_{20}O_4$ resemble those of the so-called crystallizable resins. From its alkaline solution it is precipitated by acids in the form of a resin, which separates in form of the original crystals from the alcoholic solution; (5) the above results make it extremely probable that the formation of at least some of the resins in the vegetable world is due to aldehydes and phenols coming in contact with the contents of the cells, as both of these classes of compounds are undoubtedly among the products formed in plant-life. (*Am. Chem. Journ.*, V, 338.)

Coniferin, the source of vanillin, has been found by Edmund O. von Lippmann to exist in the woody fiber of the sugar-beet. It is believed that the coniferin does not exist to any great amount ready formed in the woody fiber, but that it is produced by the decomposition of lignin in the process of extraction. Whether or not the sugar-beet will ever become a commercial source of vanillin has not been determined. (*Ber. d. chem. Ges.*, XVI, 44.)

NOTES.

A simple and convenient apparatus for rapid gas analysis has been devised and described by Arthur H. Elliott. By its aid a complete gas analysis can be made in less than one hour. For details and figure of the apparatus we refer to Annals of the New York Academy of Sciences, Vol. II, No. 12, 1883.

Carbon monoxide is conveniently prepared, according to E. Noack, by passing carbon dioxide over zinc dust heated in a glass tube below a red heat. In one hour 13 liters of CO_2 yielded 11 liters of CO.

Dr. W. Spring continues his researches on the formation of chemical compounds by great pressure. He has prepared, under pressure of 6,500 atmospheres, compounds of arsenic with zinc, lead, copper, tin, and silver direct from mixtures of the constituents. Also many metallic sulphides in like manner.

The composition of bleaching-powder has again been investigated by Lunge and Naef, who find that calcium chloride is decomposed at ordinary temperatures by hypochlorous acid, with the production of $CaOCl_2$ and Cl_2. These chemists hold to the formula Cl — Ca — OCl, first proposed by Odling, as the most correct. (*Ber. d. chem. Ges.*, XVI, 840.)

Water is decomposed by both sulphur and arsenic, according to C. Z. Cross and A. F. Higgin, yielding both the oxygen and hydrogen compounds of the elements.

Dr. J. Lawrence Smith gives in the American Chemical Journal., V, p. 44, details of his method of decomposing and analyzing samarskite. The powdered and dried mineral is decomposed by fluorhydric acid and the insoluble portion treated with concentrated sulphuric acid and the contained earths converted into oxalates, which are then submitted to careful analysis.

Samarium, discovered in 1878 in samarskite by Lecoq de Boisbaudran, has been carefully studied by P. T. Cleve, of Upsala. He obtained the pure oxide, Sm_2O_3 and several salts, including the chloride, $SmCl_3 . 6H_2O$, chloroplatinate, nitrate, $Sm(NO_3)_3 . 6H_2O$, acetate, oxalate, and sulphate, $Sm_2(SO_4)_3 . 8H_2O$. The salts in general agree closely in composition with the didymium salts, but are distinguished by a peculiar spectrum composed of several bands, four in the blue part being characteristic. (*J. Chem. Soc.*, 1883, 362.)

The emission spectra of scandium, ytterbium, and erbium have been examined by Th. Thalèn. Scandium presents a notable spectrum, having many lines of medium intensity in the orange and the indigo, and very fine brilliant lines, forming several groups, in the yellow, green, and blue portions.

Pure nickel, capable of being wrought, rolled, and hammered, is now made by Mr. Joseph Wharton at Camden. A small quantity of magnesium added to metal greatly aids in the refining and improves its quality. Mermet recommends the use of nickel crucibles in place of silver in chemical manipulations, being much cheaper and less easily fused.

Notes on the Literature of Explosives.—Under this title Prof. Charles E. Munroe, of the United States Naval Academy, is publishing a series of papers giving a compendium of discoveries in the field mentioned. The articles appear in the Proceedings United States Naval Institute, Nos. 20, 21, 22, 24, and 27 *et seq.*

A white modification of phosphorus has been described by Drs. Ira Remsen and E. H. Keiser. It is obtained by distilling ordinary phosphorus in hydrogen and collecting the element in ice-cold water. This white phosphorus is light and plastic, is soluble in carbon disulphide, and melts at the same point as ordinary phosphorus. It bears the same relation to ordinary phosphorus as "flowers of sulphur" to "roll brimstone."

The conduct of moist phosphorus and air towards carbon monoxide has been again most carefully examined by Ira Remsen, assisted by E. H. Keiser, and, contrary to the views of Leeds, negative results are reported. The small amount of carbon dioxide obtained by Leeds is ascribed to oxidation of the carbon in the phosphorus, the presence of which was not, however, demonstrated by the author. (*Am. Chem. J.*, v, 424.)

According to the latest returns published by the Italian Government, the average annual production of sulphur in Sicily and Italy during the five years 1875–1879, inclusive, was 282,000 tons, of which 216,000 tons were exported. Delivered at Marseilles the sulphur sells at about $25 per ton. (*Chem. News*, XLVII, 88.)

Cadmium iodide has been studied by Prof. F. W. Clarke, who obtained evidence of the existence of two allotropic varieties, differing in specific gravity by about a unit. The higher or normal salt is white, and undergoes no perceptible change when heated below 250°; the lower salt is brownish, and loses weight at 40°.

The use of mercury thermometers, and especially the determination of melting point and boiling point, is the subject of an exhaustive research by Prof. J. M. Crafts, who points out that the defects in the processes of graduating these instruments, as usually conducted, can be remedied by means easily within the reach of a careful mechanic.

Thiophene is a new substance, C_4H_4S, discovered by Victor Meyer in benzene (benzol) from coal tar, and which is marked by its containing sulphur in its composition. It forms a light, limpid, mobile oil, boiling at about 84°, and remaining liquid when subjected to the cold of a mixture of ice and salt. Pure coal-tar benzene contains about 0.5 per cent. of thiophene. (*Ber. d. chem. Ges.*, XVI, 1465.)

The Ethyl Derivatives of Anhydro-benzdiamido-benzine have been treated in a paper by Prof. James Lewis Howe, of the Central University, Richmond, Ky., and published in the Am. Chem. J., v, 418.

Arabic acid has been prepared in a pure state and carefully studied by C. O'Sullivan, who assigns to it the formula $C_{89}H_{142}O_{74}$.

Cryptidin has been synthetically made by Dr. Albert R. Leeds. It has the formula $C_{11}H_{11}N$. The same chemist describes œnantholanilin, œnantholxylidin, and œnantholnaphtylamin, bodies having agreeable etherial odors, and yield amorphous sublimates with partial decomposition.—(*Ber. d. chem. Ges.*, XVI, 287 and 289.)

Silicon-ethers of phenol, according to A. Martini and A. Weber, are easily prepared by heating the phenols with silicium tetrachloride. Tetraphenylsilicate and tetraparakresylsilicate are described by them. (*Ber. d. chem. Ges.*, XVI, 1252.)

The Liebig memorial was unveiled at Munich, August 6, 1883. Prof. A. W. Hofmann made the principal address on the occasion, reviewing the influence of Liebig's discoveries in chemistry. A few months after the ceremony, the white marble statue of Liebig was wantonly injured by some black liquid which was thrown over the head and left shoulder. It was feared that the statue was permanently injured, for the black substance had penetrated the pores of the marble. Later advices show that the liquid used was nitrate of silver. One thousand marks reward were offered for the perpetrator. In December the stains were successfully removed.

Frederick Wöhler is fitly honored in the *Berichte der deutschen chemischen Gesellschaft* by a long biography and bibliography prepared by Prof. A. W. Hofmann. Wöhler's contributions to chemical literature number 280. The paper is accompanied by a portrait and a fac-simile letter.

Honors to an American chemist.—The German Chemical Society of Berlin has on its rolls the following sixteen honorary members, representing, as will be seen, a variety of nationalities: R. Bunsen of Heidelberg, J. Dumas of Paris, H. Kopp of Heidelberg, S. Cannizzaro of Rome, E. Frankland of England, R. Fresenius of Wiesbaden, J. S. Stas of Brussels, A. Williamson of London, A. Wurtz of Paris, G. Kirchhoff of Berlin, H. E. Roscoe of Manchester, C. von Marignac of Geneva, F. Abel of Woolwich, A. Butlerow of St. Petersburg, Warren de la Rue of London, and Q. Sella of Rome. The society in 1883 honored itself and recognized the claims of the United States by adding to this distinguished company Dr. Wolcott Gibbs, professor of chemistry in Harvard University, who confessedly stands in the foremost rank of scientific investigators.

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NECROLOGY OF CHEMISTS, 1883.

Dr. J. LAWRENCE SMITH, of Louisville, Ky., died October 12, 1883. Dr. Smith was born near Charleston, S. C., December 16, 1818; was graduated from the University of Virginia, and from the medical department of the University of South Carolina. In early life he followed the profession of civil engineer, but afterward turned his attention to chemistry and mineralogy, making also a specialty of meteorites. He was the inventor of the inverted microscope, so useful in the study of chemical reactions. In 1851 he was elected professor of chemistry in the University of Virginia, and later to the same chair in the Medical College at Louisville, Ky. During his later years he was the chemist and superintendent of the Louisville Gas Works.

Dr. Smith's original contributions to chemistry and mineralogy are numerous and important; with the smaller papers they aggregate nearly one hundred. He published his collected researches in 1873 in an 8vo volume of 400 pages. These embrace several papers on emery, of both Chester, Mass., and of Asia Minor; several memoirs on meteorites, describing more than twenty-five different specimens, and valuable papers on analytical methods with which his name will always be associated. Dr. Smith was a member of many learned societies, and received high honors from several European Governments.

Dr. LEONARD D. GALE died in Washington, D. C., October 22, in his eighty-fourth year. Dr. Gale was a chemist and physicist and aided Prof. S. F. B. Morse in his early experiments in telegraphy.

CHARLES HERBERT HUTCHINSON, a pharmaceutical chemist, died in London in April, aged 24. He published several original researches, and at the time of his death was assistant to Professor Armstrong at the London Institution.

PETER SPENCE, born at Brechin, Scotland, in 1806, died at Old Trafford July 5, 1883. He founded the Pendleton Alum Works, near Manchester, which were the largest in the world, being capable of producing 200 tons of alum per week. Mr. Spence took out fifty to sixty patents, nearly all for improvements in chemical processes. He was accounted one of the best practical chemists of the day, obtaining this distinction by hard work in the laboratory.

Dr. JAMES YOUNG, the distinguished industrial chemist of Scotland, died near Glasgow, May 14, 1883, in his seventy-first year. His name has long been identified with the paraffin industry, in which he amassed great wealth.

JOHN ELLIOTT HOWARD, a well-known chemist of London, died in November, aged seventy-six years.

Dr. ARTHUR F. TAYLOR, professor of chemistry in the Case School of Applied Science, Cleveland, Ohio, died suddenly in New York City, June 28, aged thirty-two years. Dr. Taylor was born in Andover, Mass., December 10, 1853, was graduated at Dartmouth in 1874, and at the University of Göttengen two years later. He took an active part in the organization of the Case School of Applied Sciences, and his early death removed therefrom a man of bright promise.

Dr. KARL LUDWIG REIMER, an industrial chemist of Prussia, died January 15, 1883. Reimer was born December 25, 1845, in Leipzig. In 1875 he made the neat discovery that salicylaldehyde results from the action of chloroform on phenol in the presence of alkalies.

Prof. WILHELM WEITH, of Zurich, who died November 29, 1881, is honored with a full obituary and portrait in the *Berichte der deutschen chemischen Gesellschaft* for 1882. Weith was born at Homburg May 9, 1846.

Prof. VINZENZ KLETZINSKY died March 18, 1882. He was born July 16, 1826, in Gutenbrunn, Lower Austria. A full notice of his life and labors is published in the *Berichte der deutschen chemischen Gesellschaft* for 1882.

MINERALOGY.

By Prof. Edward S. Dana,
Yale College, New Haven, Conn.

GENERAL WORKS ON MINERALOGY.

The most important contribution of the year 1883 to mineralogical bibliography is the work of Prof. Antonio D'Achiardi, of Pisa, upon the metals, their ores and ore-deposits. This work differs from the earlier publication of the same author (on the Mineralogy of Tuscany, 1872–'73), in that its object is mainly technical, and yet the amount of material brought together is so large and the manner of handling the subject so masterly that it is of no less value to the mineralogical student than to the mining engineer. The work is contained in two volumes aggregating more than a thousand pages. The author takes up the important metals, as gold, silver, copper, and so on, in detail, but includes in the discussion nearly all the elements, even the rarest of them, as gallium, samarium, &c. Under each head a description is given of the important minerals furnishing the element in question, then of their ore-deposits, and with this is coupled a valuable discussion of the methods of deposition, the formation of mineral veins, and similar matters. In regard to the latter subject, it may be noted that the author is in general inclined to look for the source of the metals to the depths from which the eruptive rocks, which so often occur with the ore-deposits, have been derived; he favors the view, further, that in the majority of cases the ores have reached the vein by hydroplutonic processes in connection with eruptions, and as compounds with sulphur, antimony, or arsenic.

The *Lehrbuch der Mineralogie*, by Tschermak, has been completed during the past year, and forms, perhaps, the best general text-book in the German language. The physical portion of the subject is presented with much clearness, but the description of many of the most important species is meager and unsatisfactory, even for the class of students for which the book was especially prepared. A valuable general work on mineralogy by A. de Lapparent has also appeared. It is divided into three parts, of which the first is devoted to Geometrical Crystallography, the second to Physical Crystallography, and the third to the

Description of Species. The method of classification of species is novel, the part which each species plays in the formation of the earth's crust being the determining point. Thus four classes are recognized: (1) Silicates or elements of the fundamental rocks; (2) Elements of mineral veins; (3) Metallic minerals; (4) Combustible minerals. The book is intended particularly for the use of geologists, as will be inferred from the system of arrangement of species adopted.

Professor Heddle, of St. Andrew's, Scotland, has published in the 16th volume of the *Encyclopedia Britannica* a chapter on mineralogy, which covers nearly one hundred quarto pages, and which deserves to be recognized as an addition to the list of general treatises upon the science. The author covers more or less completely all the departments of his subject, giving a large number of illustrations. The description of species is, on the whole, more complete than could have been expected, considering the obvious limitations to which the author was subjected.

A new and enlarged edition of Dana's Text-book of Mineralogy has been published. This includes several new chapters upon improved instruments for crystallographic and optical study, upon new methods employed in determining the physical characters of minerals, as, for example, the specific gravity and so on, and also a chapter containing brief descriptions of new species, and new points in regard to old species. A second appendix has been issued to the third edition of the *Mineralogy of Chili*, by I. Domeyko, which contains some new matter, chiefly of local interest. Of local character, also, is the second edition of the *Minerals of New South Wales*, by Liversidge.

Under the auspices of the United States Geological Survey, Mr. Albert Williams, jr., has prepared a volume of much importance, entitled *Mineral Resources of the United States.* The design of the work is chiefly technical. It is divided into two parts: the first contains statements and statistics in regard to the occurrence and production of the more important mineral products, such as iron, copper, lead, zinc, &c., also coal and petroleum; still further, building-stones, bricks, clays, fertilizers, salt, borax, sulphur, &c. Chapters of considerable length are devoted to the more important of these, which have been prepared in most cases by specialists, whose past experience has given them unusual facilities for acquiring the kind of information called for. The second part of the volume contains statistics arranged in tabular form for each State, giving the scientific and popular names of the various ores, minerals, &c., which are now mined, and, in a second table, those which are known to occur, but which are not mined at present, with, in each case, a general statement of the localities. These tables have been prepared very rapidly, and hence are professedly incomplete; but the design is to revise and enlarge them as additional material is collected.

Although not strictly devoted to mineralogy, a new work undertaken by Tschermak deserves to be mentioned. It is to be devoted to the description of the microscopic constitution of meteorites, and will consist largely of photographic illustrations, together with such descriptions and explanations in the text as the subject calls for. The preparation of the illustrated plates has been intrusted to J. Grimm, of Offenburg, who has carried through in so admirable a manner the work of Cohen devoted to the illustration of the microscopic structure of minerals. One part of this work on meteorites has appeared, and the remainder will be looked for with interest. It promises to supply a long-felt need, that of a general work which shall present in systematic form, for the benefit of the many interested in the subject, the large amount of information which the microscopic study of meteorites has led to.

CRYSTALLOGRAPHY AND PHYSICAL MINERALOGY.

A very large number of articles have been published devoted to a description of the crystalline form of minerals, but most of them are of too limited interest to require notice here. Attention will be called only to a few of more general character. The species of the feldspar group have been the objects of much study both with reference to their crystalline form and their optical properties. Klockmann, for example (*Zeitsch. Kryst.*, VI, 493), has studied the various kinds of twin-crystals of orthoclase which occur in the granitite of the Riesengebirge, with the result of adding materially to our knowledge of this already complex subject. Förstner (*Zeitsch. Kryst.*, VIII, 125, also, I, 547) has devoted himself to the feldspars which occur in the volcanic rocks of the island Pantelleria. He has proved, in the first place, the existence there of a *soda-orthoclase*, monoclinic in crystallization and near albite in angle. The composition corresponds to one molecule of orthoclase, or potassium aluminum silicate, and two molecules of an analogous sodium-aluminum silicate. Other cases of a sodium-bearing orthoclase have long been known, but the sodium plays here a more prominent part, and the crystallographic and optical data given by Förstner are of great value in showing the relation of this monoclinic member of the feldspar family to the potassium-bearing varieties of the triclinic feldspars or plagioclase. Förstner's investigation of the plagioclase feldspars of the same locality is most complete, and yields many interesting points which can be only hinted at here. The interest connected with this group of feldspars has been much increased since the general acceptance of Tschermak's well-understood theory as to their relation in composition, and since the optical investigations of Schuster have shown that in optical characters there is a transition analogous to that in composition from the one extreme (anorthite) to the other (albite). The feldspars examined by Förstner form a series with little calcium and rich in sodium, and hence approximating to albite; but at the same time the unusual large percentage amount of potassium separates them from the ordinary plagioclase. The author shows, however, that they can be considered, in the sense of the Tschermak theory, as isomorphous mixtures of the three known species of plagioclase, containing respectively calcium, sodium, and potassium. He shows, also, that there is the same sort of correspondence in optical characters as that proved by Schuster for the varieties of plagioclase containing no potassium.

A number of other important memoirs on the feldspars can only be alluded to here, as those of Wiik on the feldspars of St. Gotthard and of Finnland (*Zeitsch. Kryst.*, VII, 76; VIII, 203), and of Beutell (*Zeitsch. Kryst.*, VIII, 351), on some Silesian feldspars of the potassium-sodium type. More important than these is a new memoir by Des Cloizeaux (*Bull. Soc. Min. France*, VI, 89), who has contributed more to our knowledge of the optical characters of the members of the group than any one else. He has made a new determination of the angle of the optic axes, the orientation of their plane, and of their bisectrices, and of the different kinds of dispersion in a large number of varieties of albite and oligoclase. As the result of these, he admits that the relations shown by Schuster exist in many cases, but he finds numerous exceptions, and concludes that these relations are not generally true as claimed by Schuster. The same author has also described a soda-orthoclase from the island of Quatre Ribeiras (*Ibid.*, VI, 197), which is interesting because it corresponds so closely to the varieties found by Förstner in Pantelleria as described above.

The discussion in regard to the cause of the so-called *optical anomalies* observed in many crystals—alluded to at some length in the last volume of this Report—has been actively carried on during the past year. The most important contribution to the subject is that of Bücking (*Zeitsch. Kryst.*, VII, 555), who has investigated the effect of a known pressure upon doubly refracting minerals, following out a line of investigation already entered into by himself, Klocke, and others. Experiments were made with sections cut transverse to the optic axis of apatite, beryl, and tourmaline, and one of sanidine transverse to the acute bisectrix. With apatite the pressure changed the uniaxial figure, seen in converging polarized light, into a biaxial figure, the axial angle appearing in the plane perpendicular to the pressure. In the case of beryl, the section employed showed already a biaxial figure with the angle in the direction of the pressure; pressure diminished this, and as it was increased an axial angle perpendicular to the direction of pressure arose. Results similar to the above were obtained with tourmaline, though the axial angle was smaller than in the other cases, and even a pressure of 100 pounds produced no change that was permanent. It need hardly be added that experiments such as the above are most conclusive in showing that pressure, as produced by internal tension, must in many cases be the true explanation of the optical anomalies.

Brauns (*Jahrb. Min.*, 1883, II, 102) has made another valuable contribution to the subject. He has followed Klocke in investigating alum, lead nitrate, and some other salts. His conclusions are that chemically pure crystals (of alum, &c.,) are completely isotropic, while the anomalous double refraction arises with the admixture of an isomorphous salt. For example, pure crystals of potash alum were isotropic, while crystals formed of isomorphous mixtures of potash-alum and ammonia-alum showed a more or less distinct double refraction. From this it is argued that the mixtures of unlike molecules must exert an influence upon each other, causing in some way not clearly made out a sort of internal tension. Further investigations in the same field and on a wider range of isomorphous compounds are much to be desired.

The species boracite is one about which much interest has centered in connection with this subject, and the thorough investigations of Klein, alluded to in the Report for 1882, had seemed to prove pretty clearly that it was to be referred back to the isometric system, and its optical characters designated as true "anomalies" due to molecular tension. The subject has been further investigated by Mallard (*Bull. Soc. Min. France*, VI, 122, 129), chiefly with reference to the effect of heat upon its optical properties. His results, as interpreted by Klein, go to prove that boracite is dimorphous, since only at a temperature of about 300° do the sections become isotropic. At the elevated temperature, then the molecules satisfy the demands of isotropism corresponding to an isometric form, while at ordinary temperatures the condition of the molecules is abnormal and corresponds to their arrangement, or their own symmetry corresponds to an optically biaxial crystal.

Some additional observations have been made by Ben-Saude (*Bull. Soc. Min. France*, VI, 260), whose investigations of analcite and perofskite are well known. These relate to rock salt and sylvite; he finds the probable cause of their doubly refracting character, as observed by him, in part by irregularities produced by rapidity of crystallization and in part by a cause like that suggested by Brauns, as stated above.

Klein has published (*Jahrb. Min.*, 1883, I, 87) results of an exhaustive study of garnet, with reference to its anomalous optical character. These are of especial interest, because garnet is often taken by the French school (Mallard, Bertrand) as a typical example of "pseudo-symmetry," they explaining the optical character as really belonging to the molecular structure and the outward form a complex twin. Klein's observations are most conclusive in showing that the latter explanation is not the correct one; on the contrary, that garnet is to be still considered as a true isometric species, and that the anomalous optical characters are due to secondary causes. This memoir of Klein is one of the most important that has been devoted to this subject.

The memoir of Groth (*Zeitsch. Kryst.*, VII, 375, 457) upon the members of the cryolite group has been concluded (the first part was alluded to in the report for 1882). The same subject has been written upon by Des Cloizeaux (*Bull. Soc. Min. France*, V, 310, VI, 254) and by Krenner (*Berichte aus Ungarn*, I). Further, Cross and Hillebrand (*Amer. Journ. Sc.*, XXVI, 271) have published an exhaustive account of the minerals of this group from the Pike's Peak region, Colorado. The crystallographic, optical, and chemical relations of these minerals are too intricate to allow of their being developed here, but it may be said in general that the result of the large amount of work done upon this difficult group has been to establish definitely the form and composition of most of the members, so that, though the conclusions reached are to some extent contradictory, we are much nearer to a full understanding of the subject than was the case a few years since.

It has been shown by H. C. Lewis that the magnetite present in dendritic forms in many specimens of mica accords in the direction of its markings with the directions of the lines of the "strike-figures" produced by a blow on the mica surface with a blunt point. It is, then, a case of parallelism between the crystalline directions of the two species, analogous to many similar examples, like rutile on hematite, albite on orthoclase, tetrahedrite on chalcopyrite, and so on. The same author (*Proc. Acad. Nat. Sci. Philad.*, February, 1883) has described what he regards as a crystallized serpentine from Way's quarry, Delaware. A very much detailed article on the structural peculiarities of the danburite crystals from the Skopi, Switzerland, has been published by Schuster. (*Tschermak, Min. Petr. Mitth.*, v, 397.)

Some progress has been made in the investigation of the relations of crystals with respect to *cohesion*. *Gleitfläche* is the German name for a slipping surface, or the direction in a crystal in which a slipping of the molecules may be made to take place by pressure or a blow. This subject was first developed by Reusch, but others have since followed in the same line. The well-known artificial twins of calcite (as shown by Baumhauer) are a good example of this molecular slipping. Recently the subject has been further investigated by Mügge (*Jahrb. Min.*, 1883, I, 32; II, 13) with respect to gypsum, stibnite, and some other species. More important than his special observations are the conclusions which he reaches that these "Gleitflächen" appear to be limited to minerals showing great differences of cohesion in different directions—that is, those with perfect cleavage—and they exist most distinctly at right angles to this cleavage direction, or where the cohesion is a maximum. This molecular slipping then takes place because the cohesion being greatest a separation of the molecules can be effected with most difficulty, while the slipping takes place with no more difficulty than in other directions. Planes of cleavage and of molecular slipping are then diametrically opposed to each other.

The methods of determining the *specific gravity* of minerals and of separating mechanically mineral mixtures have been reviewed by Gisevius in an inaugural dissertation published in Bonn. The author concludes that the methods usually employed, involving the use of the hydrostatic balance, the pycnometer, and the spiral balance of Jolly, are all liable to considerable error. He then goes on to the discussion of a method suggested by Brügelmann, namely, to determine the absolute weight of the fragment by a balance, and then its volume by the increase in volume which it causes when introduced into a liquid contained in a calibrated cylinder. The author suggests an improvement in the latter part of the process, and gives the results of numerous determinations of the specific gravity of quartz fragments. The numbers obtained vary rather widely in the second decimal place, which the author concludes is due to impurities and inclosures in the specimens taken; which, however, would hardly seem possible if the material was selected with any care. For the mechanical separation of mineral mixtures the author regards the solution of D. Klein (see report for 1882), the borotungstate of cadmium, as being the best means, preferable to the Sonstadt solution—that is, potassium-mercury iodide.

Rohrbach (*Wiedemann's Annalen*, XX, 169) has suggested as a substitute for the Sonstadt solution a solution of barium-mercury iodide. It is obtained by mixing together thoroughly in a flask 100 parts barium iodide and 130 parts of mercury iodide, then adding 20 cc. of distilled water, and heating to 150° or 200° over an oil-bath. The solution is agitated constantly, and when complete it is evaporated down in a water-bath, and then on cooling a solution in which topaz floats is obtained. The specific gravity of the solution is from 3.575 to 3.588. It is less easy to use than the Sonstadt solution, being very hygroscopic, and besides it is decomposed on the addition of water, crystals of red mercury iodide separating out. It can only be diluted consequently by the addition of a dilute solution specially prepared. Büttgenbach has proposed a method by which different minerals may be separated from their mixtures on a large scale by taking advantage of their different degrees of cohesion. If, for example, two minerals of different brittleness are thrown against a solid surface, one is broken up into smaller fragments than the other. Thus when sphalerite and pyrite were thrown several times against a cylinder and then sifted, it was found that the larger sieves collected the fragments of pyrite, while the particles of sphalerite, being finer, passed through and were collected on others. This is only useful as a metallurgical process.

In the subject of *heat* a memoir by Fletcher (*Phil. Mag.*, October, November, December, 1883) must be mentioned, which discusses from a mathematical standpoint the expansion of crystals upon change of temperature. This memoir forms a continuation of an early discussion of the subject by the same author, in which a series of propositions are established by mathematical reasoning, which result from the assumption that the geometrical and physical character of a crystal are the same along all lines having the same direction. Since the publication of the first paper an extensive series of measurements has been made by Beckenkamp with a view to determining the degree of permanency of the thermic axes (as defined by Neumann), and this second paper is largely devoted to a discussion of the bearing of Beckenkamp's measurements and their mathematical explanation. M. Dufet (*Bull. Soc. Min. France*, VI, 75) has given a discussion of the variation in the indices of refraction of quartz under the influence of change of temperature, a subject on which much work has already been done, especially by French physicists.

In the department of *electricity* attention may be called to a memoir of Hankel (*Abhandl. Sächs. Ges. Wissenschaften*, XII, 552), which forms a continuation of a line of experiments which he has been following out for a series of years. In this, the sixteenth paper, he gives the thermo-electrical properties of a number of minerals, as helvite, pyromorphite, phenacite, and so on; his experiments go to show the distribution of the positive and negative electricity on the crystalline surfaces of the minerals under examination. Röntgen has published (*Oberhess. Ges. Natur.- und Heilkunde*, XXII, 49, 97, 181) several memoirs dealing with the electrical properties of quartz, and with its optical properties as influenced by electricity. Thus he explains the development of free electricity in quartz by pressure, or by piezo-electricity (as defined by Hankel). This subject has already been treated by J. and P. Curie, but Röntgen carries it further than these authors, making use of a sphere of quartz which could be subjected to pressure in any desired direction. He also explains the development of electricity by change of temperature (thermo-electricity) and by radiation (called actino-electricity). Still further, he shows what changes in the double-refraction of quartz are caused by electrical forces. Kundt (*Wiedemann's Annalen*, XVIII, 228) has followed a somewhat similar line of investigation, developing the optical behavior of quartz when placed in an electrical field. Thus a prism of quartz, cut parallel to the vertical axis, and with a square section, was electrified on the opposite pair of prismatic faces with positive and negative electricity. This had the effect of changing the circles of the interference figures, as seen in polarized light, into ellipses whose axes varied in position according to which pair of faces was then electrified—the change corresponding to an expansion or contraction of the crystal. Another memoir by Kundt (*Ber. Ak. Berlin*, April 5, 1883) is devoted to the explanation of a simple method by which the pyro-electricity and piezo-electricity can be investigated by means of the use of the so-called "Lichtenberg figures."

The pyro-electricity of sphalerite and boracite forms the subject of an important paper by Friedel and Curie (*Bull. Soc. Min. France*, VI, 191). The observations on boracite are especially interesting in connection with the results obtained by Mallard, as stated above, that boracite is truly isometric above 265° C.; they show that boracite becomes pyro-electric only when it ceases, on the fall of temperature, to be isometric.

The use of the new contact-lever goniometer (*Fühl-Hebel Goniometer*) of Fuess is discussed by Schmidt (*Zeitsch. Kryst.*, VIII, 1). He shows that under favorable circumstances the degree of accuracy is very great. It need hardly be recalled here that the object of this goniometer is to measure the angles between two crystalline faces, which are not capable of affording reflections, so that the reflecting goniometer can be employed. It consists, briefly, of a Wollaston goniometer and a lever arrangement attached to the stand, which brings a fine point down to the plane to be measured. By use of the lever each of the planes can be adjusted so that its surface is perpendicular to their index, and then the angle between the planes is given in the usual way; in a word the touch of the index takes the place of the reflection to the eye in fixing the position of the two planes in succession.

The stauroscope, the degree of accuracy it admits of, and the kind of errors it involves, is the subject of a somewhat diffuse paper by Laspeyres (*Zeitsch. Kryst.*, VIII, 97). He claims for the instrument a high degree of accuracy, but shows that there are certain unavoidable errors which limit its use as the instruments are now constructed.

CHEMICAL MINERALOGY.

The subject of the artificial production of minerals continues to be one to which many contributions are being made, particularly by the French chemists. Bourgeois (*Bull. Soc. Min. France*, VI, 64) describes the production of crystallized rhodonite by fusing together silica and manganese dioxide. Gorgeu has obtained (*Ib.*, p. 136) hausmannite in brilliant octahedral crystals by the aid of manganese chloride kept fused at a red heat in an oxidizing atmosphere charged with water vapor. The same author (*Ib.*, p. 283) has succeeded in forming, by the synthetic method, the manganese garnet, spessartite. Lacroix (*Ib.*, 173, 175) describes artificial crystals of gypsum, and also crystals of cerussite, which had formed in bronze coins of Roman origin found in Algeria.

Two important papers bearing upon the paragenesis of certain metallic minerals have been presented by Le Conte (*Amer. Jour. Sc.*, XXV, 424; XXVI, 1). In one of them he describes the mineral vein formation—chief in interest the cinnabar deposits—which is now in progress at Steamboat Springs, in Nevada, thus following up an earlier paper on the phenomena observed at Sulphur Bank. The locality at Steamboat Springs has already been the object of extended papers by Laur in the *Annales des Mines*, 1863, and by Phillips in the *Quarterly Journal of the Geological Society of London*, 1879. The phenomena at Sulphur Bank and Steamboat Springs are in some respects very similar, though in others they are quite different. At Steamboat Springs the deposit of silica is much more extended, as explained by the fact that the hot waters contain mainly alkaline carbonates which carry silica in solution, while at Sulphur Bank they contain also largely alkaline sulphides and carry metallic sulphides in solution. In the second paper Le Conte discusses in general the genesis of metalliferous veins, arriving at various interesting conclusions in regard to them; they are in part a confirmation of earlier results reached by others.

Of the many papers dealing with chemical composition of the different mineral species, the most important is that of Tschermak (*Sitzber. Ak.*

Wien, November, 1883) upon the scapolite group, which may be taken as a companion to the earlier memoirs by the same author upon the feldspars and upon the mica group. The subject of the scapolites is a peculiarly difficult one, since there is the wide variation of composition but without a corresponding variation in crystallographic or optical properties such as characterizes the members of the feldspar group. Tschermak's work is based largely upon new analyses made with especial care to insure the highest possible degree of accuracy. His method is essentially that which has served to throw so much light upon the feldspars, namely, to explain all the varying compounds as isomorphous mixtures of two end silicates. In the case of the feldspars the two extremes of the series have a real existence, and hence the theory rests upon fact, in the case of the scapolite hypothesis plays a more prominent part, and hence the system is to some extent artificial. The two fundamental silicates assumed as fundamental among the scapolites are the meionite silicate $Si_{12}\,Al_{12}\,Ca_8\,O_{50}$ and marialite silicate $Si_{18}\,Al_6\,Na_8\,O_{48}\,Cl_2$, and all the others are regarded as intermediate isomorphous mixtures of these two extremes in different proportions.

Among the many more papers which might be referred to, can be mentioned a few by title only, as the dissertation by McCay upon the arsenides of iron and cobalt (Freiberg); a paper by Heddle (*Trans. Roy. Soc. Edinburgh*, XXX) upon the ores of iron, manganese, titanium, &c., in Scotland; the papers on the cryolite group alluded to on an earlier page; a paper by Penfield (*Amer. Jour. Sc.*, XXVI, 361) on a peculiar massive variety of descloizite (near tritochorite of Frenzel) from Mexico; a paper containing analyses of zeolites from Zritz, Pennsylvania, by Sadtler (*Amer. Chem. Journ.*, IV, 356), and another by E. F. Smith (*Ib.*, V, 272), on minerals from Lehigh County, Pennsylvania, and by D. B. Brunner (*Ib.*, V, 279) and E. F. Smith, on the composition of some minerals from Berks County, Pennsylvania.

OCCURRENCE OF MINERALS, ESPECIALLY IN THE UNITED STATES.

The State of Maine, always remarkable for the fine and rare minerals it has afforded, has had several interesting localities added to its already long list. At Stoneham, in Oxford County, Mr. Nathan W. Perry discovered a fine topaz locality. Subsequent work there by himself and by Mr. George F. Kunz has brought to light some very remarkable specimens. The finest topaz crystal, in beauty of appearance and complexity of form, is worthy of being ranked with the fine topaz crystals from Siberia. The locality at Stoneham (briefly alluded to in the Report for 1882) was described by Mr. Kunz at the Minneapolis meeting of the American Association for the Advancement of Science. The topaz crystals occur in pockets in the albite. They vary in size from the smaller ones, which are nearly transparent and of a white or faint green or blue color, to very large, coarse crystals, or fragments of crystals, weighing more than 40 pounds. An analysis by Mr. C. M.

Bradbury, made at the laboratory of Prof. J. W. Mallet, seems to show that the composition of this topaz is unusual in having three-fourths of the oxygen replaced by fluorine, instead of one-half, as usual. Associated with the topaz are a number of minerals, the most interesting being triplite, triphylite, columbite, and beryl. Stoneham also afforded some very fine aquamarines. One crystal that was found loose in the soil had a length of 5 inches, and was perfectly transparent and of a rich sea-green color. Auburn, Me., has recently afforded some beautiful tourmalines, mostly of smaller size, though one had a length of 4 inches; they have delicate shades of pink, blue, and green. A paper on this locality was also read by Mr. Kunz at the Minneapolis meeting of the Association, as were others describing the occurrence of large crystals of andalusite at Gorham, Me., and of transparent white garnets near Hull, township of Wakefield, in Canada.

Mr. W. E. Hidden (*Amer. Jour. Sci.*, XXV, 393) describes the occurrence of some remarkable fluid-bearing quartz crystals in Alexander County, North Carolina. From a single large pocket 400 pounds of fine quartz crystals were obtained, and many fragments. Some of the crystals contained enormous cavities (the largest 2½ inches) filled with a fluid, and smaller cavities similarly filled were very common. The liquid was water with some carbon dioxide. Unfortunately the collection of crystals was left exposed on a cold night, and the result was the freezing of the inclosed water and consequent shattering of the crystals, a coherent mass of fragments and cementing ice being obtained.

The occurrence of rare minerals in Amelia County, Virginia (alluded to in the Report for 1882), has been the subject of a paper by W. F. Fontaine (*Amer. Jour. Sci.*, XXV, 330). Earlier accounts of some of the minerals have been published by other writers, but the complete description of the locality is now given for the first time. The minerals were found near Amelia Court-House, in excavations in coarse granite veins made for the purpose of obtaining mica. The relations are much the same as at other localities in granite veins, so that the locality furnishes no very new points of general interest except the individual minerals it affords. The most noteworthy of these are allanite, found in thin-bladed crystals, sometimes 15 inches long; microlite, in modified octahedral crystals of, for this species, very remarkable size (one mass weighed 4 pounds); monazite, in rough crystals, in one case weighing 8 pounds; helvite, in granular particles and indistinct crystals; columbite, in masses of 6 to 8 pounds. There are also beryl, fluorite, garnet, and rarely a few other species.

The very remarkable occurrence of cryolite and other fluorides in Colorado, described by W. Cross and W. F. Hillebrand, has been mentioned on an earlier page. A new topaz locality in Colorado has been described by the Rev. R. T. Cross (*Amer. Jour. Sci.*, XXVI, 334). It was discovered by Walter B. Smith near Platte Mountain, 25 miles north of Pike's Peak. A pocket in decomposed albite yielded upwards of 100 crystals and cleavage fragments, and associated with them feldspar, quartz, göthite, and fluorite. The largest topaz fragment weighed 11½ ounces; the largest crystal weighed 4 ounces, and was of a light straw color, perfectly transparent, and free from flaws. The crystals are highly modified.

A new locality for cassiterite has been described by W. P. Blake (*Amer. Jour. Sci.*, XXVI, 235) near Harney, in the Black Hills, Dakota. It occurs in a coarsely crystalline granite, together with spodumene, in gigantic crystals 2 to 6 feet in length. The tin ore is also found in stream deposits in the same region. Cassiterite is also reported from Rockbridge County, Virginia, King's Mountain, North Carolina, and near Ashland, Clay County, Alabama. Professor Blake also describes a new locality of green turquoise or *chalchuite* (from the Mexican *chalchihuitl*) in Cochise County, Arizona. This locality is about 20 miles from Tombstone, on a spur of the Dragoon Mountains, in what is called Turquoise district. It is interesting to note that, like the Los Cerillos locality, there are ancient excavations which were worked a long time since. The color of the mineral is a light apple-green or pea-green, and it is less abundant than at the New Mexico locality.

Professor Harrington, of Montreal, has given (*Trans. Roy. Soc. Canada*, May 2, 1883) a description of the occurrence, with analyses, of some interesting minerals new to Canada, viz, meneghinite, from near Marble Lake, township of Barrie, Ontario; tennantite, from the Crown mine, Capelton, Quebec; strontianite, from Saint Helen's Island, near Montreal, and acmite, as a constituent of the nepheline syenites of Montreal and Belœil.

Of new foreign localities little need be said here. The magnificent stibnites recently brought from Japan, however, must be mentioned (see *Amer. Jour. Sci.*, XXVI, 214). The locality is on the island of Shikoku, in Southern Japan. The antimony mines at this place have been long worked, and the Japanese have long prized as ornaments the fine group of crystals they have yielded. It is stated that they mount them in flower-pots to adorn their dwellings. The crystals which have come to this country are not only by far the finest known specimens of the species, but they outrank in size and beauty the crystals of all other metallic minerals. The crystals are of splendid luster, often very highly modified crystallographically, and of remarkable size. Crystals in the Yale Museum, for example, have been described which have a slender, spear-like form and are nearly 2 feet long. There are also large groups with diverging crystals 3 or 6 inches in length.

NEW MINERALS.

Bertrandite.—This mineral was briefly announced by M. Bertrand several years since (*Bull. Soc. Min.*, III, 96); and now its characters having been fully made out, it has been named after him by his colleague, M. Damour. It occurs in minute crystals attaining a maximum length of three or four millimeters. These crystals belong to the orthorhombic system, and are sometimes tabular in habit through the extension of the brachypinacoid, but more frequently the basal plane predominates and the outline is hexagonal. The prismatic angle is 121° 20′, and twins with a re-entrant angle of about 60° have been observed. The plane of the optic axes is parallel to the brachypinacoid, and the acute negative bisectrix is normal to the macropinacoid. The crystals are generally perfectly transparent, and either colorless or with a slight tinge of yellow. The luster is brilliant and vitreous. The hardness is nearly that of feldspar, and the specific gravity is 2.59. The chemical composition of the mineral has been established by M. Damour. He shows it to be a hydrous silicate of beryllium (glucinum), conforming to the formula $2\ Be_2\ Si\ O_4 + H_2\ O$; the water goes off only when the mineral is subjected to a red heat. In composition, then, it is near the rare mineral phenacite, from which it differs in that it contains water as well as in its physical aspects. Bertrandite has been found at the quarries at Petit-Port and at Barbin, in the neighborhood of Nantes. It occurs implanted upon quartz and feldspar in cavities in pegmatite. (*Bull. Soc. Min.*, VI, 248, 252.)

Dumreicherite.—In a memoir on the volcanic rocks and minerals of the Cape Verde Islands, Doelter describes a new mineral of the alum group to which he gives the name Dumreicherite, in honor of Baron von Dumreicher, of Lisbon. It is a mineral of secondary origin, occurring in crusts lining crevices in the lava. Under the microscope these crusts are seen to be made up of an aggregate of fibrous crystals, whose optical characters correspond with the monoclinic system. Crystals were obtained from a solution of the mineral, but they did not afford the means of definitely fixing the form. The mineral has an astringent taste, dissolves readily in water, and melts in its water of crystallization. An analysis by F. Kertscher showed that in composition it consists of four molecules of magnesium sulphate, one of aluminum sulphate, and thirty-six of water.

Eichwaldite.—See below under Jeremejeffite.

Empholite.—A new mineral from the remarkable locality of Hörrsjöberg in Wermland, Sweden. It is described by Igelström, and named from the Greek word signifying to *hide*, in allusion to the difficulty of recognizing it in consequence of its minuteness and of its being confounded with the inclosing gangue. It occurs in very minute, white, transparent prismatic crystals, with brilliant luster. According to an examination by Mr. Bertrand, the crystals belong to the orthorhombic system, with a prismatic angle of 128° to 130°; the cleavage is perfect, parallel to the brachypinacoid, and yields brilliant surfaces. The plane of the optic axes corresponds to the direction of cleavage, and the acute positive bisectrix is parallel to the brachydiagonal axis. The hardness of the mineral is about six. Before the blow-pipe it is infusible, and with cobalt solution it gives a deep blue. According to several analyses it is essentially a hydrous silicate of aluminum, containing also a little magnesia, lime, and iron protoxide. The results obtained are not very satisfactory because the material analyzed contained about sixteen per cent. of gangue. The composition brings empholite near the davreuxite of M. de Koninck, which, however, differs in containing less water. The gangue in which the crystals of empholite are imbedded consists essentially of damourite and pyrophyllite; it forms a white finely micaceous mass with greasy feel; some other associated minerals are rutile, menaccanite, svanbergite, black tourmaline. (*Bull. Soc. Min.*, VI, 40.)

Groddeckite.—Described by Arzruni (*Zeitsch. Kryst.*, VIII, 343), as a new zeolite belonging to the chabazite group, more properly to be regarded as a variety of gmelinite. It occurs in small transparent crystals similar to ordinary gmelinite in habit and angles. In composition it corresponds with gmelinite in general, but contains nearly 8 per cent. of iron sesquioxide and 3 per cent. of magnesia. The mineral is known from a single specimen only, which was obtained in 1867 from Andreasberg in the Harz.

Igelströmite.—This is properly a variety of the mineral knebelite. It is described by Mats Weibull as occurring with other manganese minerals at Vester-Silfberg, Norrbärke parish, Sweden. It forms grayish-black crystalline masses with irregular texture, sometimes almost homogeneous and again mixed with magnetite and carbonate of calcium and manganese. The crystalline form was not determined, but two cleavages were observed making an angle of 131° with each other, and also a third indistinct cleavage at right angles to the others. It is translucent with a yellowish color and vitreous to greasy luster. The specific gravity is 4.17. An analysis showed that it was a silicate containing 47 per cent. of iron protoxide, and 19 per cent. of manganese protoxide, with 3 per cent. of magnesia. This makes it a member of the chrysolite group intermediate between the iron chrysolite called fayalite, and the iron-manganese chrysolite called knebelite. It should be added that Heddle has earlier used this name as a synonym of pyroaurite. (*Geol. För. Förh., Stockholm*, VI, 500.)

Jeremejeffite.—A remarkable mineral both from its physical and chemical characters. It was brought by the Russian engineer, M. Jéremejew, from the Soktoui, southeast of Adun-Tschilon, in Western Siberia. It was first examined chemically by M. Damour (*Bull. Soc. Min.*, VI, 20), who gave it its new name. He described it as occurring in hexagonal prisms resembling apatite and beryl in habit. Its hardness is 6.5, and its specific gravity 3.28. It is transparent and almost colorless, with vitreous luster on the fracture space. In composition Damour showed it to be essentially a borate of aluminum containing also a little iron protoxide. The crystalline form of the mineral has been exhaustively studied by Websky (*Jahrb. f. Min.*, 1884, I, p. 1). He shows that while in form the crystals are hexagonal, in fact only the outer shell is optically uniaxial, while the interior portion is made up of six segments all alike biaxial. Between these two parts of the crystal there is a narrow nearly opaque ring. The boundary lines of the six interior segments are perpendicular to the prismatic planes. The optical characters of all the segments correspond, the bisectrix in each being parallel to the vertical axis, and the axial plane making an angle of 30° with the sides of the exterior hexagon. Websky proposes to limit Damour's name to the uniaxial portion, while to the rest he gives the name Eichwaldite after the director of the mines of Nertschinsk who collected the crystals; it seems probable, however, that both may have the same composition. The crystalline form, according to Websky, is complex; in his view there are present, besides the prismatic and pyramidal planes belonging to the hexagonal part of the crystals, also some terminal planes belonging to the interior eichwaldite which he refers to a drilling of the orthorhombic system. It cannot, however, be regarded that the relations of the two parts of the crystals have been fully made out.

Manganhedenbergite.—This is another manganese mineral from the same locality as igelströmite, described above. It is a grayish-green pyroxenic mineral very near the variety of pyroxene, called hedenbergite, and differing only in that it contains between 6 and 7 per cent. of manganese protoxide. Its hardness is 5 and its specific gravity is 3.55. (*Geol. För. Förh.*, *Stockholm*, VI, 499.)

Picroepidote.—According to the examination of MM. Damour and Des Cloizeaux this is a magnesian member of the epidote group, differing from ordinary epidote in that the calcium is replaced by magnesium; this result, however, is based only upon some qualitative tests by M. Damour, and hence needs confirmation. It occurs in small transparent to translucent crystals, which are white or slightly yellowish in tint. They scratch glass, and are infusible before the blow-pipe. They were too imperfect for exact determination, but according to M. Des Cloizeaux correspond with ordinary epidote in form and optical characters. The specimens examined were from Lake Baikal, in Siberia, where they occur with diopside, calcite, dolomite, lapis lazuli, and pyrite. (*Bull. Soc. Min.*, VI, 23.)

Richellite.—MM. G. Cesaro and G. Despret have given the name richellite to a supposed new mineral from Richelle, in the neighborhood of Visé, Belgium. It occurs in compact masses of a cream-yellow color, becoming ochre-yellow by alteration. The hardness is between 2 and 3, the specific gravity is 2. The luster is greasy or resinous to earthy. An analysis yielded some doubtful results, but led the authors to regard it as a hydrous fluo-phosphate of iron and calcium, with, as they believe, the fluorine in combination with the iron. A more complete examination is needed to prove that it is a new and definite mineral. (*Ann. Soc. Belg. Mem.*, X.)

Scovillite.—This is a hydrous phosphate of didymium, yttrium, and other rare earths, described by Brush and Penfield (*Am. J. Sc.*, XXV, 459), from Salisbury, Conn. It occurs sparingly in incrustations in limonite and pyrolusite. It is botryoidal or stalactitic in form and has a fibrous radiated structure. The hardness is 3.5, the specific gravity about 4. The color is pinkish or brownish to yellowish white. The authors have since called attention to the fact that it is essentially identical with the mineral rhabdophane, which was first announced in 1878 by Lettsom, and afterwards examined by Bertrand, and more fully by Hartley. The analysis of the latter shows it to be a hydrous phosphate of the cerium and yttrium earths. The American mineral contains no cerium oxide and a larger percentage of the yttrium earths, but the two conform to the same formula and are essentially the same species. Rhabdophane is known only in a few specimens, which were obtained many years ago in Cornwall, England, and which have since been called blende.

Silfbergite.—A mineral near anthophyllite, and probably a variety only peculiar in containing 8 per cent. of manganese protoxide. It occurs in bladed crystals and crystalline aggregates with prismatic cleavage like amphibole. It has a honey-yellow color and vitreous luster. It is described by Mats Weibull as occurring with other manganese minerals at Vester-Silfberg, Norrbärke parish, Sweden. (*Geol. För. Förh.*, Stockholm, VI, 499.)

Viandite.—A name given by Goldsmith (Peale's *Report on Thermal Springs*) to an unusually hydrous variety of opaline silica or geyserite from the Yellowstone Park. It forms a leathery incrustation, drying to a soft, crumbling mass; it probably does not represent a definite stable compound.

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NECROLOGY OF MINERALOGISTS, 1883.

J. Reinhard Blum.—Born October 28, 1802; died August 21, 1883. For many years professor of mineralogy at Heidelberg; his principal work was his treatise on pseudomorphs, published in 1843, with four supplements published in 1847, 1852, 1863, 1879; he was also the author of a general work on mineralogy and another on lithology.

Franz von Kobell.—Born July 19, 1803; died November 11, 1882. Professor of mineralogy at Munich, author of a general work on mineralogy, a volume of tables for the determination of minerals (in 11 editions), of a work on the history of mineralogy, and of many separate memoirs.

J. Lawrence Smith, of Louisville, Ky. Born December 16, 1818; died October 12, 1883. He was the author of many memoirs devoted to the chemical composition of American minerals, and also to the description of meteorites. He was for some years professor of chemistry at the University of Virginia, and later at Louisville.

FRIEDERICH WÖHLER.—Born July 31, 1800; died September 23, 1883. From 1836 to his death professor of chemistry at Göttingen. His chief contributions to science were in the department of chemistry, but he was also a mineralogist and published numerous memoirs on mineralogical chemistry.

BOTANY.

By Prof. William G. Farlow.

The year 1883 has not been marked by any especially striking discovery in regard to the physiology or morphology of plants, although the mass of botanical literature is perhaps greater than in previous years. In this country, in particular, an unusually large number of notes and papers on phænogams have appeared, and the same is true of papers relating to fungi, while there has been a comparative dearth of writings on mosses and algæ. The works on physiology, although numerous and in many respects important, have not been so elaborate in character as in some years. The countless papers on bacteria can no longer be considered under the head of botany, for by far the greater part of them have a purely medical bearing.

VEGETABLE ANATOMY AND PHYSIOLOGY.

Schimper, in *Bot. Zeitung*, gives the results of observations on the development of chlorophyll-grains and other pigment bodies, and, following Fr. Schmitz, who found that in algæ these bodies were not formed from the protoplasm directly but arose from the division of previously existing pigment-grains, Schimper has examined the young parts of plants, as well as seeds, and finds that either chlorophyll-grains or starch-builders are always present, and by their division are formed the pigment-grains found in older parts of the plant. Th. W. Engelmann, in *Bot. Zeitung*, has a paper on color and assimilation in which he considers the question whether the chlorophyll-grains are the only seat of assimilation in green cells, and by using the bacteria-method of detecting an evolution of oxygen, he finds that no oxygen is given off unless living chlorophyll-grains are present. Tschirch, in two papers in *Bericht. Deutsch. Bot. Gesell.* on chlorophyll and the morphology of chlorophyll-grains, regards chlorophyllan, which is identical with Pringsheim's hypochlorin, as the primary oxidation product of chlorophyll, and differs with Meyer in believing that chlorophyll and aleuron-grains are surrounded by a protoplasmic membrane, and that the coloring matter proper is in the form of an etherial oil rather than of granules. Boehm, in *Bot. Zeitung*, expresses the opinion that the presence of starch in chlorophyll-grains is not sufficient proof that it is the first product of assimilation, and cites the fact that when a solution of sugar is applied to the cut surfaces of herbaceous plants starch appears at once in the chlorophyll-grains. Arthur Meyer has a paper in the *Bot. Zeitung* on crystalloids of trophoplasts and on chromoplasts of angiosperms. Pringsheim, in *Bericht. Deutsch. Bot. Gesell.* gives the name of cellulin-grains to bodies found in hyphæ and oogonia of *Saprolegnieæ*, which he says have been mistaken by Zoff for amæboid bodies. They resemble in their chemical nature cellulose, but do not give the same colors with the ordinary tests. They do not appear to be capable of assimilation, but are rather excretory products. Errara reports that true glycogen, identical with the glycogen of animals is found in fungi, especially in some *Ascomycetes* where it at first pervades the whole plant but afterwards accumulates in the asci.

The coloring matters of plants, more particularly the non-green colors, are elaborately treated in two papers; one by Fritzsch, in Pringsheim's *Jahrbücher*, and the other by Pick in the *Bot. Centralblatt.* Borodin, in *Bull. Acad. Imp. St. Petersburg*, has a paper showing the wide distribution in plants of some crystalline pigments related to chlorophyll. Lemaire, in *Ann. Sci. Nat.*, states that besides cutinization the epidermis of plants is capable of lignification. Zacharias, in *Bot. Zeitung*, in an article on albumen, nuclein, and plastin, states that a great part of the starch-builders is composed of albumen, which is also found in smaller amounts in chlorophyll-grains.

The subject of the direct connection of the protoplasm of adjoining cells through openings in the cell walls, which has long been known to be the case in *Florideæ*, and which has recently been shown by Gardiner to be true also in the sensitive organs of some plants as *Mimosa pudica*, has given rise during the present year to several papers. W. Hillhouse, in *Bot. Centralblatt*, shows that a connection of the protoplasm of adjacent cells is not limited to *Mimosa*, but is much more general than had been suspected. Gardiner, in *Proc. Roy. Soc. London*, confirms this fact, and Russow goes so far as to say that "in every plant during its whole life the mass of protoplasm is continuous."

De Vries, in *Bot. Zeitung*, in an article on the part which vegetable acids play in the turgescence of growing organs, thinks that in great part they act merely by assisting the roots to absorb salts of potash. The *Ann. Sci. Nat.* contains the results of Vesque's experiments on the direct observation of the movement of the water in the vessels of plants. He says that there is a movement of water when the vessels are full of water or when long columns of water are separated by air-bubbles. But when small amounts of water and air-bubbles are alternately arranged there is no motion.

Volkens, in *Jahrb. Bot. Gart. Berlin*, has shown the relation of water-pores to underlying tissues in a large number of species belonging to 36 families. A very full treatise by Famintzin an metastasis and metamorphosis of energy in plants has appeared in *Schrift. Akad, St.*

Petersburg, and has been issued as a separate edition. It is in Russian, and is a detailed account of assimilation and related topics. Leclerc, in *Ann. Sci. Nat.*, has a paper on transpiration, where he gives a history of modern theories and discoveries.

Reinke, in *Bot. Zeitung*, has a paper on autoxidation in living vegetable cells. He states that in every cell are found autoxidators or substances which, at a low temperature, and by the action of molecular oxygen, can be oxidized in the presence of water, producing peroxide of hydrogen. Wortmann, also in *Bot. Zeitung*, shows that radiant heat falling on a growing organ causes it to curve to or from the source of heat, and that the phenomena resemble those caused by light. Wieler states that plants grow more rapidly under diminished atmospheric pressure, although beyond a certain point the converse is true. Stahl, in a paper on the influence of light on the growth of plants, *Ges. Med. & Naturwiss. Jena*, says that in plants exposed to the light the palisade cells are specially developed, and that in plants growing in dry, sunny places, the leaves tend to assume a vertical position, owing either to a lengthening of the upper side of the leaf-stalk, or more frequently to its upward bending. The difference in aspect of the leaves of the same species when growing in the shade or exposed to the sun arises from the fact that, in the former case, the parts of a leaf lie more nearly in a single plane, while, in the latter case, they are curved and bent in different planes. The action of electric light on the growth of plants has been noticed in several journals during the year, but the results arrived at are unsatisfactory and, at least as far as any practical application of the electric light is concerned, it seems as if little was to be expected. Wiesner, in *Bot. Zeitung*, maintains that there are two maxima of growth in the epicotyl of *Phaseolus multiflorus*, and a repetition of his earlier experiments on this point confirms their accuracy.

The first series of *Investigations of the Laws of Growth of Plant Organs*, by Wiesner and Wettstein, is devoted to a study of the nutation of internodes. Baranetzki, in *Mem. Acad. Sci. St. Petersburg*, has a paper on the nutation and winding of stems. Bengt Joensson, in *Bericht. Deutsch. Bot. Gesell.*, considers the effect of currents of water on growing plants, or, as he calls it, *Rheotropismus.* He finds that in the plasmodia of *Myxomycetes* the growth is against the current, *i. e.*, positively rheotropic, while in some mucors it is with the current, or negatively rheotropic. Pfeffer has an important communication in the same journal, *Locomotorische Richtungsbewegungen durch chemische Reize.* He states that the antherozoids of ferns are attracted by the malic acid given off by the open archegonia, while in mosses the antherozoids are attracted by cane sugar. Capillary tubes filled with a weak solution of malic acid or its salts can be used for attracting the antherozoids of ferns, which will enter the mouth of the tubes. Zoospores of *Saprolegnia* are attracted by the denser parts of solutions in which any good nourishing material is unequally distributed.

The structure and function of the epidermal system of plants is treated in detail by Westermaier in Pringsheim's *Jahrbuecher.* Ambronn, in the same journal, shows that the presence of pores in the outer walls of epidermal cells is not opposed to the theory that the pores in internal cells are for the purpose of assisting diasmotic changes. Wilhelm, in *Bericht. Deutsch Bot. Gesell.*, reports that in a considerable number of *Coniferæ* he found the outer opening of the stomata filled with a fine-grained, waxy substance, evidently intended to diminish transpiration. In the same journal are papers by Schwendener on the protective sheath in stems and the way in which it is strengthened; a preliminary communication by A. Fischer on the sieve-cell system of *Cucurbita;* and Wilhelm gives the results of some experiments with young oaks, which had been stripped of their leaves in June, and on examination in the autumn were found to have a double annual ring, confirming the observations of Kiny. The *Bot. Centrablatt* has a paper by Russow, *Zur Kenntniss des Holzes, insonderheit des Coniferen Holzes*, which is summed up as follows by the author: The vessels and tracheids are merely pumps, by which the water is transferred from the roots to the leaves by the action of two forces, a suction acting through the "zweiseitigen Hoftuepfel" and a direct pressure acting through the "einseitigen Hoftuepfel." The microscopic anatomy of the principal Japanese *Coniferæ* is illustrated by Nakamura in Hartig's *Untersuch. forstbot. Instit. Munich.* Klebahn has a paper on the structure and function of Lenticells and their substitutes in plants destitute of lenticells in *Bericht. Deutsch. Bot. Gesell.* In the last-named journal is a short paper by Korschelt, in which he states that not only in *Gymnosperms*, as had been shown by Dingler, but in certain Phænogams he found that the terminal growth took place by means of a three-sided scheitel-cell. Also in the same journal is a paper by Urban on the morphological significance of the thorns of *Aurantiaceæ.* He thinks that they are not transformed axillary branches, as is generally supposed, but the two lower leaves of an axillary branch. The *Torrey Bulletin* has a paper by Shrenk on the hausstoria of *Commandra.*

Van Tieghem and Guignard give some observations on the mechanism of the fall of leaves, and the species specially examined by them was *Gymnocladus canadensis.* In the case of the leaves proper a layer of cork is formed at the insertion of the leaf, and the layer of separation forms above the cork layer. The leaflets have a meristem formed around the vascular bundle of their petioles, and by the forcible growth of the meristem the bundle is finally ruptured. In the *Proc. Akad. Wiss. Berlin*, Schwendener, in a paper entitled *Zur Theorie der Blattstellungen*, replies to the criticisms of his opponents, especially C. De Candolle. Goebel's paper in Pringsheim's *Jahrbuecher* on the development of certain inflorescenses confines itself to the *Gramineæ* and *Urticaceæ.* In the *Bot. Zeitung* Goroschankin describes and figures sieve-plates in the membranes of the corpuscula of Cycads and Conifers, and Prohaska states that in *Daphne* the nuclei of the embryo-sack neither unite with one another nor subsequently divide to form the nuclei of the endosperm. Celakovsky, in Pringsheim's *Jahrbuecher*, has a paper on *Homologien der generativen Produkte der Fruchtblätter* in Phænogams and higher Cryptogams.

To settle the question whether *Drosera* was really nourished by the insects caught and dissolved by the leaves, Büsgen started with seedling plants and kept them under control, feeding some with insects while others were kept free from insects. His results, given in *Bot. Zeitung*, confirm the accuracy of Darwin's views, for the *Droseræ* fed on insects were better developed than those which were not. Marcus A. Jones finds that insects are caught by *Mentzelia lævicaulis*. The hairs on the leaves are furnished with barbs, so that insects which insert their heads between the barbs cannot withdraw them. There was no evidence, however, that the insects were digested by the plants. In the *American Naturalist* J. F. James, in an article entitled *Pitcher Plants*, describes the contrivances of *Sarraceniæ* for catching insects.

Of the numerous papers treating of the mode of fertilization of different flowers we can refer only to a few of the more important. Kosmos has several papers by Fritz and Hermann Mueller. In *Die Blumen des Melonenbaumes* Fr. Mueller remarks that *Carica papaya*, the pawpaw, is an exception to Sprengel's rule, that, in entomophilous plants with imperfect flowers the males are more conspicuous than the female, and Hermann Mueller follows with remarks on fertilization of monœcious species. The last-named botanist has two other papers in *Kosmos:* one on the significance of the change in color of *Pulmonaria officinalis;* the other, *Arbeitstheilung bei Staubgefæssen*, in which he discusses the different functions of the stamens with long filaments and pale pollen and those with short filaments and showy pollen both in the same flower, as in the crape myrtle, *Lagerstrœmia*. The showy pollen is to attract insects and serves them as food, while the pale pollen is for fertilization of the flowers. Facts on this subject have also been given by Fr. Mueller in *Nature*. In some biological observations on flowers from South Brazil, in *Bericht. Deutsch. Bot. Gesell.*, Fr. Mueller describes the peculiar fertilization of two species of *Cypella*.

The pollination of *Araceæ* has been studied by Arcangeli, who gives a number of interesting details in *Nouv. Giorn. Bot.* The peculiarities of the anther of *Roscœa purpurea* are described by Lynch in *Jour. Linn. Soc.*, in which are also papers by A. W. Bennett on the constancy of insects in their visits to flowers, butterflies being very irregular and bees very constant, and by Christy on the habits of insects when visiting flowers, in which he shows that insects prefer a number of successive visits to the same species of flowers. Meehan announces the discovery of sensitive stamens in *Echinocactus Whipplei*, and he gives in *Proc. Acad. Nat. Sci. Philadelphia* some remarks on the fertilization of *Cactaceæ*. Meehan reports in *Torrey Bulletin* that he has found cleistogenous flowers in *Nemophila maculata*, *Impatiens pallida*, *Opuntia lepticaulis*, and *Viola sarmentosa*. Urban describes the fertilization of *Rulingia* in *Bericht. Deutsch. Bot. Gesell.*, and a large number of facts with regard to the fertilization of *Rutaceæ* in a paper on that order in *Jahrb. Bot. Gart. Berlin.*

BACTERIA AND FERMENTS.

We can in this connection mention merely some of the more important papers on bacteria which are of interest from a botanical point of view. By far the greater part of the very numerous papers on these organisms have treated the subject from a medical or sanitary standpoint. Zopf's *Die Spaltpilze*, originally published in the *Encyklopædie der Naturwissenschaften*, is a clear and well-illustrated treatise which gives the botanical characters and what is known of the development of the principal *Schizomycetes* which produce chemical or pathogenic changes. Miller describes and figures in the *Bericht. Deutsch. Gesell.* a large form, *Leptothrix gigantea*, found on the teeth, and in the same journal Kurth describes a new *Bacterium Zopfii* with coccus and bacterium forms. The *Am. Naturalist* gives a description of some pathogenic *Micrococci* by Burrill, reprinted from the Report Illinois Museum.

The report of the Carlsberg Laboratory has an article by E. Hansen on the *Physiology and Morphology of Alcoholic Ferments*. He studied especially the endospores of different *Saccharomycetes* which, although they cannot be distinguished from one another by morphological characters, yet differ in the time required for germination when exposed to different temperatures. He gives tables showing by curves the maxima and minima at different temperatures. The forms called by Pasteur *Torulæ* resemble species of *Saccharomyces*, but as they do not produce ascospores they are considered by Hansen to be distinct from that genus. Hansen's paper concludes with an account of some secondary injurious changes which take place in beer from the growth of certain ferments.

THALLOPHYTES.

Fungi.—The fifth part of Brefeld's *Botanische Untersuchungen* treats of *Ustilagineæ*, and he has carefully studied the mode and conditions of germination of the spores of several genera. The form of germination depends largely on the nature of the medium in which the spores may be at the time. Under certain circumstances yeastlike cells are produced and these may be propagated indefinitely. Even in other orders, as shown in *Exoascus*, yeastlike germinations occur, and Brefeld is not willing to accept the view that species of *Saccharomyces* are distinct, but he regards them as derived from other fungi. The development of some anomalous *Ustilagineæ* has been studied by Cornu who, in the *Ann. Sci. Nat.* describes and figures some new genera distinguished by the mode of germination and anatomical peculiarities. The development of the anomalous genus *Graphiola* has been studied by Ed. Fischer, whose results have been published in the *Bot. Zeitung.* An examination of living material and of dried specimens including those in Ravenel's Fungi Caroliniani shows that the genus is not related to *Æcidium* as some have supposed, although it is not easy to say in what order of fungi *Graphiola* should be placed. The *Proc. Royal Society* contain two papers by Plowright; in one *Mahonia aquifolia* is stated to be a propagator of the wheat mildew, the æcidium, of which appears abundantly on *Mahonia* in some places in England where the more common æcidium on barberry is scanty or quite wanting; the second paper is on the *Life History of the Dock Æcidium*, which he asserts is connected with *Puccinia arundinacea* D. C. The discussion between Pringsheim and De Bary in regard to the details of the fertilization in *Saprolegnieæ* has been continued this year. The first-named botanist has twice referred to the subject. In the *Bot. Centralblatt* he replies sharply to the criticisms of Zopf concerning the supposed amœbæ in the tubes and oogonia of *Saprolegniæ.* The other paper appeared in Pringsheim's *Jahrbuecher*, where he reaffirms his views in opposition to the apogamic nature of the spores in some species of *Achlya.* In the *Bot. Zeitung* of January, De Bary reiterates his belief in the apogamic character of the reproduction and denies the validity of Pringsheim's views. The *Centralblatt* has a paper by Zalewski on the reproduction in *Cystopus* followed by a description of the species of the genus; Bainnier in the *Ann. Sci. Nat.* has two papers on *Mucorini* in one of which he gives a detailed account of the conditions which affect the production of zygospores, while the other is an abridgment of the author's larger work on the subject. In his *Aperçu systématique des chytridiacées* in the *Arch. Bot. du Nord*, Sorokin gives an account of the species of the order known to him more especially, however, those examined by him in Russia and the East. Hermann Hesse in an inaugural thesis discusses the systematic value of the anatomical structure of the gills in *Agaricini* without, however, arriving at any very satisfactory results. A contribution to our knowledge of the lower forms of *Myxomycetes* is found in a paper by Fayoel in *Bot. Zeitung* where he gives the development of *Guttulino protea.* The mechanism of the discharge of the spores in *ascomycetes* has been studied by Zopf who, in *Zeitschrift naturwissenschaft Halle*, describes and figures in full the process which takes place in several *Sordariæ* where by an expansion of the protoplasm behind the spore at the tip of the ascus, the spore is violently ejected and the ascus closed afterwards. Eidam in Cohn's *Beitrage zur Biologie* has a paper on the development of *ascomycetes*, as shown by species of *Sterigmatocystis*, of which some new and curious forms are described. In one instance an ascus is formed by the union of two similar spiral hyphæ. At the end of the paper is a reply to some of Brefeld's views on reproduction in this group.

The papers treating of American species of fungi have been unusually numerous. The 33d and 34th *Reports* of the *New York State Museum* include descriptions and figures of a large number of fungi new to the

State by the State botanist Mr. C. H. Peck, together with an account of certain common injurious fungi. Peck has also several papers on new fungi in the *Torrey Bulletin*, including a new fern rust, *Cæoma Cheilanthis*, and a new genus, *Neopeckia* Sacc., founded on the older *Sphæria Coulteri* Pk. A considerable number of new species of the United States have been described in the *Torrey Bulletin* by Ellis and Kellermann and in the *Am. Naturalist* by Ellis and Martin. Hedwigia has notes and descriptions of several United States fungi by Winter, some of the descriptions being also given in *Torrey Bulletin*. Farlow in *Proc. Am. Acad. Boston* gives critical notes and descriptions of some of the species contained in the 3d and 11th centuries of Ellis's North American Fungi. The *Peronosporeæ of the United States* is the title of a paper presented by Farlow at the meeting of the *Soc. Promotion of Agriculture* at Minneapolis, and printed with a supplement in the *Bot. Gazette.* The same writer has also a paper on *Some Ustilagineæ of the United States*, also in the *Bot. Gazette.* A description and figure of a *Phallus* collected in Pennsylvania by Rau, *P. togatus* Kalch., are given in the *Gazette*, and in a later number is a note by Farlow who regards the species as identical with *P. duplicatus* Bosc. The *Proc. Cincinnati Soc. Nat. Hist.* has a paper by A. P. Morgan, *Mycologic Flora of the Miami Valley*, with full descriptions of the *Agaricini* known to occur in that region, illustrated by 9 colored plates. Morgan has also notes on some Kentucky fungi in the *Gazette.* The species of *Uromyces* found in Iowa are fully described by J. C. Arthur in the *Bull. Minnesota Acad. Sci.* A new species of *Entomophthora* infesting *Caloptenus differentialis* is described by Bessey in *Am. Naturalist.* New American fungi have also been described by Cooke in *Grevillea*, where among other things he reports the appearance of a new *Cycloderma* in Ohio, and states that *Milleria herbatica* Pk. is the long-lost *Testicularia Cyperi* Klotzsch.

In *Bot. Gazette* A. B. Seymour has a note on the synonymy of *Puccinia heterospora* B. & C. A partial *List of the Fungi of Wisconsin* is given by W. F. Bundy in the *Geology of Wisconsin*, Vol. I.

The most extensive systematic work on fungi which has appeared during the year is the second volume of Saccardo's *Sylloge Fungorum* including the remainder of the *Pyrenomycetes.* Saccardo has also issued a series of plates illustrating the fruit of the genera included in the first two volumes of the *Sylloge* under the title *Genera Pyrenomycetum Schematice Delineata*, and the *Fungi Italici Delineati* have been continued to No. 1440. The classification of Saccardo is not accepted by Cooke in many points, and in *Grevillea* the latter has given a revision of some of the genera already treated by Saccardo, viz, *Xylaria*, *Hypoxylon*, *Nummularia*, *Anthostoma* and their allies, and in the *Journal of Botany* a revision of *Sphærella.* The first volume of Cooke's *Illustrations of British Fungi*, including the *Leucospori* in 292 plates, has been completed, and the beginning of the second volume has a number of the *Hyporhodii.* *Grevillea* has also a notice of new *British Fungi* by Cooke, a classification of the *British Uredineæ* on the continental method by Plowright, and a paper on the general classification and nomenclature of the order by Cooke. The fungi of the Netherlands are treated by Oudemans in his revision of the *Perisporiaceæ* of that country, and by Calkoens in his synopsis of the *Uredineæ* and *Ustilagineæ* of Holland. French species have been described in several articles in the *Revue Mycologique*, and by Fabre in the *Ann. Sci. Nat.* in a continuation of his *Sphæriaceæ* of Vaucluse, and illustrations of French species are given in the continuation of Gillet's *Hyménomycètes de France* and Patouillard's *Tabulæ-Analyticæ.* Australian fungi have been enumerated and described by Cooke in *Grevillea.* The fungi of *Rabenhorst's Kryptogamen Flora* have been continued this year through the Basidiomycetes, and two centuries of Winter's *Fungi Europæi* have appeared. Erikssen's *Fungi Scandinavici* has been continued by a second century, and a new series of fungi exsiccati, *Ungarns Pilze* or Hungarian fungi, has been started by Linhart.

Numerous papers have appeared on fungi which produce diseases of plants, more especially those of the grapevine. The *Untersuchungen aus dem forstbotanischen Institut of Munich*, edited by Prof. Robert Hartig, has several important papers. Dr. Heinrich Mayr gives an account of the disease caused by *Nectria cinnabarina* in maple, linden, and horse-chestnut. Hartig describes the diseases of the white pine (*Pinus strobus*) which appears to be much more susceptible to fungous diseases in Germany than with us. Hartig also gives a very full account with illustrations, of what he calls *Rhizomorpha necatrix*, which produces the rot of the root and lower part of the stem of grapes, a disease which had been previously attributed to a number of different fungi by French and Italian writers. No perithecia were found by Hartig, who asserts that the *Rhizomorpha* is quite different from that which has been connected with *Agaricus melleus.*

The elaborate memoir of Cornu, *Le Peronospora des vignes*, which forms one of the series of papers on the diseases of the vine, published by order of the French Academy, although printed in 1882, was not widely distributed until the present year. The writer gives a very full account of the literature of the subject and details of the microscopic structure with numerous excellent plates. Prillieux, in the *Bull. Bot. Soc.*, reports that the oospores of *Peronospora viticola* have been made to germinate. In germination the oospores give out a tube instead of zoospores, which is contrary to what take place in the case of the conidia. The *Bericht. Deutsch Bot. Gesell.* contains a paper by Frank, on some new and little-known diseases of plants, in which he describes a fungus, *Fusicladium tremulæ*, which attacks *Populus tremula*, and he refers also to *Glœosporium Lindemuthianum*, which produces discolored spots on the pods of cultivated beans, and has prevailed not only in Europe but also in this country during the year. The *Gardener's Chronicle* has several notices of fungous diseases, a considerable space being devoted to the discussion by Plowright and others of Jensen's experiments on the protection against the potato rot afforded by a deep layer of soil over the potatoes. The cause of the yellows in peaches has been studied by Penhallow in the reports of Haughton Farm, and the conditions of the soil and the alterations in the peach trees are given in detail, but no special fungus is assigned as the cause of the disease.

We should in this connection mention a few works which treat of fungi which cause disease in man and animals, although they are of medical rather than of botanical interest. The structure and development of the Soorpilz, *Oidium albicans* are treated by Dr. F. A. Kehrer in a paper published at Heidelberg. The writer states that the spore capsules mentioned by Burckhardt are merely conidia, surrounded by epithelial cells, but he agrees with Gramitz as to the existence of resting spores. The relations of *Aspergillus flavus*, *A. niger*, *A. fumigatus*, and *A. glaucus*, to *Otomycosis aspergillina* are discussed in a paper by Dr. F. Siebenmann, of Brugg. The species are described and figured in three plates of poor quality, and a considerable part of the paper is taken up with an account of the effects of certain reagents on the growth of the species studied. Dr. L. Lichtheim has discovered two new species of *Mucor*, named by Cohn *M. rhizopodiformis* and *M. corymbifer*, which produce disease when introduced into the blood of rabbits. The writer gives the results of his inoculations, and a differential diagnosis of the Mucormykoses and Aspergillomykoses. Zopf, in *Biol. Centralblatt*, describes a new species of *Myxomycetes*, *Haplococcus reticulatus*, which is found in the hog. Dr. J. Schrœter gives some statistics of cases of poisoning by eating fungi, which have occurred in Silesia up to 1880. The number is, however, small, and the determination of the species eaten was only possible in a few instances.

Algæ.—Relating to species of the United States may be mentioned *Notes on New England Algæ*, No. 2, by F. S. Collins, in the *Torrey Bulletin*, where he reports the discovery of *Codiolum longipes* Foslie, *Callithamnium membranaceum* Magnus, and other species not before known our coast. In the same journal Mr. G. W. Perry has a note on large specimens of *Arthrocladia villosa*, found at Falmouth, Mass. No. 7 of Wolle's *Fresh-Water Algæ*, also in the *Bulletin*, describes and enumerates a considerable number of species new to the United States, principally Desmids. The *Bull. Minnesota Acad. Sci.* has a paper by J. C. Arthur on some algæ of Minnesota supposed to be poisonous. There is also a *Note on Fresh-Water Algæ*, by Farlow, in *Bot. Gazette*, where he records the finding of *Nostochopsis lobata* in Vermont by Mr. Faxon, and of *Sphæroploea annulina* in California collected by Mrs. Austin.

The sixth part of Agardh's *Till Algernes Systematik* is a monograph of *Ulvaceæ*, in which Agardh includes the *Porphyreæ* of other writers. The work is in Latin and is illustrated by colored plates. The fourth part of Areschoug's *Observationes Phycologicæ* is devoted to notes on

Laminarieæ, in which, among other things, are descriptions of several forms from the Pacific coast of the United States. The memoirs of the zoological station of Naples include an illustrated monograph of the *Cystoseiræ of the Bay of Naples* by Valiante, who, in addition to the descriptive part, gives an account of the development of the conceptacle in the genus. He differs from Bowers in thinking that the conceptacles are not developed from the depressions which bear the hairs, as was said by Bowers to be the case in *Fucus*. The fructification of the *Florideæ* has been studied by Fr. Schmitz, who, in a paper in the *Bericht. königl. Akad. Wissenschaft. Berlin*, gives the results of his special studies of the formation of the cystocarp in different representatives of the order, together with general remarks on the significance of the reproductive process in this group of plants. The development of *Cutleria adspersa* has been studied by Janczewski, who has an illustrated paper on the subject in the *Ann. Sci. Nat.*, where he also considers the relative position of the *Cutlerieæ* to other algæ, and describes a new genus, *Godlewskia*, belonging to the *Phycochromaceæ*. Dr. Max Franke, in Cohn's *Beitraege zur Biologie*, gives the development of a curious alga, *Endoclonium polymorphum*, a parasite of *Lemna gibba*.

The first part of Borzi's *Studi Algologici*, which is illustrated with nine quarto plates, is a minute study of several *Chlorophyceæ*, five of which are made the types of new genera. Flahault, who has studied the variations of *Nostocs*, has a paper in the *Bull. Soc. Bot. France*, with a plate of some of the forms examined by him. He maintains that *Nostoc flagelliforme*, supposed to be peculiar to Texas, is only a form to the old *N. commune*, and he has found the same form in France. Under the title *Zur Morphologie der Cyanophyceen*, Ed. Tangl describes a new genus, which he calls *Plaxonema*, related to *Oscillaria*, and gives an account of some stages of its development. In the *Bot. Zeitung* Hansgirg explains the motions of *Oscillariæ* by a difference in the turgescence of the cells at the two extremities of the filaments, and does not accept the statement of Englemann that the motion is caused by a protoplasmic exudation. Wille, in a paper in *Bericht. Deutsch. Bot. Gesell.*, states that he has seen a nucleus in *Tolypothrix lanata*, which undoubtedly belongs to the *Phycochromaceæ*, an order in which it was very doubtful whether a nucleus existed. In the *Bericht. Deutsch. Bot. Gesell.* Zopf has a paper on the development of *Tolypothrix amphibica*, which he claims supports his view of the variability of the *Phycochromaceæ*.

The most extensive work which has appeared during the year relating to local floras is Ardissone's *Phycologia Mediterranea*, in the memoirs of the *Soc. Critt. Ital.* It is a large octavo of five hundred pages, with very full synonymy and notes of the Italian *Florideæ*. The part of Rabenhorst's *Kryptogamenflora* edited by Hauck has been continued through the remainder of the *Florideæ* and the *Phæosporeæ*. Cooke's *British Fresh-Water Algæ* has been continued through part 6, comprising *Chlorosporeæ*, *Vaucheria*, and *Œdogonium*. New British algæ have also been described by E. M. Holmes in *Grevillea*. Piccone has published an account of the algæ collected in the cruise of the "Volante" in the Mediterranean. In an interesting paper on the flora of snow and ice, especially in Arctic regions, Wittrock gives an account of the forms known to occur in such regions, with notes and figures of the development of *Sphærella* (*Protococcus*) *nivalis*. Lagerheim read a paper on the snow flora of Lapland before the Botanical Society of Stockholm. Lundell states that he has found Desmids in a living condition in blocks of ice. In Pringsheim's *Jahrbücher* A. Fischer has a paper on the occurrence of gypsum crystals in *Closteria*, and in the *Bot. Zeitung* a detailed account of the cell division in *Closteria*. Additions to British *Desmidieæ* are given by Joshua in *Journal of Botany*. Parts 11 and 12 of Wittrock and Nordstedt's *Algæ Scandinavicæ* appeared this year. Two new series of algæ exsiccatæ have made their appearance—a British series of marine species by E. M. Holmes, and a French series of fresh-water species by Mougeot, Manoury, and Roumeguère.

Diatomaceæ.—Two very elaborate papers by Otto Mueller have appeared. The first is on the *Law of the Successive Cell Divisions of Melosira arenaria*, and appeared in the *Bericht. Deutsch. Bot. Gesell.* The second, in Pringsheim's *Jahrbücher*, has a similar title, and is in fact an extension of the last-named paper, with ample illustrations. He gives diagrams of the divisions of the cells by two's and three's, showing how provision is made for retarding the diminution in size of the cells to such a degree that further increase can only take place by the formation of auxospores. The cell divisions of *Synedra ulna* have been studied by Schaarschmidt. Numerous papers have been written on the cause of locomotion in diatoms, but the writers differ widely on this point. A paper by Engler on pelagic diatoms of the Baltic was read at the annual meeting of German naturalists. Lanzi has given a short account of the diatoms of Lago di Bracciano, paying particular attention to the floating forms. Prinz and Ermenghem have been able to make out some obscure points in the structure of the valves of diatoms by means of sections of what is known as the *Cementstein of Jutland*. The *Synopsis des Diatomées de Belgique* of Van Heurck has been continued, and series 1 and 2 of Grunow's notes and determinations of this work have been published. The diatoms collected during Nares's Arctic expedition have been described by Cleve in the *Jour. Linn. Soc.*, and those collected on the Vega expedition have been published in the reports of the expedition, also by Cleve.

Characeæ.—Dr. T. F. Allen's *Notes on the American Species of Tolypella*, in the *Torrey Bulletin*, has full descriptions of six species, with numerous illustrations. Henry and James Groves have notes on *British Characeæ* in the *Journal of Botany;* a description of a new species, *Chara socotrensis*, is given by Nordstedt in the *Bericht. Deutsch. Bot. Gesell.;* and Spegazzini describes a considerable number of *Characeæ* from the Argentine Republic, several of which are new, in *Characeæ Platenses*.

Lichens.—The *Bericht Deutsch. Bot. Gesell.* has a paper by Krabbe on the morphology and development of the *Cladonieæ*, in which he states that the podetia do not belong to the thallus, but represent a part of the reproductive system, and, together with the spermogonia and apothecia, which they bear, form the fructification of the lichen. The thallus proper of the *Cladonieæ* consists of what is called the protothallus, from which the prodetia spring. The development of the thallus of the *Caliciece* is treated by Neubner in *Flora*. He describes the changes which protococcoid gonidia undergo when growing with hyphæ, and states that the protococcus form may change into a stichococcus form. O. J. Richards has an article in the *Act. Soc. Linn.* of Bordeaux on the substratum of lichens, enumerating 44 species which grow on glass, 43 on leather, besides others on iron and bones, and maintains that on substances like glass the development can be clearly seen and does not support the algo-fungal theory of Schwendener. In his *Stuaies on Cephalodia*, in the *Proc. Roy. Swedish Acad.*, Forssell describes different forms of cephalodia, or formations containing one or more algæ of a different type from that of the lichen proper, and considers their bearing on the Schwendener theory.

New American species of lichens have been described in two papers in the *Torrey Bulletin* by Prof. Edward Tuckerman. The papers are entitled, *A new Ramalina, R. crinita*, from San Diego; and *New Western Lichens*, in which three new species are described, *Lecidea Brandegei* from Colorado, *L. Pringlei* and *Aeolium S.ti Jacobi* from California, together with a new genus, *Pyrenothamnia*, represented by *P. Spraguei* from Washington Territory. A new genus has been made by J. Mueller from *Staurothele diffractella* Tuck., which he calls *Willya*.

Grevillea contains two papers by Crombie on British lichens, *Enumeration of the British Cladoniei*, and *On the Lichens in Dr. Withering's Herbarium*. The second part of Wainio's *Adjumenta ad Lichenographiam Laponiæ Fennicæ* is a catalogue with critical notes describing a considerable number of new species. Stizenberger has issued a second part of his stations and distribution of Swiss lichens, and Zwackh-Holzhausen has published an account of the lichens of Heidelberg with determinations by Nylander. The lichens of Franche-Comté have been continued in a third fasciculus by Flagey, and Olivier's *Herbier de l'Orne et du Calvados* has reached its seventh fasciculus. The *Bull. Soc. Bot. France* has a paper by Lamy de la Chapelle on the *Lichens of Cauteret and Lourdes*. Part 17 of J. Mueller's *Lichenologische Beitraege* in *Flora* is devoted to species from Australia, and part 18 includes for the greater part species from Brazil. The same botanist has also described the lichens collected by Dr. Naumann on the Gazelle expedition in Engler's *Jahrbücher*, and given a revision of extra European lichens published by Meyen and Flotow in 1843. Additions to European lichens have been given by Nylander in *Flora*. The *Journ. Linn. Soc.* has papers by Nylander and Crombie on lichens collected in Eastern Asia by A. C.

Maingay and by Crombie on lichens of the Challenger expedition. The *Trans. Bot. Soc. Edinburgh* has descriptions of new lichens from Newfoundland, New Zealand, and Scotland by Stirton.

ARCHEGONIATA.

Mosses and Hepaticæ—Very little has appeared during the year in this department, and that includes principally accounts of the mosses of limited districts. Haberlandt has a paper on the function of the axial bundle in moss stems in the *Bericht. Deutsch. Bot. Gesell.*, and W. W. Bailey has an article on the general structure of mosses in *Am. Naturalist*, an *Enumeratio*. The list of plants from Southwestern Texas and Northern Mexico, collected by E. Palmer, to which reference is given under Phænogams, includes mosses and hepaticæ determined by T. P. James, an *Enumeratio*.

Muscorum Europæorum, by Gravet in *Revue Bryologique*, is intended to be an exchange list for European species. The seventh part of Braithwaite's *British Moss-Flora* includes *Dicranaceæ*. For French species we may mention Husnot's *Flore analytique et déscriptire des mousses du nord-ouest*, of which a second edition has been published with a general introduction to the study of mosses, and the first part of Delogne's *Cryptogamic Flora of Belgium* includes the mosses of that country. In Germany there has appeared a description of new mosses by Limpricht in the *Bericht. Schles. Gesell.*, and a paper on the *Sphagna* of Flotow's herbarium by Warnstorf in Flora. For Italy we should note two papers, one by Saccardo and Bizzozera on the mosses of the Venetian district, and by Bozzi on the mosses of the province of Pavia. The *Atti Soc. Critt. Ital.* have a first installment of a paper on the bryologic flora of Catalina by Bottini, Arcangeli, and Macchiati. The *Centralblatt* has an original paper by Karl Müller, entitled *Musci Tschuctschici*, in which he describes a number of new species from a little known region of Northeastern Asia. Stephani has described six new *Hepaticæ* in *Hedwigia*, one of the species *Frullania Pennsylvanica* collected by Rau being also described in the *Torrey Bulletin*. Massalongo and Carestia have a paper of *Hepaticæ* of the Apennines in the *Revue Bryologique*.

Ferns and Higher Cryptogams.—Of general works we may mention *Nomenclator der Gefässkryptogamen*, by Carl Salomon, which gives the synonym and distribution of the vascular cryptogams in a condensed form, Van Tieghem's *Quelques points de l'anatomie des eryptogames vasculaires* in the *Bull. Soc. Bot. France*, which treats of certain fossil as well as living types, and Potonié's *Structure of the woody bundle in the vascular cryptogams* in the *Report of the Botanic Garden of Berlin*. The last-named journal has also a paper by Prantl entitled *Systematische Uebersicht der Ophioglosseen*. The same writer has a paper in *Bericht. Deutsch. Bot. Gesell.* on *Helminthostachys zeylanica*, and its relations to *Ophioglossum* and *Botrychium*. The *Torrey Bulletin* includes the greater part of the contributions to North American pteridology for 1883. The thirteenth and fourteenth parts of Eaton's *New or Little Known Ferns of the United States*, include a number of new forms, principally Western species. In Watson's *List of Plants from Southwestern Texas and Northern Mexico* there is an enumeration of ferns by Eaton, with two new species, *Cheilanthes meifolia* and *Ch. cinnamomea.* In *Fern Notes*, No. 6, G. E. Davenport records the occurrence of some interesting forms, and the *Bulletin* also contains a description of a new species from Arizona, *Cheilanthes Pringlei*, Davenport. The same writer has a paper on the distribution of ferns in the United States in the *Proc. Am. Phil. Soc.* A new variety of *Camptosorus rhizophyllus*, var. *intermedus*, is described by J. C. Arthur in the *Bot. Gazette.* The *Development of the Male Prothallium* of the field horse-tail is the subject of an illustrated paper in the *Am. Naturalist.*

Comparatively little has been written this year on exotic forms. The most extensive work is Beddome's *Hand-book to the Ferns of British India, Ceylon, and the Malay Archipelago.* The *Journal of Botany* has a *Synopsis of the genus Selaginella*, by J. G. Baker, continued through several numbers. Kuhn, in *Bericht. Deutsch. Bot. Gesell.*, has an account of the ferns of Socotra, and in Engler's *Jahrbuecher* Luerssen refers to species from Japan and the Loo-Choo Islands. The first part of Adolph Oborny's *Flora of Moravia and Austrian Silesia* contains the vascular cryptogams of that region. In the *Journal of Botany* Hance describes seven new ferns from China and Formosa, and Baker gives a list of ferns from east tropical Africa, including two new species collected by Rev. J. Hannington.

PHÆNOGAMS.

Additions to our knowledge of North American Phænogams have been very numerous, although most of them have been rather brief and in the form of notes in the different botanical journals published in this country. The most important paper is that of Professor Gray in *Proc. Am. Acad. Boston* on *Characters of new Compositæ* with revision of certain genera and critical notes. This is followed by *Miscellaneous Genera and Species* in which a considerable number of new forms are described and synopses of American species of *Valerianella*, *Buchnera*, and *Orthocarpus* are given in foot-notes. The eleventh part of Sereno Watson's contributions to American botany in the *Proc. Am. Acad.* is devoted to a continuation of the *List of Plants from Southwest Texas and Northern Mexico*, principally collected by E. Palmer in 1879–'80. This portion includes all from *Gamopetalæ* to *Acotyledons.* The determinations of the species of *Compositæ* included in the list are by Professor Gray. The ferns and mosses were determined by D. C. Eaton and T. P. James. In the same journal is a Description of some new Western Species by Watson. A *Supplement to Chapman's Southern Flora* has been issued, including a large number of species particularly from Florida, which were not discovered at the time the Flora was published. Dr. Engelmann has a note on *Vitis palmata* Vahl in the *Bot. Gaz.* Dr. Parry has two papers in *Proc. Davenport Acad Sci.;* one on *Arctostaphylos* in which he gives an account of the species of the genus found on our Pacific coast; the other on *New Plants from Southern and Lower California* including species of *Phacelia*, *Ptelea*, *Polygala*, and *Gilia;* Parry also describes a new *Oxytheca luteola* from the Mohave desert, and has a note on *Cucurbita Californica* in *Torrey Bulletin.* In the same journal E. L. Greene describes *New Western Compositæ* and a number of other new Western species, and in the *Bot. Gazette* he has an article on Californian species entitled *Notulæ Californicæ.* M. E. Jones has *Notes from Nevada and Utah* in *Torr. Bull.*, *Notes from California* in *Bot. Gaz.*, and *New Plants from California and Nevada* in *Am. Nat.* Jos. F. James gives a revision of the genus *Clematis* of the United States in *Journ. Soc. Nat. Hist. Cincinnati.* The *Torrey Bulletin* has a paper on *Potamogetons* in Western New York, by E. J. Hill; a description of a new *Eleocharis diandra*, by C. Wright; *Notes on the Adirondacks*, by Professor Prentiss; an account of some leafy berries of *Mitchella repens*, by Professor Dudley, and an account of some *Hybrid Oaks near Washington*, by Dr. Vasey.

A number of papers on the grasses of the United States have appeared, of which we may specify the following: *The Grasses of the United States*, by Dr. Vasey, special report No. 63 of the Agricultural Department, in which the genera are described and a list of the species is given; new species of grasses, and descriptions of two new species from Oregon and Arizona, by Vasey, in *Torrey Bull.; Notes on Spartina; List of Grasses from Washington Territory*, and *List of Grasses collected by C. G. Pringle in Arizona*, by F. L. Scribner, in *Torrey Bull.* Frank Tweedy has notes on the *Coniferæ of Washington Territory* in *Torr. Bull.*, and Robert Ridgway gives additions and corrections to the list of *Native Trees of the Lower Wabash* in *Bot. Gaz.* The *Gazette* also has *Notes on Edible Plants*, by Dr. E. L. Sturtevant; *Notes on the Virginia Creeper*, by Meehan; *Notes from Franconia*, by W. W. Bailey, and on *Eriodictyon glutinosum* as illustrating evolution by Rothrock. The *Am. Nat.* has Prof. J. M. Coulter's *Development of a Dandelion Flower*, a paper originally read at the meeting of the Am. Ass., and an abstract, by Professor Bessey, of Lojacono's *Revision of the North American Trifolii* in *Nuovo Giorn. Bot.* The *Proc. U. S. Nat. Mus.* has a paper by Lester F. Ward on *Marsh and Aquatic Plants of the Northern United States*, and *Notes on the Natural History of Labrador*, including the plants, by W. A. Stearns. Several catalogues have appeared during the year, of which we may mention *Macoun's Catalogue of Canadian Plants*, including *Polypetalæ*, *Catalogue of Native and Naturalized Plants of the City of Buffalo and Vicinity* by David F. Day, including cryptogams, as well as phænogams; *Flora of Worcester County*, Massachusetts, by Joseph Jackson; *Flora of Floyd County*, Iowa, by J. C. Arthur, and *Flora of Oak Island*, Massachusetts, by H. A. Young.

The great work of Hooker and Bentham, *Genera Plantarum*, was completed this year with the end of the third volume. The *Monographiæ Phanerogamarum* of De Candolle has been continued in several parts, including *Burseraceæ* and *Anacardiaceæ* by Engler, *Pontederiaceæ* by Solms-Laubach, and *Cyrstandreæ* by C. B. Clarke, the last-named article being illustrated with 32 plates. Engler's *Botanische Jahrbuecher* has a number of papers on phænerogams, among which may be enumerated the editor's *Beiträge zur Kenntniss der Araceæ*, in which some new genera are described; a continuation of Koehne's monograph of *Lythraceæ;* Warming's studies of the family of *Podostemaceæ* and *Tropische Fragmente*, including the development of *Rhizophora* with illustrations. The *Jahrb. Bot. Gart.* Berlin has a monograph of *Turneraceæ* and a paper on *Rutaceæ* by Urban.

The *Journal of Botany* has a paper by Masters on *New Passifloræ*, several papers by Hance on Chinese and Formosan plants, particularly important to American botanists on account of the discovery of additional species belonging to characteristic genera of the Eastern United States; descriptions of new Bermuda plants by Hemsley, not to mention other articles. The *Jour. Linn. Soc.* has an article by Masters on *Passifloræ* collected by E. André in Ecuador and New Granada, and descriptions of a large number of Madagascar plants by Baker. In *Incrementa Floræ Rossicæ* Trautvetter gives additions to the flora of Russia, and Kjellmann has published two valuable papers on the Phænogams of the Vega expedition from Northern Siberia, Nova Zembla, and Waigatsch, giving the general aspect and conditions of vegetation of those regions, together with a detailed account of the phænogams collected. Some new plants from the Argentine Republic have been described by Spegazzini in *Plantæ Novæ Austri-Americanæ.*

A. De Candolle in *Nouvelles Remarques sur la Nomenclature Botanique*, a pamphlet of 80 pages, considers some questions which have arisen in connection with his "Lois de la Nomenclature Botanique." An English translation of Poulsen's *Botanische Microchemie* with notes by Trelease has been published by Cassino. Grant Allen's *Flowers and their Pedigrees* is a work in the usual vein of this author, who has during the year written a number of papers on plants in connection with evolution in different popular journals. The *Torrey Bulletin* has a continuation of Gerard and Britton's *List of State and Local Floras* of the United States and a series of biographies of some North American botanists was begun in the *Bot. Gazette.*

Necrology of Botanists, 1883.

Anzi, D. M. Died at Como, April 19.

Bianco, Giuseppe. Died at Avola, Italy, November 12, æt. 82.

Breindl, Alfred. Died at Nabresina, November 24.

Cesati, Baron Vincenzo. Born at Milan May 24, 1806. Died at Naples, February 13.

Corry, Thomas Hughes. Drowned on August 4, in Lough Gill, Ireland, while botanizing with Charles Dickson.

Crewe, Rev. Henry Harpur. Died September 7.

Dickson, Charles. Died August 4, at Laugh Gill.

Duval-Jouvé, J. Died at Montpellier, France, August 25.

Fendler, Augustus. Died at Trinidad, W. I., November 27, æt. 71.

Gibson, George Stacey. Born at Saffron Walden, England, July 20, 1818. Died at London, April 5, 1883.

Heer, Oswald. Born in Glarus, Switzerland, August 31, 1809. Died at Lausanne, September 27.

Kolb, E. Died at Kissleg, Wurtemberg, May 14.

Lauche, Wilhelm. Died at Wildpark near Potsdam, Prussia, September 12, æt. 57.

Mueller, Hermann. Born at Mühlberg September 28, 1829. Died at Prad, Tyrol, August 26.

Nitschke, Theodor. Died at Münster, Westphalia, August 30, æt. 50.

Parker, Charles F. Died at Camden, N. J., September 7.

Pedicino, Nicola Antonio. Born in 1839. Died at Naples, August 2.

Poselger, H. Died at Berlin, Prussia, October 4.

Ruhmer, Gustav. Died at Schmalkalden near Berlin, Prussia, August 23.

Spreitzenhofer, G. C. Died at Kierling near Vienna, July 28.

Steele, William Edward. Died May 6, æt. 66.

Wood, Rev. Robert. Born at Tallentire December 18, 1796. Died at Wigton, England, March 15.

Young, Alfred Robson. Born at York, England, January 14, 1829. Died at Brooklyn, N. Y., April 12.

ZOOLOGY.

By Prof. THEODORE GILL.

INTRODUCTION.

The progress of Zoology during 1883 has been unattended by any startling discoveries, but, nevertheless, has not been less real than during the past. Not the least unimportant of the events that has at least given a new impulse to scientific investigation, and caused a kind of census and review of past acquisitions to be made, was what has been justly called "The Great International Fisheries Exhibition" held in London during the summer and autumn of the year. The exhibit was very large, the numbers of visitors were unexpectedly great (and expectations were high), and a large surplus in money gains was the result. The greatest gain, however, was in the knowledge acquired, the numerous publications which were the direct outcome of the exhibition, and, above all, the impulse to new investigations. As one of the results, is a movement to organize and equip a well-provided laboratory at some central point on the English coast where facilities may be had, such as have given the Naples zoological station a world-wide renown. One of the most important zoological publications, at least as far as American zoologists are concerned, is a "Synopsis of the Fishes of North America," published by Messrs. Jordan and Gilbert. It supplies, as well as could be expected in the present condition of Ichthyology, a great want, and one that has long been felt. A quite extended notice of the work will be found in the subsequent pages of this report.

As in the previous reports, the language of the original from which the abstract is compiled is generally followed as closely as the case will permit. It has, however, been found necessary to limit the abstract to the illustration of the prominent idea underlying the original memoir, and pass by the proofs and collateral arguments. At the same time it has been often attempted to bring the new discovery into relation with the previous status of information respecting the group under consideration. As to the special discoveries recorded, they have been generally selected (1) on account of the modifications the forms considered force on the system; or (2) for the reason that they are or have been deemed to be of high taxonomic importance; or (3) because the animals *per se* are of general interest; or, finally, (4) because they are of special interest to the American naturalist. Of course zoologists cultivating limited fields of research will find in omissions cause for censure, and may urge that discoveries of inferior importance have been noticed to the exclusion of those better entitled to it. It is freely admitted that this charge may even be justly made; but the limits assigned to the record have been much exceeded, and the recorder has studied the needs of the many rather than of the few. The summary is intended, not for the advanced scientific student, but for those who entertain a general interest in zoology or some of the better known classes.

A very partial bibliography of noteworthy memoirs and works relating to different class of animals is supplied, and will, it is hoped, prove to be of use to those to whom the voluminous bibliographies and records of progress in science are inaccessible. Instead of being inserted at the head of each class to which the respective memoirs relate, as in the last report, the whole is brought together at the end.

It has been a difficult matter to select the titles which might be most advantageously introduced in a limited report like the present. Articles of a general interest or of special importance as contributing to throw light on the affinities of certain groups have been given the first place. Necessarily many very important papers have not been referred to, and very few descriptive of species have been admitted, and only when unusual interest attaches to the new species or the groups which they enlarge.

The compiler desires to make special acknowledgment for most material assistance to the *Zoologischer Anzeiger* of Professor Carus and to the *Journal of the Royal Microscopical Society.*

SYNOPSIS OF ARRANGEMENT.

I. GENERAL ZOOLOGY.

II. PROTOZOANS.
    Sporozoans; Rhizopods; Infusorians.

III. PORIFERS.
    Sponges.

IV. CŒLENTERATES.
    Polyps; Acaleps.

V. ECHINODERMS.
    Crinoids; Asteroids; Echinoids; Holothurians.

VI. WORMS.
    Platyhelminths; Nematelminths; Annelids.

VII. ARTHROPODS.
    Merostomes; Crustaceans; Arachnids; Insects.

VIII. MOLLUSCOIDS.
    Brachiopods.

IX. MOLLUSKS.

Acephals; Gastropods; Cephalopods.

X. VERTEBRATES.

Fish-like Vertebrates; Leptocardians; Myzonts; Fishes; Amphibians; Reptiles; Birds; Mammals.

I. GENERAL ZOOLOGY.

The deep-sea fauna.—Prof. T. Fuchs has sought to ascertain "what is to be understood by the term 'deep-sea fauna,' and by what physical conditions is its occurrence governed." He recalls that (1) the limit to which sea-weeds descend is about 30 fathoms, that (2) the reef-building corals decrease perceptibly below 8 fathoms, "and a depth of 20 fathoms is generally regarded as their extreme limit," and that (3) "a third important element of the littoral fauna consists of the beds of large bivalves" which appear "no longer to occur below 20 fathoms." It is claimed "that fully two-thirds of the whole of the littoral marine animals are more or less intimately connected with one or other of these three assemblages," and that "it follows directly that the great majority of the littoral animals cannot descend much below 30 fathoms in the sea." It is then claimed that "the great mass of littoral animals do not descend in the sea much beyond 30 fathoms, and, on the other hand, that at a depth of 90 fathoms the fauna already everywhere shows the marked type of the deep-sea fauna." As to the relations between the littoral and deep-sea faunæ, Professor Fuchs thinks "we are in a position to lay down a more exact boundary," and comes to the conclusion that the "long series of facts from different seas indicate very accordantly a depth of about 50 fathoms as that critical zone in which is situated the great turning point that separates the littoral from the deep-sea fauna; and we are therefore justified in regarding the line of 50 fathoms as an ideal boundary between the littoral and the deep-sea fauna." It is added that "it is very interesting to observe that *this depth is pretty nearly the same in all seas*," but that between the tropics the separation of the littoral and deep-sea faunæ is "to a certain degree real." Moreover, in those regions "below a depth of 30 fathoms there follows an extremely sterile region, with few animals." Within the tropics, in fact, the littoral fauna would be separated from the deep-sea fauna by "a comparatively sterile region extending about from 30 to 90 fathoms." Such an intermediate region is said to be unknown in temperate and cold seas.

As to the cause of the limitation of the faunæ, it is claimed that "light is the most powerful factor amongst all the agents which influence life upon the earth." It is urged that "the difference which is produced in the fauna of the sea by its conditions of light is no other than that which we distinguish as littoral fauna and deep-sea fauna; in other words, that the littoral fauna is nothing but the fauna of light, and the deep-sea fauna the fauna of darkness." Professor Fuchs goes so far as to contend that "the occurrence of the deep-sea fauna is in no way connected with the temperature of water."

The views thus enumerated by Professor Fuchs will not go unchallenged, and indeed all his propositions appear to be too much generalized at least, and are more or less contradicted by facts within our knowledge.

The origin of sexual differences.—The search for the cause which determines that the offspring should be of the male or female sex has been long carried on by various persons, and every now and then the discovery of the cause is announced. Hitherto the results of investigation have been illusive and unsatisfactory. Prof. E. Pflüger has recently renewed inquiries into the fascinating subject, and published the results in the *Archiv für Physiologie* (vol. XXIX). His researches were made on frogs, of which many hundreds were experimented upon.

Dr. Pflüger especially investigated the question whether the concentration of the spermatic fluid influences the sex of the offspring. Taking all due precautions (for the eggs are very delicate), he secured in a watch-glass the spermatic fluid of the male, taken in the act of sexual congress, and subjected it to various degrees of dilution in water in various glasses. Eggs taken from the right uterus of the female were allowed to glide into these mixtures. The experiments established two facts: (1) the fertilizing power of the spermatic fluid was not diminished by dilution, and "all the ova were fertilized in each observation"; (2) "dilution of the male fluid had no effect on the sex of the frogs which came to maturity after the artificial fertilization."

There are three categories as to sex manifested in young frogs: (1) male, (2) female, and (3) hermaphrodite. "The hermaphrodites become finally either male or female, but in their earlier stages they have the sexual organs of the female only; in those which are finally to become males the testicles gradually develop around the ovaries and the latter are resorbed." The apparent numerical preponderance of the female believed to exist in the earlier life history of the frog is illusive, and has led some investigators astray, it is urged. The fertilizing power of the male spermatic fluid diminishes rapidly after the end of the sexual season.

Dr. Pflüger has to think that it is "impossible" to produce offspring by the union of the sexes of different species of Batrachians. Segmentation may commence, but this segmentation was frequently of an abnormal type. (*Am. Naturalist*, vol. XVII, pp. 441, 442.)

Sense of direction in animals.—That wonderful faculty developed in so many animals of being able to find their way to a long-distant spot has been the subject of much speculation and some serious investigations. Some of the hypotheses respecting the "sense of direction" thus manifested are more ingenious than probable. A French searcher for knowledge, M. Vignier, has recently discussed the subject in the *Revue Philosophique*, and published a memoir on the subject of the sense of orientation and its organs, and he co-ordinates the faculty with a perception or perceptibility of magnetic currents. (*Jour. Franklin Inst.*, vol. XV.)

Influence of canals in extension of geographical range of species.—As was naturally supposable, the Suez Canal has been the means of dispersing various animals of the respective seas which it connects and effecting a limited interchange of the two faunæ. On the one hand, the *Umbrina cirrhosa* (related to the king-fish of the United States) and the *Labrax lupus* (a relation of the striped bass) have made their way through into the Red Sea; and, on the other, the *Pristipoma stridens* and *Crenidens Forskali* have passed from the Red Sea into the Mediterranean. With these fishes invertebrates of various kinds have also passed and crossed each other's way into the opposite seas. The many facts bearing on this case have been recorded by Professor Keller, of Zurich.

II. PROTOZOANS.

Sporozoans.

A peculiar Gregarinid.—A number of new forms of Gregarinidæ have been discovered and examined by A. Schneider, and among them is one of special interest. It was found in the digestive tube of *Glomeris*, one of the diplopod myriopods, and has been named *Cnemidospora lutea*. "It is remarkable for the characters of its protomerite, the contents of which are formed by two masses, distinguishable by various characters. The lower has finely granular, the upper highly refractive, and apparently fatty contents, and is of greenish and not, as the others, of a yellow or brown color." (*Arch. Zool. Exper. et Gen.*, vol. x, pp. 423, 450; *J. R. M. S.* (2), vol. III, p. 675).

Rhizopods.

Endoparasitic Amœbæ.—Some interesting observations have been made by Grassi on Amœbæ parasitic in the Chætognathous worms. Six kinds of Chætognaths are found in the straits of Messina, where that naturalist pursued his investigations, and in all of them Amœbæ of one kind or another were found; they were of two species—*A. sagittæ* (or *chætognathi*) and *A. pigmentifera*, a new species, and chiefly harbored in the caudal chamber and vasa deferentia (rarely in the cœlom) of the adult or adolescent sagittids, but not in the young. (The *A. pigmentifera* was found in two species of *Spadella*.) The endoplasm in both species of *Amœba* contains a number of granules which are considered to be of a fatty nature, and these are supposed to constitute a reserve of nourishment. Reproduction is effected by modification of the internal structure of the body, resulting in its breaking up in a number of corpuscles containing granules, but still united by the body-wall of the parent; when they separate they are flattened bodies 7-1000ths millimeters long and 3-1000ths thick, and of an oval contour; from one pole there issues a flagellum twice as long as the body. It is thought by Grassi that their development tends to approximate the *Amœbæ* to the *Moneræ*, and the forms studied by him are supposed to have many connections with *Protomyxomyces ciprinarius* of Cunningham. (*Arch. Ital. de Biologie*, vol. II, pp. 402, 444; *J. R. M. S.* (2), vol. III, 3, p. 674.)

Infusorians.

New parasitic Flagellates.—Dr. Grassi has investigated the endoparasitic "Protista" and recognizes five families of Flagellata. He satisfied himself that the number of flagella is of but little taxonomic importance, and bases his families on the condition of the extremities and especially of the posterior. One of the families recognized was based on a newly discovered type, the *Trichomonas melolonthæ*, found in the beetle indicated. The family—called Trichomonadidæ—is distinguished by the tapering of the posterior extremity and the development of several flagella as well as trichocyst-like bodies at the anterior extremity. Megastomidea and Lophomonadidea are two families proposed for previously known forms. (*Arch. Ital. de Biol.*, vol. II, pp. 402, 444; *J. R. M. S.* (2), vol. III, pp. 673, 674).

III. PORIFERS.

Sponges.

The mode of boring of Clione.—The means by which the celebrated boring-sponge *Clione* finds its way into shells and other hard substances has long been a matter of doubt and dispute. Recent observations have been made by H. Nassonow, and he has attempted to answer especially two questions—(1) how the sponge excavates hard calcareous structures and completes its destructive work, and (2) the effect of its parasitic habits on the sponge itself.

For the solution of the first question young sponges were cultivated on thin transparent calcareous lamellæ. "The larvæ, after a free stage, settled on the plates, and soon a rosette-shaped mark appeared; the sponge gave off thin processes, which passed into the substance of the plate and followed the contour lines of the rosette; about a day after the sponge settled a rosette-shaped particle was taken out of the plate; the body of the sponge entered the depression thus formed, took the particles into and then cast them out of its body. Toward the evening of the day of observation the rosette-shaped marking had totally disappeared, and its place was taken by a small pit; into this the sponge contracted the greater part of its body. Chemical as well as mechanical agencies appeared to be at work, but the demonstration of the presence of the acid was prevented by the strong alkaline reaction of the sea-water. Contrary to the view of Hancock, Nassonow thinks that the spicules of the sponge take no part in the boring operation; indeed, the young sponge began before it had developed any skeletal structures, not to say before it had completely taken on the other characters of the adult."

With reference to the second question, it is contended that one of the results of the parasitism of *Clione* is the peculiar mode of ovulation, in that the sponge appears to pass its eggs into the water, where they become fertilized, whereas in other sponges the eggs pass into the body of the animal and are there fertilized. (*Zeitschrift für wissench. Zool.*, vol. XXXIX, pp. 295–308, 2 pl.; *J. R. M. S.* (2), vol. IV., pp. 65–66.)

A supposed new animal type.—A peculiar and unknown organism was found by Prof. F. E. Schulze in the salt-water aquarium of the Zoological Institute of Graz. It was a thin, lamelliform object, a few millimeters in diameter and 0.02^{mm}. thick, translucent, but of a grayish-white color, and of a variable, constantly changing form. When at rest it had usually a rounded contour, but it could elongate itself into a long and variously curling thread-like form. Its movements, however, were very slow and scarcely observable, as the animal crept along upon its under surface. The entire surface was ciliated. "Close under the upper surface is a layer of highly refractile balls from 5$^{\mu}$ to 8$^{\mu}$ in diameter and distributed pretty evenly; besides these there are other balls nearer the under surface, which seem to be essentially different from those first mentioned. There is no indication of internal organs, nor of only bilateral or radiate symmetry; the organism is uniaxial." But what is of more importance from a systematic point of view than any of these details is the intimate structure. There are two different epithelial layers of cells, which form respectively its upper and lower surfaces, and between them is a fully developed layer of connective tissue. There are, in fact, three layers, which are comparable with the ectoderm, mesoderm, and entoderm of Metazoans generally. Whether, however, the several layers of the unknown organism are really homologous with them may be regarded as uncertain till the development of the animal is known. What the affinities of the animal are is also quite doubtful. It was under observation by Professor Schulze for about a year, but showed no sign of metamorphosis or reproduction. Its structure, exhibited in the development of the several layers, removes it from the Protozoans, but this is merely negative evidence. Mr. C. S. Minot has suggested that it was the larva of a sponge, but there are objections to this view. The name conferred on the organism is *Trichoplax adhærens*, the generic name containing an allusion to the plate-like form and its ciliated surface, and the specific recalling the manner in which it clings to the substance on which it moves. (*Zool. Anzeiger*, vol. VI, pp. 92–97; *Journ. Royal Mic. Soc.* (2), vol. III, pp. 350–351; *Science*, vol. I, p. 305.)

IV. CŒLENTERATES.

Polyps.

A new type of Pennatuloid Polyps.—A remarkable form of Pennatuloid polyps has been recently discovered by Messrs. Koren and Danielssen in a special work on New Alcyonids, Gorgonids, and Pennatulids of the Norwegian fauna; it has been named *Göndul mirabilis*, and specimens were obtained in the fjord of Throndheim at a depth of 180 fathoms, attached to *Oculina prolifera*. This form represents a peculiar "section" of Pennatulida, called "Gonduleæ," distinguished by the fixed rachis with developed bilateral lobes, furnished with long calcareous spicules. The Gondulidæ were defined as Pennatulida Gonduleæ, having "a polypidom without a stalk, fixed, furnished with bilateral pinnules in which are calcareous spicules, having along its center a canal divided by four valves into as many longitudinal canals." In other words, they are Pennatulida Gonduleæ with a fixed, stalkless, bilateral polypidom, having a rachis with a hollow canal divided by four converging longitudinal septiform valves, and on each side with subspiral polypigerous ridges, fortified by calcareous spicules.

A deep-sea cancrisocial Actinian.—Several cases of association of polyps with decapod crustaceans have been recorded (*e. g.*, *Cancrisocia expansa* with a *Dorippe*, *Sagartia parasitica* with an *Eupagurus bernhardus*), but an instance recently discovered seems to be worthy of notice in this place on account of the habitat of the associates and the extent to which the association has been verified. The polyp has been described as a new species by Professor Verrill under the name *Epizoanthus paguropliilus*, and about 400 specimens were obtained at one station (947, 89 miles S. by S. ¾ W. from Gay Head, Mass.), at a depth of 312 fathoms, but all associated with a hermit crab, the *Parapagurus pilosimanus.* The polyp is evidently "a true commensal, forming out of its own tissues the habitation of the crab; and hitherto it has not been found elsewhere than upon the back of this particular species of crab, which likewise has not been found without its polyp." The associates were previously obtained "by the Gloucester halibut fishermen in deep water, off Nova Scotia," and by Professor Verrill in 1880. (*Am. J. Sc.* (3), vol. XXIII, p. 137.)

Acalephs.

Reappearance of Limnocodium.—It is noteworthy that the fresh-water medusa, named *Limnocodium Sowerbii*, which appeared in numbers in June, 1880 and 1881, in the *Victoria regia* tank in London, did not develop at all in 1882. It made its reappearance, however, in 1883 in the tank, but earlier than in the previous years, being discovered April 28. The tank had remained empty during the preceding winter, and was filled with water on March 8. (*Nature*, vol. XXVIII, p. 7.)

V.—ECHINODERMS.

Crinoids.

Basal plates of Crinoids.—It has been asserted that some Crinoids—for example, those of the family Eugeniacrinidæ—were destitute of basal plates. Mr. P. H. Carpenter investigated representatives of the family named, and was convinced that "the supposed absence of basals in certain Crinoids mostly rests upon empirical reasoning alone; and that when we come to inquire into the matter rationally, *i. e.*, from the point of view of morphology, we not only find good reason to believe in the existence of those plates, but also that their supposed absence involves considerable morphological difficulties." (*Ann. and Mag. Nat. Hist.* (5), vol. XI, pp. 327–334.)

New orders of Crinoids.—Mr. S. A. Miller, in the second edition of his American Palæozoic Fossils, has proposed to isolate several of the family types of Crinoids as distinct orders. The Agelacrinidæ have further the name Agelacrinoidea, the Lichenocrinidæ constitute the order Lichenocrinoidea, and the ordinal name Myelodactyloidea is intended for a group of two families—the Myelodactylidæ and Cyclocystoidæ. The characters given to these groups appear to be scarcely those requiring recognition as orders.

Asteroids.

Number of Ophiuroids.—In connection with a "Report on the scientific results of the voyage of H. M. S. Challenger" (Zoology, vol. V, part 14), the Hon. Theodore Lyman has attempted to enumerate all the species of the order described up to the time of publication. Not less than 167 new species and 20 new genera were found in the collections made by the famous expedition.

Echinoids.

Physiology of the Echinoids.—If a sea-urchin or *Echinus* is turned mouth upwards it will commence to right itself, and does so by using two or more adjacent rows of pedicels. Whether the consequent endeavor was due to the co-ordinating influence of a nerve center, or whether it was the result merely of the serial action of the pedicels, was uncertain, although various experiments tended to show that the action must be due in part at least to the co-ordinating influence of a nerve center. Mr. Romanes considers that he has now settled the question by a device suggested by Mr. F. Darwin.

A sea-urchin was placed back downward in a bottle filled to the brim with water and then corked up. The whole was then placed on the rotating apparatus used by the Darwins in their experiments on the geometrism of plants, and the sea-urchin was continuously rotated in a vertical plane. While rotation was continued the sea-urchin made no attempt to turn itself, but when within two or three minutes of its cessation it commenced to do so. Moreover, if allowed to do so until it had raised itself into the equatorial, or any other intermediate position, if rotation was resumed, the sea-urchin remained in the position it had then gained as long as it lasted. "Therefore no doubt could be entertained that the effect of the rotation was that of confusing, as it were, the co-ordinating influence of a nerve center, the stimulus to the operation of which, in the absence of rotation, is gravity." (*Journ. Linn. Soc. London, Zool.*, vol. XVII, pp. 131–137; *J. R. M. S.* (2), v. III, pp. 660–661.)

Holothurians.

The feeding of Holothurians.—The celebrated Darwin, in his work on Coral Reefs (p. 14), stated, on the authority of another, that the Holothurians subsisted on living coral. The question has been lately investigated, and an advance made in a knowledge of the economy of those animals. Surgeon-Major H. B. Guppy, of the British navy, undertook experiments at St. Christoval, one of the Solomon Islands, which satisfied him that it was dead and not living coral that the Holothurians ingested. They selected, however, "those feeding grounds where the attachment of molluscs, zoophytes, and stony algæ had to some degree loosened the surface of the rock." One of the Holothurian species which the surgeon studied was 12 to 15 inches long. From three independent observations on this species it was found that the amount of coral sand voided by each individual daily was not less than two-fifths of a pound avoirdupois. "At this rate some fifteen or sixteen of these animals would discharge a ton of sand from their intestinal canals in the course of a year, which represents almost 18 cubic feet of the coral rock forming the flat on which these creatures live."

The *raison d'être* and mode of ingestion of the Holothurians have been explained by Mr. W. Saville Kent. That the Holothurians are not devourers of living corals is shown in connection with different facts, but especially from the circumstance that several were kept in a tank containing sea-anemones and corals without interfering with them in any way. All they require is derived from the coral or shell *débris* with which they are constantly associated. At first sight this material would appear to be in the last degree adapted for the sustenance of such highly organized animals, but, as may be confirmed at any time by investigation, "shell-sand, gravel, and other *débris* forming the superficial layer at the bottom of the water, when exposed to the light, is more or less completely invested with a thin pellicle of Infusoria, Diatoms, and other microscopic animal and vegetable growths." It is upon these minute organisms that the Holothuriæ feed, swallowing both them and the shelly or other matter upon which they grow, much in the same way as we might subsist on cherries, swallowing stones and all.

It is by means of the tentacles which surround the anterior extremity that the Holothurians seize their food. Cucumariæ of two kinds—*C. com-*

munis and *C. pentactes*—were the special subjects of Mr. Kent's observations thus recorded, the former sometimes attaining a length of a foot and the other about half the size of the larger. The tentacles are ten in number and developed as "extensively ramifying pedunculate plumous or dendriform tufts stationed at equal distances around the oral opening." These, when the animals are "on the full feed," are in constant motion, "each separate dendritic plume in turn, after a brief extension, being distally inverted and thrust bodily nearly to its base into the cavity of the pharynx, bearing along with it such fragments of sand and shelly matter as it had succeeded in laying hold of." As soon as a tentacle obtains a supply, it is thrust into the mouth, and one or another is always moving toward or in the mouth.

The supply thus taken in is probably ground down by "the characteristic teeth that arm the pharynx," and the sand-reduced remains, divested of their living contents, are in time discharged by the anal cavity.

Another gentleman, from certain observations in Bermuda and Jamaica, "fancied that they were catching swimming creatures," and thought that his observations were supported by "a fine specimen from the zoological station at Naples, which has a half-swallowed fish protruding from its mouth." The fish in question was, however, probably a *Fierasfer*, which is a parasite of the Holothurian, and enters and departs from its cavity voluntarily. (*Nature*, vol. XXVII, pp. 7–8, 433, 508.)

VI. WORMS.

Nemathelminths.

A nematoid worm parasitic on the onion.—The common onion, it seems, is sometimes infested with a parasite in the shape of a nematoid or thread-worm. The animal has been discovered and described by J. Chatin as a new species of the genus *Tylenchus*. It has considerable resemblance to the *Anguillula* of wheat. In its larval state it penetrates into the bulb and disorganizes the central tissue, converting the fibro-vascular bundles into a brownish-pultaceous mass. In the course of ensuing growth the sexual organs become developed and offspring appear as claviform larvæ. These may escape through the destruction of the bulb and fall to the ground. If the earth is sufficiently damp they wander about, but if it is dry they are quiescent until moisture ensues. They then seek the bulbs of the onion, and those that succeed complete the normal cycle of life. If the worm finds entrance into an animal it is passed out with the fæces, neither becoming encysted nor undergoing any further development. It is urged that the best remedy against the spread of the pest is, to burn all affected onions. (*Comptes Rendus Acad. Sc.*, *Paris*, vol. XCVII, pp. 1503–1505; *J. R. M. S.* (2), vol. IV, p. 232.)

The homologies of the Nemertean proboscis.—Several unexpected types of the animal kingdom have been brought forward, from time to time, as exemplifying in some form or other the notochord of the primitive vertebrates. One of the most unexpected to furnish such a structure is the Nemertean, and yet Dr. Hubrecht has claimed that the Nemertean worms actually have the homologue of the notochord developed in a proboscis. In his opinion "the proboscis of the Nemerteans, which arises not as an imaginable structure (entirely derived, both phylogenetically and ontogenetically, from the epiblast) and which passes through a part of the cerebral ganglion, is homologous with the rudimentary organ, which is found in the whole series of vertebrates without exception—the hypophysis cerebri. The proboscidean sheath is comparable in situation (and development?) with the chorda dorsalis of vertebrates." The chief reason urged for this homology is that the proboscis and hypophysis are both ectodermal invaginations. There are, on the other hand, reasons which seem to strongly militate against this view. (*Quart. Jour. Micr. Sci.*, vol. XXIII, p. 349; *Science*, vol. II, p. 631.)

Annelids.

The function of the Morrenian glands of the Earthworm.—The character and physiology of the glands observed by and named after the French naturalist Morren have been investigated by C. Robinet. The secretion of those glands, on drying, proves to be a mineral body, formed of carbonate of calcium, whose functions appear to be to adapt the ingesta for nutrition; this is supposed to be effected by four stages:

(1.) The acids of the humus are neutralized and converted into a nutrient medium, a condition which is indispensable for the digestion of the quaternary substances of the humus by the digestive fluid of the hepatic glands.

(2.) Part of the carbonates are transformed into soluble bicarbonate.

(3.) The soluble bicarbonate acts on the humus, and forms soluble salts from the insoluble acids of the humus. The ulmate of calcium, which is formed by the action of the ulmic acid on the carbonate of calcium, becomes soluble in the presence of an excess of carbonic acid.

(4.) The soluble ulmate thus obtained is more easily absorbed in the intestine.—(*Comptes Rendus Acad. Sc. Paris*, vol. XCVII, pp. 192–194; *J. R. M. S.* (2), vol. III, p. 657.)

VII. ARTHROPODS.

Merostomes.

Sexual characteristics of the Horseshoe-crab.—The sexes of the Horseshoe-crab, when adult, are readily distinguishable by modifications of the "claws" of the second pair of thoracic appendages, the female having the penultimate joint prolonged in the axis of its body so as to be parallel with and apposable to the last joint, while the male has the penultimate joint truncated at its distal extremity and the last joint abruptly decurved. The sexes are further distinguishable by the genital openings on the under side of the first pair of abdominal appendages, the exits of the oviducts in the female being transverse slits, while the external genital apparatus of the male consists of two papillæ with circular openings at the ends. The claws of the young male are essentially like those of the female. Prof. B. F. Koons examined "at least one thousand specimens of exuviæ or cast-off shells along the shores of Long Island Sound, about New Haven and Vineyard Sound," and "among all of these not a single specimen with the modified claw was found." A closer examination of the cast shells, however, revealed the other sexual characters and indicated that the males and females were nearly equally numerous. The conclusion, therefore, was that the male assumed the peculiar claws in the last stage of development, and that "it is possible that he never sheds his shell after the modified claw is acquired, because, as stated above, of over one thousand specimens examined, not a single specimen possessing this character was found. Further, we are led to believe that large Limuli rarely, possibly never, shed, because among all those examined there were no large exuviæ." (*Am. Nat.*, vol. XVII, pp. 1297–1299.)

These observations are mainly reiterations of some made many years before by Dr. S. Lockwood (*Am. Nat.*, 1871, p. 257), but that gentleman recorded the finding of large cast shells.

Number of Cirripeds.—The cirripeds collected by the Challenger Expedition have been studied and reported on by Dr. P. P. C. Hoek, and in connection with the report an interesting historical sketch of the group is given. One hundred and forty-seven species of the subclass were described by Darwin in his celebrated monographs, and only 18 were known to Dr. Hoek by have been added up to the time of his studies. Sixty species previously unknown apparently were discovered among the collections of the Challenger. The number of living species, exclusive of the suctorial forms, has been thus raised to 225, representing 34 genera. The most noticeable feature of the new additions is the great increase of the genus *Scalpellum*. Six species were known to Darwin, and 5 were subsequently made known, but Dr. Hoek has recognized 43 new species in the Challenger collections, thus enlarging the number to 54. The genus *Verruca* received the next greatest accessions. The number known to Darwin was 4, and 6 new ones were discovered by Dr. Hoek, thus increasing the number to 10. According to Dr. Hoek, "the occurrence of *Scalpellum* and *Verruca* in the great depths of the ocean coincides in a striking manner with the paleontological history of these genera." It is noteworthy, however, that "the fossil species of *Verruca* resemble much more those of the same genus which at present inhabit shallow water than those occurring at a considerable depth; the latter form together a very characteristic division of the genus. With regard to the genus *Scalpellum*, the fossil forms and those found in the deep sea have no doubt some features in common, but none were con-specific.

Crustaceans.

Extinction of Crustaceans in old habitats.—On several occasions in these reports reference has been made to the practical extinction or excessive reduction of various animals, but especially of the tile-fish (*Lopholatilus chamæleonticeps*) from deep-sea plateaus, where they were formerly found in exuberant abundance. The chief mortality occurred, as Professor Smith remarks, in a narrow belt of comparatively warm water (approximately 50° F.), in from 60 to 160 fathoms, which has a more southern fauna than the colder waters either side. Professor Verrill has suggested (*Amer. Jour. Sci.*, III, XXIV., p. 366, 1882) that the great destruction of life in this belt was caused by a severe storm in the winter of 1881–'82, which agitated the bottom-water and forced outward the cold water that even in summer occupies the great area of shallow sea along the coast, thus causing a sudden lowering of the temperature along the warmer belt inhabited by the tile-fish and crustacea referred to by Professor Smith in the communication now to be noticed.

Prof. Sidney I. Smith, in a "preliminary report on the Brachyura and Anomura dredged in deep water off the south coast of New England by the United States Fish Commission in 1880, 1881, and 1882," has given some details of the disappearance or extinction, for the time being at least, of certain crustaceans.

According to Professor Smith the last season's dredging off Martha's Vineyard revealed the total, or almost total, disappearance of several of the larger species of crustaceans which were exceedingly abundant in the same region in 1880 and 1881. The most remarkable cases are those of *Euprognatha rastelligera*, *Collodes robustus*, *Catapagurus Sharreri*, *Munida Caribæa?* Smith, and *Pontophilus brevirostris*, all of which were found in great numbers in both of these years. Of the first two not a specimen was taken in 1882, of the *Munida* only a single one, and of the other species very few specimens. *Lambrus Verrillii*, *Acanthocarpus Alexandri*, *Latreillia elegans*, *Homola barbata*, and *Anoplonotus politus*, which were each taken several times in 1880 and 1881, were none of them taken in 1882; they were, however, far less abundant than the other species, and the non-occurrence of some of them was very likely accidental; but the disappearance of part of them at least was undoubtedly due to the same causes which occasioned the disappearance of the more abundant species. The disappearance of these species, continues Professor Smith, was undoubtedly connected directly with the similar disappearance of the tile-fish (*Lopholatilus*) from the same region, and on this account specially he gave in detail, for many of the species enumerated by him, tables of specimens examined from the region explored by the Fish Commission. All the species mentioned above as having disappeared in 1882 were specially characteristic of the region above indicated. (*Proc. U. S. Nat. Mus.*, vol. VI, pp. 1–57.)

Arachnids.

The hearing of Spiders.—No specialized organs that have been recognized as having auditory functions have been certainly recognized in the spiders. Some experiments lately conducted by F. Dald, however, convinced him that the sense of hearing was not denied to those animals, and he located it in certain hairs of the legs and palps. When sounds were produced within reasonable distances of various spiders, their actions, such as suddenly pausing when the sounds were made, although the cause was not visible, rendered it evident that they took cognizance of them. The only parts to which the evident faculty of hearing could be attributed were two kinds of hairs arising from the legs and palps. (1) One is of hairs of equal thickness throughout, fringed with a short, fine pile toward the apex, implanted in cup-shaped depressions, and extremely mobile; a nerve is connected with the base of each one; (2) the other is of hairs set in rows and projecting outwards more than the ordinary protecting hairs. Objections may be urged to this theory, and it may be thought that the hairs receive sensations of vibrations of the web or of the motions of the air, but under a high magnifying power they were found to be responsive to waves of sound, the hairs vibrating when a note was sounding and resuming quiescence when it ceased. The graduations in length of the hairs are supposed to indicate adaptation to different notes, especially as their regularity in certain spiders of the Epeirid family, which are claimed to be decidedly fond of music, is very decided. Further, the author suggests that the arrangement of the hairs is co-ordinate with structural characters, and may, therefore, be used in classification. His observations of German spiders furnished two primary groupings:

(1.) In the Epeirids and Theridiids the tibiæ have two rows of auditory hairs, the metatarsi single hairs and the tarsi "depréssive, but no projecting hairs."

(2.) In the Saltids, Thomisids, and Lycosids the tibiæ, metatarsi, and tarsi have all two rows of hairs.

The Tubitelarians exhibit intermediate conditions. (*Zool. Anz.*, vol. VI, pp. 267–270; *J. R. M. S.* (2), vol. III, p. 652.)

Insects.

Classification of Insects.—In connection with studies "on the classification of the Linnæan orders of Orthoptera and Neuroptera," Professor Packard has reviewed the classification of all the Hexapods or the typical insects and proposed a new arrangement for the subclass. He has especially "examined the fundamental characters of the head, thorax, and abdomen, points neglected by most systematic writers." The outcome has been to lead Professor Packard to separate the Neuroptera from the Pseudoneuroptera, and "to regard these two groups, with the Orthoptera and Dermatoptera, as four orders of a category which may be regarded as a superorder, for which the name Phyloptera is proposed, as these four orders are closely allied to, if not in some cases identical with, the stem or ancestral groups from which probably all the higher orders" have originated.

The head of Insects.—Prof. A. S. Packard, jr., in consequence of an investigation into "the number of segments in the head of winged insects," reached the following conclusions: "The epicranium, or that piece (sclerite) bearing the eyes, ocelli, and antennæ and in front the clypeus and labrum, is formed from the original procephalic lobes, and represents the first or antennal segment, and is pleural, the clypeus and labrum bearing the terminal portion of the segment; while the remainder of the original or primitive segments, are obsolete, except in those insects which retain traces of an occiput or fourth cephalic tergite. All of the gular region of the head probably represents the base of the primitive second maxillæ." (*Am. Nat.*, vol. XVII, pp. 1134–1138.)

Vitality of Insects.—It is tolerably well known to most persons that insects will live for some time after mutilation, but the knowledge is vague. Mr. R. Canestrini undertook a number of experiments to determine how long various species could survive mutilation. The head was cut off generally by thin-bladed forceps, and when spontaneous movements ceased he employed sundry irritating devices, such as pricking, squeezing, and blowing tobacco smoke over the insect. As a result of these experiments he ascertained that beetles (Coleoptera) at once showed signs of suffering from the amputation, while the more active Hymenoptera (ants, bees, &c.) remained as if unaffected; others seemed to recover their senses only after a long interval from the operation. Butterflies (Lepidoptera) seemed but little discomposed after decapitation, and flies (Diptera) appeared to mind it still less; flies, indeed, were observed in copulation some time after being beheaded. Flies, however, only lived about a day and a half (36 hours) after being operated upon, while the bodies of butterflies survived eighteen days, the head nevertheless showing no sign of life after a few hours of decapitation. The last signs of life were manifested by either the middle pair of legs (most frequently) or the last (not quite so often). Similar experiments were made on Myriopods, and they, too, showed great tenacity of life and indifference to the loss of the head. (*Bull. Soc. Venet.-Trent. Sci. Nat.*, vol. II, pp. 119–125; *J. R. M. S.* (2), vol. III, pp. 645, 646.)

How Insects can adhere to smooth vertical surfaces.—The mode by which insects adhere to vertical walls has been investigated by H. Dewitz, who reaches essentially the same conclusions as did the English arachnologist Blackwell. The insects secrete a glutinous liquid in their feet, which exudes, in insects which have hairy feet, from the tips of the hairs which surround the lobes of the feet, and in those which had no hairs the liquid was extruded from pores in the feet. It is conjectured that about half of the insects, including most Dipters and Hemipters, many Hymenopters and Coleopters, and apparently such Orthopters as do not either fly or leap. If the feet are drawn away, drops of the fluid in question may be detected.

American Palæozoic Insects.—Within the last few years our knowledge of the insects of the Palæozoic period has been greatly increased, chiefly through the labors of Mr. S. H. Scudder. A catalogue of these has recently been published by Mr. R. D. Lacoe in the Journal of the Wyoming Historical and Geological Society, from which it appears that 72 species, representing 40 genera, are now known. Of these, 48 species, of 26 genera, belonged to the true insects or Hexapods; 19 species, of 9 genera, to the Myriapods; and 5 species, representing as many genera, to the Arachnids.

The lightning organs of the Glow-worms.—The light-producing organs of the principal European Lampyrids, or glow-worms (*Lampyris splendidula* and *L. noctiluca*) have been examined by Heinrich Ritter von Wielowiejski and the results published in an elaborate memoir contributed to the Zeitschrift für wissenschaftliche Zoologie. The tracheal system was especially investigated in relation to the luminiferous organs, and the entire memoir will well repay perusal. Here it can only be said that the luminiferous organs are shown to be the morphological equivalents or homologues of the fatty bodies, and that the light-giving function is peculiar to the parenchyma cells of the organs in question. The luminosity is the result of slow oxidation of a substance formed by them under the control of the nervous system.

Genital armature of Butterflies.—The genitalia of the Lepidopters, as well as other insects, are surrounded by various elements at the end of the abdomen, and those of the true butterflies have been recently examined by Mr. P. H. Gosse. A new nomenclature has been proposed for the several pieces. Some interesting facts are brought forward in connection with the relations of families and the distinction of genera. (*Trans. Linn. Soc. London, Zool.*, vol. II, p. 265; *Science*, vol. I, pp. 22, 23.)

A viviparous Moth.—A noteworthy fact has been verified by Dr. Fritz Muller, of Brazil, and communicated to the Entomological Society of London. A small Brazilian moth was found to be viviparous, and living larvæ or caterpillars were seen to be deposited or born of the female.

The sucker of the Butterflies.—In 1880 and 1881 Mr. E. Burgess published a couple of well-considered memoirs on the anatomy of two butterflies. During the past year Mr. P. Kirbach made known the structure of the mouth parts and pharynx of the Lepidopters in general, and came to essentially the same conclusions as to the morphology of the parts as the American naturalist, although apparently unacquainted with his articles, and his terminology for the parts, especially the suspensory muscles of the pharynx, is mostly the same. Kirbach, however, contends that the proboscis is extended by muscular contraction and rolled up by elasticity—a view opposite to that suggested by Burgess and not fortified by proofs. The special new feature brought out by Kirbach is the syringe-like mechanism of the salivary duct, by means of which saliva is injected into the proboscis. (*Zoologischer Anzeiger*, vol. VI, p. 553; *Science*, vol II, p. 833.)

VIII. MOLLUSCOIDS.

Brachiopods.

The relations of the Brachiopods.—The much-mooted question as to whether the Brachiopods are closely related to the Chætopod worms, and, it may be, simply modified worms, or not has been again discussed. Mr. A. E. Shipley, in studies on the genus *Argiope* at Naples, gives his views resulting from a recent survey of the fields. They are antagonistic to those of Morse and Kowalevsky. It is contended that "the segments of the larva do not seem to have the value of true metameres, but to be due simply to the formation of the shell from the central region of the body. There is no trace of any segmentation of the mesoderm, and no organ exhibits serial repetition. The Brachiopod differs from the Chætopod larva in having an alimentary canal which is not curved nor divided into three regions nor provided with mouth or anus. The body cavity is but feebly developed, and there is no provisional renal organ.' On the other hand, Mr. Shipley declines to adopt the more generally current view that the Brachiopods are closely related to the Polyzoans, and that the two constitute a natural phylum. He recalls that (1) the homologies of the lophophore have been considered to be very doubtful; (2) that the characteristic position of the nerve-ganglia of the Brachiopods, which remain in the ectoderm, is not shared with the Polyzoans; (3) that the larvæ of the two classes do not really resemble each other, and (4) that the Polyzoans became fixed by the preoral and the Brachiopods by the aboral extremity.

In fine, Mr. Shipley has been led to consider with Gegenbauer the Brachiopods to be a "primary class," most closely related to the Vermes, but also allied to the Mollusca. (*Mitth. Zool. Stat. Neapel*, vol. IV, pp. 494–520, 2 pl.; *J. R. M. S.* (2), vol. IV, pp. 215–217.)

IX. MOLLUSKS.

Acephals.

The alleged water-pores of Lamellibranchiates.—It has been claimed, especially by H. Griesbach, that there are aquiferous pores developed in the feet of certain Acephals. The alleged discovery provoked re-examination of the subject, and J. Carrière, J. T. Cattie, and T. Barrois have all expressed their opposition to the hypothesis in question, basing their antagonism on the examination of many species, including most of those species to which pores have been attributed. The conclusions are summed up by Barrois: "No pores exist for the introduction of water into the circulation; the only pores of the foot are those connected with the byssus organ, which never communicates with the interior of the foot. The blood may have water introduced into it, but this may be effected by osmosis, or in some manner not discussed." (*Science*, vol. III, pp. 130–131; *J. R. M. S.* (2), vol. IV, pp. 212–213.)

The European Oyster.—An elaborate series of reports on the oyster and its culture in the Netherlands is being prepared under the auspices of the Zoological Society of that country, and the first, by P. P. C. Hoek, the secretary of the society, appeared in 1883. It enters fully into the anatomy and physiology of the species, but only that portion relative to its generation need be noticed here. The ova are fertilized by sperm from other individuals, with which the circumambient water must be charged, and which enters into the mantle cavity and genital ducts. The ova are matured and cast together at about the same time, but the sperm appears to be more gradually matured and spent. The bivalves are about two years old before they have broods, and they are most prolific at the age of some four or five years. The males are more numerous than the females. The ova, when discharged, having been fertilized in the ovary, have already undergone the first stage of segmentation in their development. After propagation the exhausted parents rest, and a period follows in which no sperm is reproduced. It is claimed that a large proportion of the spat of the Eastern Schelde (where the observations were chiefly made) was probably derived from others than the oysters of the cultivated beds. As a corollary it is contended that culture seems to injuriously influence and impair the reproductive powers of the oyster. There is a somewhat inverse relation between the development of the liver and the generative organs, shown by the fact that the former is much more developed in the old after the reproductive faculty has decreased.

Gastropods.

Deep-sea Solenoconchs.—The order of Solenoconchs, represented by the tooth-shells (*Dentalium*) are much more numerous in the deep seas than in the littoral faunas, and form indeed quite a characteristic feature of the Bassalian realm. Professor Fischer considers that they are especially adapted for life on the bottom in the midst of the ooze which covers it. There they prey upon the Foraminifera which abound around them and which they secure by means of their filaments. According to Professor Fischer's experience, the best represented species is the *Dentalium agile*, originally described by Sars from individuals dredged in the

Norwegian sea. A new species, named *Dentalium ergaticum*, was obtained by the Travailleur Expedition, which, when living, was 9 centimeters (about 3½ inches) long, and another even larger was found which could not be specifically distinguished from an Italian Pliocene fossil. (*Comptes Rendus Acad. Sc.*, t. XCVI, pp. 797–799.)

The gastrula-mouth of Vivipara.—Dr. Carl Rabl has investigated some questions respecting the development of certain organs and structures in the pectinibranchiate Gastropods, and among others the history of the mouth of the gastrula-stage of the common *Vivipara* or *Paludina* of Europe. His conclusions are at variance with those of his predecessors, and, on account of the interest of the subject, a notice will be in place here. Dr. Rabl's observations convinced him that the gastrula mouth gradually but completely closes in the median line of the ventral surface. About the place where this obliteration occurred the anus soon afterwards appears, but is in no way connected with the gastrula mouth; finally the permanent mouth becomes developed at the spot where the last residue of the gastrula mouth had closed up. (*Anzeiger Akad. Wiss. Wien*, 1883, p. 13; *J. R. M. S.* (2), vol. III, pp. 192, 193.)

The Doridoid Nudibranchiates.—Prof. Rudolph Bergh, in a summary of his views on the classification of the Dorididæ proposes to divide them into primary groups called by him subfamilies, (1) the *D. cryptobranchiata*, or Dorididæ proper, distinguished by the combination of the branchiæ into a single large retractile crown, and (2) the *D. phanerobranchiata*, in which the branchiæ are numerous and severally retractile. The "subfamily" of the *D. phanerobranchiata* are in their turn divisible into groups named Polyceradæ and Goniodorididæ. The Polyceradæ (or Polyceridæ) have a simple pharyngeal bulbus and are represented by 16 generic types. The Goniodorididæ have sessile or petiolate tympaniform and suctorial pharyngeal bulbus, and are exemplified under 10 generic types. The essential characters mentioned here are co-ordinated with a number of others. A phylogenetic table gives Dr. Bergh's ideas as to the relations and divergence of the Polyceridæ and Goniodorididæ. These are connected with the typical Dorididæ through *Staurodoris*. The genus *Heterodoris* of Verrill and Emerton is believed to belong to a peculiar family of the Ichnopoda. (*Verhand. k. k. zool.-bot. Gess. Wien*, vol. XXXIII, pp. 152–175.)

Cephalopods.

Digestion in the Cephalopods.—The physiology of various organs of Cephalopods concerned in digestion has been investigated by E. Bourquelot. The secretion of the salivary glands exhibits no influence on raw or hydrated starch; the hepatic secretion converts the latter into sugar, and the pancreatic juices exercises a similar function; "in other words, we may say that the ferment produced by the liver and pancreas is identical with the salivary ferments of higher animals." It is supposed that the action of the ferment ought to be considered separately from that of hydration. "If in any animal raw starch becomes saccharified, we must suppose that it has been previously hydrated under conditions which are as yet unknown to us."

The so-called liver of the Cephalopods has furnished no evidence as yet that it forms glycogen, and, from a physiological point of view, it is rather a pancreas, inasmuch as it contains a peptic and a diastatic ferment. The development of the last ferment in carnivorous animals it is difficult to account for. (*Arch. Zool. Exper. et Gen.*, vol. x, pp. 385-423; *J. R. M. S.*, (2), vol. III, p. 636.)

X. VERTEBRATES.

Families of Vertebrates.—From a recent census taken by the present writer, it appears that there are nearly 800 families of vertebrate animals, extant or extinct, now known. This estimate is on the basis of the groups admitted as such in the "Arrangement of the families of fishes" by Gill, the "Check-list of North American Batrachia and Reptilia, with a systematic list of the higher groups" by Cope, and the "Arrangement of the families of mammals" by Gill, for the classes therein considered, and various later contributions to our knowledge, affecting the number of the existing but still more of the extinct groups.

The families of the several classes of vertebrates thus recognized seem to be reduced to a common standard of value almost as much as can be done in the present state of our knowledge for quite unlike types, and of course it must be a matter of opinion as to the degree to which the ideal has been realized. Most of the families, at any rate, rest upon a tolerably sound morphological basis; but among the passerine birds many groups designated as families are founded upon the most superficial external characters, such as the extent of atrophy or development of a wing-feather (the first primary), the existence or want of a notch in the sheath of the upper jaw, the degrees of extension of one or others of the wing-feathers, &c. It is manifest that such characters have not of themselves the significance of the modifications which differentiate families in other classes. It is indeed possible that in some cases differences of that kind may be coincident with true morphological variations, and if such proves to be the case, the trivial features in question may be employed for diagnosis and as the indices of the morphological characteristics with which they happen to be concomitant. It is scarcely probable, however, that such will be found to have been often the case, and at any rate the present use of the features referred to for family distinction is an illegitimate anticipation of what may be hereafter discovered. The progress of discovery may reveal that there has been much sagacity and prophetic insight exhibited in the appreciation of the true relations and grouping of families, but past discoveries, and especially within the last few years, do not hold out the anticipation or hope that such sagacity and intuitive genius have been often displayed. But whatever may be the eventual outcome, the following are presented as approximately the numbers of families at present recognizable:

Families.	Extant.	Extinct.	Total.
Leptocardians	1	0	1
Myzonts	3	0	3
Selachians	26	10	36
Fishes	240	51	291
Amphibians	35	10	45
Reptiles	61	42	103
Birds	115	6	121
Mammals	106	58	164
	587	177	764

Mortality from wild beasts in India.—The two hundred and fifty odd millions of inhabitants of British India have by no means crowded out the wild animals of the country, and a small percentage even annually contribute to furnish a dainty meal or otherwise fall victims to beast or serpent. Sir Joseph Fayrer has recently published in Nature (v. 27, pp. 268–270) some interesting statistics of the loss of life by such means. The average of recorded cases is about 2,800 persons a year; in 1880 2,840, and in 1881 2,757 persons were killed; of cattle, in 1880 55,850 and in 1881 41,640 head were lost. Such a mortality naturally provokes retaliation, and bounties are given for the destruction of a number of destructive animals. In 1880 14,886 were killed and rewards therefor paid to the extent of over 88,327 rupees, and in 1881 15,279 were killed and the bounties given amounted to 91,850 rupees. The "wild animals destructive to life in India" specifically enumerated by Sir Joseph Fayrer are twenty in number, viz, fifteen mammals, four crocodilians, and one shark. Besides these, fifteen genera of poisonous snakes are specified; of these, five belong to the family of Elapids, two to the Viperids, four to the Crotalids, and four to the Hydrophids, or sea-snakes. The animals most destructive to human life are the tigers and wolves, which are nearly equally malignant, as will be seen from the following summary of somewhat old figures:

Animals.	Killed in 1875.		Killed in 1876.	
	Persons.	Cattle.	Persons.	Cattle.
Elephants	61	6	52	3
Tigers	828	12,423	917	13,116
Leopards	187	16,157	156	15,373
Bears	84	522	123	410
Wolves	1,061	9,407	887	12,448
Hyænas	68	2,116	49	2,039
Other animals	1,446	3,011	143	4,573

Fish-like Vertebrates.

North American fresh-water fishes.—In the account of progress in zoology in the year 1882, the character of the fresh-water fish-fauna of Australia was referred to and its few genera enumerated. It was shown that only five true fresh-water families existed, and that but one had more than one or two species, and that only seventeen. The revision of the North American fishes, by Jordan and Gilbert, enables us to contrast the rich fresh-water fauna of temperate and northern America with the poor Australian one. Not less than 617 species have been recognized, and these represent 143 genera and thirty-four families. The families and sub-families only can be mentioned here, but their enumeration will suffice to give a good idea of the characteristics of the fauna.

Families and sub-families.	Genera.	Species.	Families and sub-families.	Genera.	Species.
Petromyzontidæ	4	10	Percopsidæ	1	1
Polyodontidæ	1	1	Amblyopsidæ	3	5
Acipenseridæ:			Cyprinodontidæ	4	20
Acipenserinæ	1	1	Umbridæ	1	1
Scaphirhynchopinæ	1	1	Dalliidæ	1	1
Lepidosteidæ	2	3	Esocidæ	1	5
Amiidæ	1	1	Anguillidæ	1	1
Siluridæ:			Gasterosteidæ	4	8
Ictalurinæ	5	26	Atherinidæ	2	21
Catostomidæ:			Aphredoderidæ	1	1
Ichthyobinæ	1	9	Elassomidæ	1	1
Cycleptinæ	1	1	Centrarchidæ:		
Catastominæ	8	49	Centrarchinæ	2	3
Cyprinidæ:			Lepominæ	7	33
Campostominæ	1	4	Micropterinæ	1	2
Chondrostominæ	10	24	Percidæ:		
Exoglossinæ	1	1	Etheostominæ	16	67
Leuciscinæ	28	234	Percinæ	2	3
Plagopterinæ	3	4	Labracidæ	2	4
Cyprininæ	2	2	Sciænidæ:		
Characinidæ	1	1	Haplodinotinæ	1	1
Hyodontidæ	1	3	Embiotocidæ:		
Clupeidæ	3	6	Hysterocarpinæ	1	1
Dorosomidæ	1	1	Cichlidæ	1	1
Argentinidæ	1	1	Cottidæ:		
Salmonidæ:			Uranideinæ	5	22
Coregoninæ	2	12	Gadidæ:		
Salmoninæ	4	18	Lotinæ	1	1
Thymallidæ	1	1			

The only families of this list which have also true marine species are fifteen—the Petromyzontids, Silurids, Clupeids, Dorosomids, Argentinids, Salmonids, Cyprinodontids, Anguillids, Gasterosteids, Atherinids, Labracids, Sciænids, Embiotocids, Cottids, and Gadids. The fresh-water species and even genera of most of these families are, however, to a large extent, peculiar to the interior waters; of the others, (1) some are anadromous, like certain of the Salmonids, Clupeids, and Labracids; (2) others inhabit fresh and salt water almost indifferently, as the Dorosomids, many Cyprinodontids, and most Gasterosteids; and (3) one (the eel) perhaps should be considered as a salt rather than a fresh water species, inasmuch as it is catadromous, and appears to breed only in the sea. Conversely, those fishes which resort to fresh water to spawn and spend their early days therein may be considered to be fresh-water forms. If all species which to some extent run up into fresh water were included, the list might be very greatly increased.

Number of North American fishes.—A much needed work was completed and published during 1883 (although dated 1882), under the title "Synopsis of the Fishes of North America," by David S. Jordan and Charles H. Gilbert: it is the sixteenth "Bulletin of the United States National Museum." Bearing the same title as a work published in 1846 by Dr. D. H.Storer, it not only contrasts with the latter in fullness of details and as an epitome of all that has been done in North American ichthyology, but is greatly superior in the mode of treatment of its subject, and is truly a work of eminent scientific merit. It embraces within its scope all the species which visit any part of our extended coast, as well as those ranging to the farthest north, and the inhabitants of our inland rivers and lakes; it does not, however, include any of the West Indian fishes, except those which touch on our coast, and thus has a more restricted aim than Dr. Storer's work. The classification adopted by the authors "is essentially based on the views of Professors Gill and Cope, who have," it seemed to our authors, "been more fortunate in reflecting nature in their groupings of the fishes than have any of the European systematists." They commence with the lowest or most generalized forms, and successively take up the more specialized. The four classes of Leptocardians, Marsipobranchs, Elasmobranchs, and Fishes proper are adopted. The true fishes, so far as the North American species are concerned at least, are subdivided into the "series Ganoidei," with the "subclasses" Chondrostei and Holostei, and the "series Teleostei" with the "subclasses" Physostomi and Physoclisti. The last two "subclasses" seem to be unnecessary, or, rather, not entitled to such rank, for they not only intergrade, but the presence or absence of the duct may be of minor importance. For example, the duct is not obliterated, it has been urged, in such forms as *Holocentrum*, *Priacanthus*, *Cæsio*, &c., and inasmuch as the bladder is developed as a diverticulum from the intestinal canal, it is ever liable to resume the evidence of such origin in the persistence of the duct. Twenty-three orders are recognized for all the North American fish-like types, from the "Cirrostomi" upwards.

Reduced to their several elements, there are along our east coast about 436 species; from the Gulf coast about 307 have been obtained; but it must be remembered that the latter region is comparatively but little known ichthyologically. From the west coast 310 species have already been secured, which contrast remarkably with the few that were alone known to Dr. Storer in 1846. As many as 617 species have been attributed to fresh-water, and of exclusively fresh-water types there are 577. These numbers of course include duplications of species which are common to two or more regions, chiefly the east coast and Gulf of Mexico. Such duplicated species are about 170 in number, and the aggregate with these subtracted amounts to about 1,460 species for the whole of North America north of Mexico. In the number of east coast species are, however, included a number of deep-sea forms—about forty—which do not properly belong to the true American fauna. These figures have been communicated to the writer by Professor Jordan.

Myzonts.

Fertilization of the Lamprey's eggs.—M. L. Ferry has been led to believe that the eggs of the *Petromyzon marinus* are fecundated by intromission of sperm within the body of the female. A female lamprey, caught early in June, was opened and the eggs taken from it and consigned to a pan filled with water; in about twenty days thereafter the eggs were hatched. It is consequently thought that the females are fecundated "while they and the males are adhering side by side to the same rock or the same tree," or rather, probably, while in mutual embrace.

Fishes.

The functions of the pyloric cœca of fishes.—About the pyloric extremity of most fishes are certain diverticula or processes called the pyloric cœca. The functions of these appendages have been investigated by Dr. Blanchard, at Havre, in the case of ten species common there—the shad, dory, scad, three gurnards, weever, hake, pout, and whiting. It was found that in all instances the fluids secreted by the cœca transform starch into glucose and albuminoids into peptones, but do not act at all upon fats. It thus appears that the cœca are, to some extent, representatives of a pancreas, as was early supposed, but only partially. (*Am. Nat.*, vol. XVII, p. 1302.)

A new order of fishes.—In the last month of 1882 a communication was made by M. Leon Vaillant, the French ichthyologist, to the French Academy of Sciences, in which he announced the discovery of a remarkable type of fishes. The newly discovered form was obtained by the French exploring vessel Travailleur off the coast of Morocco, at a depth of 2,300 meters, or about 1,100 fathoms. It was some eighteen inches long, and was especially notable for an excessively deep-cleft mouth and correspondingly elongated jaws, which were at least several times longer than the cranium. The new type was named *Eurypharynx pelecanoides.*

In August, 1883, several specimens of a kindred fish were obtained by the United States Fish Commission steamer Albatross in deep water off the coast of the United States, at depths varying between 389 and 1,467 fathoms. The jaws in this form were excessively elongated and about six or seven times larger than the cranium. The species was named *Gastrostomus Bairdii.* It was at once evident that these fishes represented a new or undifferentiated group of fishes, and which was probably of ordinal value. A study of the anatomy was undertaken by Messrs. Gill and Ryder, and some very remarkable structural peculiarities were discovered. The branchial system was found to be extraordinarily reduced, and, in fact, to be less developed than in any other fish, and even than in the Marsipobranchs. All the four usual branchiferous arches, however, were present and one of those whose function is diverted in ordinary fishes had resumed its branchiferous function, so that five were actually present. Nevertheless the brain and heart were those of Teleost fishes. Many were the other peculiarities found in the new type, and those that contrasted most with the characteristics of normal fishes or appeared to be of the highest morphological value were embodied in the ordinal diagnosis, the two genera *Eurypharynx* and *Gastrostomus* being segregated not only as a family (Eurypharyngidæ) but as a distinct order, named Lyomeri. The characters of these categories are as follows:

The order Lyomeri is framed for fishes with five branchial arches (none modified as branchiostegal or pharyngeal) far behind the skull; an imperfectly ossified cranium, articulating with the first vertebra by a basioccipital condyle alone; only two cephalic arches, both freely movable, (1) an anterior dentigerous one, the supramaxillary, and (2) the suspensorial, consisting of the hyomandibular and quadrate bones; without palatine bones; with an imperfect scapular arch represented by a simple cartilaginous plate on each side, remote from the skull; with pectoral rays spiniform and articulated directly with the scapular plates, and with the dorsal and anal rays simple and not articulated.

The family Eurypharyngids is then limited to Lyomeres, with the head flat above and with a transverse rostral margin, at the outer angles of which the eyes are exposed, with the jaws excessively elongated backwards and the upper parallel and closing against each other as far as the articulation of the two suspensorial bones, with minute teeth on both jaws, with a short abdomen and long attenuated tail, branchial apertures narrow and very far behind, dorsal and anal fins continued nearly to the end of the tail, and minute pectoral fins.

The mandibular rami are exceedingly narrow and slender, but the jaws are extremely expansible and the skin is correspondingly dilatable; consequently an enormous pouch may be developed. Inasmuch as the slenderness and fragility of the jaws and the absence of raptorial teeth (at least in *Gastrostomus*) preclude the idea of the species being true fish of prey, it is probable that they may derive their food from the water which is received into the pouch, by a process of selection of the small or minute organisms therein contained.

The peculiar closure of the anterior half of the upper jaws upon each other, and the co-ordinate joint between the hyomandibular and quadrate elements of the suspensorium are doubtless correlated with the mode of ingestion or selection of food. The skin constituting the pouch, it may be added, has a peculiar velvety appearance, and also reminds one of the patagium or wing membrane of a bat. For a more detailed summary of the salient characteristics of the type the memoir in the Proceedings of the United States National Museum must be referred to.

Variation in number of rays.—The numbers of rays in the various fins generally afford a sure as well as easy means of diagnosing the species and genera of fishes, and the variation is usually but slight, although there is considerable difference in this respect. The number, however, is the same in the young as adult. A most remarkable variation in the number of rays co-ordinate with difference in size has, however, been found in a fish of a very peculiar type, popularly known as the "king of the herrings," and belonging to the family Regalecidæ. This species—the *Regalecus glesne*, or *Banksii*—is a deep-sea fish which occasionally is found as an estray on the coasts of Northern Europe, chiefly after a storm, and reaches a length of at least twenty-four feet. It has a long, compressed body, somewhat like a board, and on this account has been also called deal-fish. Dr. Lütken and Professor Collett have lately and independently studied this species, and the latter found that in comparatively small specimens (*eg.*, 3,180 millimeters long) there are only about 218 dorsal rays, while in a large one (5,647 millimeters long) as many as 406 dorsal rays were developed; the tail, also, apparently becomes disproportionately longer with increase of size. The ratio is by no means exact between the development of the rays and increase of size of the fish, but nevertheless it *appears* to be true that the tendency does exist and becomes manifest on contrasting extremes in size and interposing many of intermediate size. Such a development would be so anomalous, however, that further investigations are necessary before the truth can be considered established. (*Christiania Videnskabsselskabs vorhandlinger*, 1883, No. 16.)

The Orfe, or Golden Ide.—Four species of Cyprinids have been the object of more or less cultivation in Europe: (1) the common carp (*Cyprinus carpio*), (2) the gold-fish or carp (*Carassius auratus*), (3) the ide (*Idus melanotus*), and (4) the tench (*Tinca vulgaris*). All have varieties due to selection and cultivation, and of the last three reddish yellow or golden colored varieties have been especially propagated. The golden variety of the ide is known as the orfe, and has been introduced into the United States as well as England. It is recommended as an ornamental fish superior to the gold-fish on account of "its larger size, livelier habits, and rapid reproduction," and "will thrive in all inclosed waters suitable to roach and gold-fish"; it is also edible. (*Nature*, vol. XXVIII, p. 304.)

The "Ahyu" or "Ai" of the Japanese.—In the ichthyological portion of the Fauna Japonica, completed in 1850, Temminck and Schlegel described a very peculiar and remarkable fish found in Japan as *Salmo* (*Plecoglossus*) *altivelis*. In 1866 Günther recorded specimens from Formosa as well as Japan. Nothing, however, seems to have been known to Europeans respecting the habits of the species till 1883. It now appears that the form is of unusual interest. Mr. K. Nabeshima, in a communication to Mr. Narinori Okoshi, of the Japanese consulate at London, the author of "A Sketch of the Fisheries of Japan". (p. 35), gives some interesting details. The fish has the elegant appearance of a young salmon or smolt, but the teeth of the sides of the upper jaw (supramaxillaries) are of a broad lamelliform shape, and the rami or branches of the lower jaw are not joined at the symphysis, but each juts out into a small knob. According to Mr. Nabeshima, it varies in size from about 6 to 12 inches, and inhabits fresh and rapid streams, except in the breeding season. On the approach of the period of reproduction, which is autumn, it descends the stream to the estuaries for the purpose of spawning. After this labor is performed the old die out and the species is represented only by the young, which ascend the streams, grow to full size, and in their turn descend the next season to repeat the cycle of life. The species is consequently known as the "*one-year fish*." The special interest connected with the species results from the fewness of those which have analogous habits. Certain gobies of the genera *Aphya* and *Crystallogobius* have been shown by Professor Collett to be annual fishes, while the common eel, the *Retropinna** of New Zealand, and some species of *Galaxias*, are the only certain known catadromous fishes or visitors to the sea for reproduction. Although doubtless there are others, the ahyu is especially worthy of record as the only fish known to combine the habits of the *two* classes indicated. Like the smelt, the ahyu has a "smell remarkably resembling that of the cucumber." It is very sensitive, and the slightest handling is immediately fatal to it; further, its flesh rapidly deteriorates in flavor, and it therefore cannot be conveyed to distant markets. When fresh, however, it is "considered the most delicately flavored of all river fish" in Japan. The combination of proneness to speedy decay and delicacy of flesh naturally causes it to be "somewhat expensive." It rises to the fly, and this habit is taken advantage of as a preliminary to a peculiar mode of capture which has been described by William Pierre Jouy (*Proc. U. S. Nat. Mus.*, vol. VI, p. 275, December 13, 1883). "After whipping the stream with flies, as for trout, and securing a fish, a fine gut line is passed through the nostrils and fastened to a line held in the hand; trailing behind the fish thus fastened, which is simply a decoy, are several bright hooks, which flash in the sunlight and attract other fish. The decoy is now gently led up stream, and the fish, in darting after it, get snagged on the hooks." Horse-hoof parings, used as lures, are also said to be

* Possibly the Retropinna and Galaxias are also "annual" fishes.

successful with *ahyu*. Other methods of capture are detailed by Mr. Nabeshima.

An important Arctic fish.—In 1879 Dr. Bean described, in the *Proceedings of the U. S. National Museum* (vol. II, pp. 358, 359), a new generic type of fishes from Alaska, under the name *Dallia pectoralis*. Although an interesting addition to the Arctic fauna, it was not regarded as of sufficient importance to be especially referred to in an article for popular use. It turns out, however, that the species is not only of more than ordinary scientific interest, and that it raises a question of taxonomy, but that it is an extensively distributed species, and of very considerable economic value. Dr. Bean's specimens were obtained at Saint Michael's, Alaska, but the fish has since been found in Siberia, and some interesting data have been published respecting it. Professor Nordenskiöld, in his "Voyage of the Vega," records it as having been obtained at Yinretlen, in Northeastern Siberia (the Chukche Peninsula), and at Port Clarence, in Alaska, on Bering Sea (pp. 442–444, 582). Professor Nordenskiöld first heard of it at Yinretlen, his winter quarters, in 1878–1879; the natives (Chukches) told him that "an exceedingly delicious black fish was to be found in the fresh-water lagoon at Yinretlen, which is wholly shut off from the sea, and in winter freezes to the bottom." On the 8th of July, 1879, a fishing party set out for the place, taking a net 9 meters long and 1 wide. A lively account is given by Nordenskiöld of the fishery. Suffice it to say that "hundreds" of the *Dallia* were obtained. "The fish were transported in a dog-sledge to the vessel, where part of them was placed in spirits for the zoologists, and the rest fried, not without a protest from our old cook," says Nordenskiöld, "who thought that the black, slimy fish looked remarkably nasty and ugly. But the Chukches were right; it was a veritable delicacy, in taste somewhat resembling eel, but finer and more fleshy. These fish were besides as tough to kill as eels, for after lying an hour and a half in the air, they swam, if replaced in the water, about as fast as before. How this fish passes the winter is still more enigmatical than the winter life of the insects, for the lagoon has no outlet, and appears to freeze completely to the bottom. The mass of water which was found in autumn in the lagoon, therefore, still lay there as an unmelted layer of ice not yet broken up, which was covered with a stratum of flood water several feet deep, by which the neighboring grassy plains were inundated. It was in this flood water that the fishing took place." It is stated by Professor Nordenskiöld that Professor Smitt, of Stockholm, regarded the Yinretlen fish as a distinct species, and has named it *Dallia delicatissima;* but it has been since ascertained by Dr. Bean that it is conspecific with the *Dallia pectoralis*. What manner of fish the *Dallia* is remains to be shown. It has some resemblance externally to the salt-water minnows or mummichogs, but more to the species of *Umbra*, which are sometimes called in the United States mudfishes, and in Hungary by a name equivalent to dogfish; it is consequently figured in Nordenskiöld's work as the "Dog-fish from the Chukche Peninsula" (p. 444). The resemblance, however, is only superficial, and the animal is found to have many peculiar characters. The pectorals have very numerous rays (33–35), and are set on convex skin-covered bases, and when the skin is taken up it is found that there is a simple cartilage, and no bones, as in most fishes. Further, the bones of the upper jaw are grown together, and not separate, as is usual. In fact, the *Dallia* is the only known representative of a very remarkable family (Dalliidæ), and even of a peculiar suborder (Xenomi) of fishes. The fish rarely grows much beyond six inches long.

Danger from Garfish.—The fishes variously known along the United States coast as garfish, bill-fish, and needle-fish are remarkable for their elongated, bill-like jaws, and are very agile, and may occasionally be seen to leap out of the water. It seems that this propensity may be not without some inconvenience, or even danger, especially in the case of the large, stout-billed species. Mr. S. Archer "was being pulled off from the shore to H. M. S. Himalaya in the harbor of Aden, when a fish jumped out of the water over the boat, and in doing so struck the hat of another officer and knocked it into the water. When the hat was recovered" there was found "in the hard felt a slit about four inches in length" (*Nature*, vol. XXVIII, p. 226). The fish was doubtless a gar. Professor Moseley, in comments upon this incident, asserts that "it is the constant habit of large belones," some of which attain a length of five feet, "when startled, to move along the surface of the water with astonishing rapidity." Professor Moseley had "seen them thus spring out of the water when scared by a boat," and had been told "that in some of the Pacific islands these fish not uncommonly cause the death of the natives, who, when wading in the water, have their naked abdomens speared by the sharp snouts of the fish, with the result of causing peritonitis. The fish appear to bound blindly away from danger, and strike any object in their way haphazard." (*Nature*, vol. XXVIII, p. 436.)

Amphibians.

Spermatozoa of Newt.—In view of the great uniformity of the spermatozoa, an observation by Mr. G. J. Dowdeswell is of some interest. The spermatozoa of the common newt of Europe (*Triton cristatus*) were found to have a structure not found in any others. The head of each spermatozoon was found to be surmounted by a minute barb about 2 μ long and 1.5 μ broad. It is thought that this barb may have as a function an enhanced power for the spermatozoon to attach itself to and penetrate into the ovum in the early stages of fertilization, as has been shown to occur by Fol and others. (*Quart. Journ. Royal Mic. Soc.*, vol. II, pp. 336–339.)

Reptiles.

A new reptile-house.—A special reptile-house, or "reptilium," was built in 1882 and 1883 by the Zoological Society of London, which will doubtless afford the means for the more thorough study of the animals for which it is destined. The structure is 120 feet long and 60 feet wide. Fixed cages for the pythons and other large reptiles occupy three sides, and the south front is reserved for small movable cases. A large oval tank for crocodiles, and two smaller ones for tortoises, are in the center of the building. (*Nature*, vol. XXVIII, p. 17.)

New researches on the Dinosaurians.—Several important contributions to our knowledge of the Dinosaurians have been published during 1883, among them, Notes, by Mr. L. Dollo, on the Belgian Iguanodontidæ of the now celebrated Bernissart "find"; one by Prof. J. M. Hulke, in which an "attempt" (and doubtless approximately successful one) is made to illustrate the complete osteology of *Hypsilophodon Foxii* of the English Vealden; and an article by Prof. E. D. Cope on "The Structure and Appearance of a Laramie Dinosaurian"—the *Dioclonius mirabilis*, one of the Hadrosauridæ.

A peculiar family of Gecko-like lizards.—The Gecconidæ, or Geckos, are exceptional among the Lacertilian reptiles by the possession of of biconcave vertebræ, and have a peculiar physiognomy by which they can, as a rule, be at once recognized. It has recently been discovered, however, that several generic types of lizards, which superficially resemble the Geckos, are distinguished from them by concavo-convex or procœlous vertebræ, and other differential characters are associated with this divergence. The genera now known to be thus distinguished are the Indian *Eublepharis*, the West African *Psilodactylus*, and the American *Coleonyx*. Mr. Boulenger has recently proposed for the reception of these forms a peculiar family, which he has named *Eublepharidæ*. The new family is definable as *Lacertilia* with procœlous vertebræ, united parietal bones, incomplete orbital ring, and without a parietal bar; the Gecconidæ remain still as Lacertilians with biconcave vertebræ, distinct parietal bones, incomplete orbital ring, and deficient parietal bar. It is urged by Mr. Boulenger that, in view of the facts, the suborder Nyctisaura should be abandoned, and it is recalled that the Varanidæ have the orbit incompletely surrounded, and the Helodermidæ are destitute of a parietal bar.

The poison of Heloderma.—"A partial study of the poison of *Heloderma suspectum* (Cope), the Gila monster," has been made by Drs. S. Weir Mitchell and E. T. Reichert, of Philadelphia. The poisonous character of the lizard has been fully confirmed, and the physiological and pathological characteristics of the poison have been made known. It is a "virulent heart poison," which "contrasts" strongly with the venoms of serpents, since they give rise to local hemorrhages, and cause death chiefly through failure of the respiration, and not by the heart, unless given in overwhelming doses. They lower muscle and nerve reactions, especially those of the respiratory apparatus, but do not, as a rule, cause extreme and abrupt loss of spinal power. Finally, they give rise to a wide range of secondary pathological appearances which are absent from Heloderma poisoning." The poison of the lizard leaves no trace of any local effect, but the heart is arrested in complete diastole, and becomes full of firm black clots. The muscles (except the cardiac) and nerves respond readily to irritants, "but the spinal cord has its power annihilated abruptly and refuses to respond to the most powerful electrical currents."

Composition of snake-poisons.—The poison of snakes, especially of the family of Crotalids, has been chemically and physiologically investigated by Drs. S. Weir Mitchell and Reichert, of Philadelphia. They succeeded in separating, from poison obtained from rattlesnakes and moccasons, three different proteids, which they have proposed to distinguish severally as venom-peptone, venom-globuline, and venom-albumen. The details of these investigations are given in the *Medical News*, of Philadelphia, for April 28, 1883.

Birds.

American Ornithologists' Union.—In response to a call of several of America's most eminent ornithologists, Messrs. J. A. Allen, of Cambridge, Elliott Coues, of Washington, and William Brewster, of Boston, "sent to a little less than fifty of the more prominent ornithologists of the United States and Canada," a meeting for organizing "the American Ornithologists' Union" was held at New York, on the 26th of September, 1883, and following days. The Union took as its exemplar the "British Ornithologists' Union." Four classes of members were recognized: (1) active, limited to fifty; (2) foreign, limited to twenty-five; (3) corresponding, limited to one hundred; and (4) associate, to be unlimited in number. Mr. J. A. Allen was elected president, Dr. E. Coues and Mr. R. Ridgway vice-presidents, and Dr. C. Hart Merriam secretary and treasurer.

The Nuttall Ornithological Club transferred to the new Union its Bulletin, and this will therefore be discontinued as such. It is succeeded by "The Auk" of the American Ornithologists' Union. The Union was organized under happy and harmonious conditions, and much good to ornithology may be expected from its activity. Its most important promised work will be "a revision of the classification and nomenclature of North American Birds," for which a special committee was appointed of five, viz, Messrs. Coues, Allen, Ridgway, Brewster, and Henshaw.

Cholera and Birds.—It has been claimed that there is a marked decrease in the number of birds in regions where cholera is for the time raging, and this belief has been indorsed by a number of correspondents in the columns of Nature. Exodus of birds from sundry places afflicted with cholera has been recorded. Before the disease had fairly developed, or at latest in its incipiency, birds of various kinds almost or quite deserted, apparently, the towns of Zagazig in Egypt (p. 329), Salisbury in England (342), the island of Mauritius (p. 366), and West Barbary (p. 389). Other instances have been recorded, but in a rather skeptical spirit, by Pfarrer Häckel, of Windsheim, in the "Zoologische Garten" of Frankfurt-am-Main (vol. XIV, p. 328). At Zagazig, so long as the birds remained flying about as usual, it was considered that the inhabitants were quite secure from any attack, but when they left some citizens would leave also from fear of impending pestilence. "The birds had been observed by old hands to depart before the approach of cholera during the last four epidemics" (p. 329). At Salisbury, a man, "whose duty it was to oil the vane upon the spire, had made his usual ascent (of 404 feet), and had perceived a foul scent, which it seems had not been noticed below. The inhabitants connected this with the appearance of the epidemic shortly afterwards. Birds might, no doubt, be affected by such a circumstance" (p. 342). These observations seem to be to the point, but more, scientifically conducted, are requisite before full credence can be put in the alleged coincidence of cholera and absence or paucity of birds.

Relations of the Penguins.—The Penguins or Spheniscids have been anatomically examined by Professor Watson, of Manchester, and some interesting conclusions adduced. These have been embodied in a "Report on the anatomy of the Spheniscidæ collected during the voyage of H. M. S. Challenger." Among the most important peculiarities of the group are the skeletal characteristics of the limbs. The anterior are distinguished by the peculiar form and mode of articulation of the carpal bones; by the union of the first or radial, which, although independent in the embryo, becomes inseparably anchylosed with the second metacarpal bone in the adult; and by the absence of a free pollex. The posterior have a tarso-metatarsus which "presents features which serve at once to distinguish that bone from the corresponding skeletal element of any other group of birds, being altogether shorter and broader than in these, with the single exception of the genus *Fregatta*. From *Fregatta*, however, as grow all other birds, the Penguin is distinguished by the clearly-defined *separation of the metatarsal elements*, the shafts of which are differentiated from one another, while in other birds these bones are indistinguishably fused together." Further, the position of the tarso-metatarsus seems to be peculiar among birds. "In all other birds, during terrestrial locomotion, the tarso-metatarsus is elevated so that only its distal extremity comes into relation with the ground, the 'heel' of the foot, physiologically considered, in the case of other birds being situated at the distal extremity of the tarso-metatarsus, while in the Spheniscidæ it is formed by the proximal end of that bone. In accordance with this arrangement we find that while in the majority of birds the metatarso-phalangeal articulations admit of great mobility in the Spheniscidæ, on the other hand, these joints are relatively stiff, and greater freedom of movement is permitted at the intertarsal articulation or ankle joint. May we not regard this plantigrade condition of the foot of the Penguin as a survival of a similar feature in the anatomy of the ornithoscelidan ancestors of the Spheniscidæ."

The characteristics of the Spheniscids, as shown by Professor Watson and others, are, in fact, so salient and co-ordinated in such number that we can now scarcely doubt that they are the most aberrant of all living birds, and even more remote from the general stock than are the Ratitæ or Ostrich and the like. If the living birds admit of subdivision into orders, the Penguins appear to be best entitled to such segregation, and at least they should be isolated as an independent suborder. The family of Spheniscids, in the opinion of Professor Watson, is divisible into three genera—(1) *Spheniscus*, with three species and a variety; (2) *Eudyptes*, with two species, and of which the forms *Eudyptes chrysome* from Tristan, the Falklands, and Kerguelen Island are distinguishable as so many varieties; and (3) *Aptenodytes*, with two species.

A new species of Ostrich.—More than once it has been thought that a second species of ostrich should be distinguished, but there was always some uncertainty as to differential characters. During the past year, however, Dr. Richenow, of Berlin, has urged the specific distinctness from the common African (*Struthio camelus*) of specimens sent from the Somali country and given to them a characteristic name (*Struthio molybdophanes*). The naked parts are colored quite differently in the two forms. The *S. camelus* has the exposed surfaces of the head, neck, thighs, and legs of a flesh-red, while the corresponding parts of *S. molybdophanes* are of a delicate slate-gray. The bill and gape of the newly-discovered type is of a delicate pink hue, except at the tip, where it is brownish.

Incubation of the Ostrich.—A discussion respecting the incubation of the eggs of the ostrich ensued in the *Spectator* and *Nature* in consequence of a denial, by a critic of Mr. Romanes's "Animal Intelligence," that the task of incubation is shared by both the sexes. It was maintained by the critic, in accordance with the statements current in books of natural history, that "female ostriches take *no* part in the duty of incubation." Several respectable and eminent authorities, however, adduced positive testimony to the concurrence of the females, on some occasions at least. It appears to be well established that in the Cape colony both sexes assist on the nest. In the words of Mr. E. B. Biggar, who has reported on the ostrich-farms of the Cape colony, "some will sit throughout with the most solicitous maternal instinct, others manifest such anxiety that, when the hen has been a little late in taking her morning turn upon the nest, he has gone out, and, hunting her up, has kicked her to the nest in the most unmanly manner.

Some are very affectionate over their young, others the reverse; thus do individuals differ even among ostriches. As a rule, the cock bird forms the nest, sits the longest, and takes the burden of the work of hatching and rearing."

Testimony is divided as to whether the cock sits invariably at night to the exclusion of the hen.

On the one side, Dr. W. G. Atherstone, in a work on ostrich-farming, has said that the sexes "sit alternately, *the male at night grazing and guarding the females.* During the daytime, the time of the male bird going on the nest varies during the period of incubation, as also does the time between the female leaving the nest and the male taking her place, the exposure and cooling being probably regulated by the temperature of the incubation fever at different stages."

On the other side, Mr. Biggar maintained that, "contrary to what has been currently understood, and what is still stated even in recent colonial accounts, *the cock bird sits at night, not the hen.*" He even urged that "in this peculiarity the hand of Providence may be seen, for the worst enemies of the nest appear at night, and the cock, being stronger and braver, is better able to resist them; moreover, the feathers of the cock being black, night sitting would not expose him to that exhaustion from the sun's rays which would ensue if he sat during the day; while at the same time the gray feathers of the female are less conspicuous while she sits during the day."

Mr. Romanes claimed that the experience at Florence coincided with that at other places, viz, "that the cock bird undertook the whole duty of sitting during the night."

There is a general tendency—and a natural one—to concentrate attention on facts individually observed and to generalize from those, but nature is often very elastic and her impositions are not always with rigid fetters. Truth may pervade opposite statements and the same shield may be quite different on different sides. Professor Moseley has recognized this truth, and suggested that "an interesting subject of inquiry seems to be still open in the matter. It is, how far do the habits of nidification of the ostrich vary in the different climates through which it ranges? The nest of the ostrich is commonly described as a heap of sand, and so no doubt it is in warm desert regions," but a nest which he saw "at the Cape was carefully built of grass and other warm materials, so as to aid in retaining heat. The birds kept the nest almost constantly covered between them. In warmer regions, however, the hen appears often to leave the nest in the daytime, and it is just possible that when the temperature is very high the hen may not incubate at all, and the cock alone may do so at night." (*Nature*, vol. XXVII, pp. 480, 530.)

The Thrush family.—The thrushes have been re-examined by Dr. Leonhard Stejneger, the learned Norwegian ornithologist, now resident at Washington, with quite satisfactory results. His conclusions have been embodied in an article published in the Proceedings of the U. S. National Museum (vol. V, pp. 449–483), entitled "Remarks on the Systematic Arrangement of the American Turdidæ."

The most essential characters of the group are given as the booted tarsi, coincident with the spotted plumage of the young. The most prominent feature of the new arrangement, contrasted with that most current in the United States, is that the *Miminæ* have been removed altogether from the family, the genus *Cichlherminia*, formerly regarded as a connecting link between the two subfamilies, being broken up into *Cichlherminia* proper, and *Margarops*, the former belonging to the true *Turdinæ*, the latter to the *Miminæ*, which are referred to the neighborhood of the Troglodytinæ. Furthermore, the *Saxicolidæ* (including *Sialia*), and the *Lusciniidæ* have also been included among the *Turdidæ*, while the *Myadestinæ* have been given rank as a subfamily under the same head after having been removed from the *Ptilogonatidæ*, among which, however, *Myadestes leucotis* is left under the new generic term *Entomodestes*. The groups have been made more natural by removing heterogeneous elements and putting them in their proper place. Thus *Turdus pinicola* was made the type of the new genus *Ridgwayia* and placed among the *Sialeæ*, while *Turdus flavipes* and allies were transferred to the *Myadestine* genus *Platycichla*, which the author shows to have been founded upon a female of the species in question or a very nearly related one.

Mammals.

Extinct Rodents of America.—The extinct rodents, whose remains have been resurrected from the Tertiary deposits of the United States, have been examined by Professor Cope, and interesting details have been supplied. No evidence has been furnished as yet of the existence of any representative in the lowest beds (Puerco-Eocene epoch), but species have been found in the next succeeding (Wasatch-Eocene epoch), and have continued to the present in gradually increasing numbers. Representatives of apparently nine families have been found in pre-pliocene strata, of which three are extinct and the rest still existing. The older extinct families were related to the squirrel-like types, and are (1) *Ischyromyidæ*, with thirteen species, twelve of the Eocene and one of the Oligocene, representing three genera; (2) *Mylagaulidæ*, known only through one species found in the Upper Miocene; and (3) a form named *Heliscomys*, either of an undifferentiated or doubtful family, described from the jaws of a species found in the Oligocene. No remains of any of the existing families have been found earlier than the Oligocene; during that epoch the beavers, squirrels, mice, and hares were represented by extinct genera, and in the Miocene the porcupines and gophers (Geomyidæ) left remains. "The ancient genera all differ from their modern representatives in the same way; that is, in the greater constriction of the skull just posterior to the orbits and accompanying absence of postorbital processes." Contrary to what prevails among many other types, "none of the species of this fauna are of larger size than their modern representatives. In the cases of the beavers, squirrels, and rabbits, the ancient representatives are the smaller." This generalization, however, can only be regarded as true for Miocene and earlier Tertiary species. Certainly two of the rodent types (without living species) at least were larger than any of their modern relations. These were described by Professor Cope among "the Pliocene and Post-pliocene rodentia," under the names *Castoroides Ohioensis* and *Amblyrhiza;* the former was the type of an extinct family, the Castoroididæ, and the latter related to the chinchillids. The *Castoroides* attained to about the size of a black bear, and one of the *Amblyrhizæ*—the *A. latidens*—must have been larger than the male Virginia deer. (*Am. Nat.*, January, February, April, 1883, vol. XVII.)

A third kind of Corpuscule in Blood.—Besides the red and white blood corpuscules, there are indications of a third kind in the blood of mammals, but the exact nature of the element has remained obscure. In 1883, Bizzozero solved the difficulties of examination, and practically made known for the first time the third kind of corpuscules. They are colorless lens-shaped disks of comparatively small size, having a diameter only a quarter to a half that of the red corpuscules and destitute of hæmoglobin. They are especially interesting on account of their supposed physiological relations. It is claimed that they are the chief factors in the coagulation of the blood, and that the fibrin is derived from their disintegration. This view is entirely different from those previously enunciated, which referred the fibrin chiefly to the breaking down of the white corpuscules. Investigation of the blood of birds and amphibians revealed an homologous element with the newly differentiated corpuscule—pale, nucleated blood-plates, whose functions were similar to those of the mammals. (*Am. Nat.*, vol. XVII, pp. 1303–1305.)

In a reclamation made to the French Academy of Sciences (*Compte Rendus*, vol. 96, pp. 1804–1806) G. Hayem insists that the elements of the blood, to which he gave the name of hematoblasts, are identical with the "plaquettes," or corpuscules, described by Bizzozero. He further contends that Norris's third corpuscular element is a red corpuscule decolorized as the result of the manipulation to the blood was subjected. [*J. R. M. S.* (2), vol. III, p. 631.]

The function of the cochlea of the mammalian Ear.—Years ago Professor Helmholtz, recalling that the membrana basilaris of the cochlea, in which the terminal filaments of the auditory nerve are distributed, increases in width from the bottom towards the upper part, broached a hypothesis to explain the differentiating perception of certain higher tones; it was suggested that "the sound waves that penetrate into the cochlea occasion a synchronous vibration, either in the broader upper half or in the narrower lower half of the membrana basilaris, so that the higher tones would excite the fibers of the auditory nerve distributed in the lower part, and the deeper notes of the fibers distributed in the upper part. In animals which are low in the scale of development there is a similar arrangement, which consists of auditory cilia of different lengths, which have the same function, as the shorter ones are intended for the higher notes, and the longer ones for the deeper notes and noises, and are set into synchronous vibration by them. This hypothesis has been experimentally confirmed in the case of the auditory cilia of the lower animals, and it had actually turned out true that deep notes produced vibrations in the long hairs and high notes in the short ones."

During the past year Dr. B. Baginsky, of Berlin, experimented on dogs, with a view of ascertaining to what extent the Helmholtzian hypothesis was applicable to the cochlea of the mammals. The difficulties to be encountered were, of course, great, but they were partly overcome. "He wounded the top of the cochlea of the healthy ear in dogs which had been made absolutely deaf of their other ear, and then observed their hearing powers by means of the different notes of organ pipes between *c* and *c'''''*. On the third day after the immediate consequences of the operative interference had disappeared, it was found that the dogs responded perfectly to the notes *c'''''*, *c''''*, *c'''*, *c''*, but were deaf to the deeper notes. This condition remained unaltered for weeks, and when the animal that had been the subject of experiment was killed, post-mortem examination showed that the top only of the cochlea had been wounded, and that the filaments of the auditory nerve that were distributed to that portion were destroyed. Less precise were the results of the experiments in which the lower part of the cochlea was destroyed." The result on the whole, however, supported the hypothesis of Helmholtz. (*Am. Nat.*, vol. XVII, pp. 1195–1196.)

Milk-giving Males.—A number of cases have been recorded in which the male had developed functional mammary glands, and even man has given sometimes quite copiously milk therefrom. Such cases, however, are always of interest. The observations of Dr. C. Hart Merriam, made in 1872, on the milk-giving faculty of males of the so-called Baird's Hare have been recalled recently in *Nature* (vol. XXVII, p. 241), and a correspondent in a subsequent number (vol. XXVII, p. 267) revived an old account of a he-goat which gave milk. In the island of Amboyna, in 1546, the famed Saint Francis Xavier found "a he-goat giving suck to his young kids with his own milk; he had one breast which gave every day as much milk as would fill a basin"; this, the saintly Jesuit wrote, he saw with "his own eyes."

South American extinct Mammals.—While the paleontologists of the United States have been rewarded by the rich discoveries of extinct mammals whose fame has already been widely bruited, a corps of investigators has sprung up in the southern continent who are being almost equally recompensed for their labor by strange new types. Perhaps the most active of these new laborers is Mr. Florentino Ameghino, who has contributed several important memoirs on fossil mammals to the "*Boletin de la Academia Nacional de Ciencias*" of the Argentine city Cordoba (vol. V, pp. 1–34; 101–116; 257–306; 1883). In one of these memoirs (Sobre una coleccion de mamiferos fósiles, recogidos por el profesor Scalabrini en las barrancas del Parana, in vol. V, pp. 257–306,) he has described a number of new animals from a formation antecedent to that which has furnished so many well-known pampean types, and has expressed his belief that they were the legitimate predecessors of the latter. For example, the *Chlamydotherium typus* was preceded by the *Chlamydotherium paranensis*, *Hoploplorus* by *Palæhoplophorus*, *Mylodon* by *Promylodon*, *Megatherium* by *Promegatherium*, *Toxodon* by *Toxodontotherium*, and *Macrauchenia* by *Scolibrinitherium*. Both series of these animals—the later as well as the earlier—are not only themselves extinct, but have left no successors of the same families even. They belong to four extinct families. But in addition to these, forms still living were represented by relatives of the same family and even by closely allied genera in the Parana period. The deer were then exemplified by a certain generic type called *Proterotherium*. Of that giant of existing rodents, the *Hydrochœrus* or *Capybara*, a still larger predecessor named *Cardiatherium* existed, and the genus *Lagostomus* had then already been developed under the form *L. paranensis*, and the genealogy through *L. angustideus* and *L. fossilis* is traceable directly or indirectly into the *L. trichodactylus* now living (*op. cit.*, p. 305).

Maternal intelligence in Deer.—An interesting instance of maternal solicitude and intelligence has been noticed by Mr. W. H. Ravenscroft in the spotted deer (*Cervus axis*) of Ceylon. A newly made mother was noticed without her young in the afternoons of several successive days, and a man set to watch to detect what she had done with it. It appeared the doe went to certain bushes and "put the fawn to bed every afternoon, for about eight or ten days, at about 4.30 P. M., and hid it so successfully that, though" the observer "knew within a few feet the place in which it was" concealed, he "never succeeded in finding it." (*P. Z. S., London*, 1883, p. 465.)

Extinct Dogs of North America.—The family Canidæ, including the dogs, wolves, foxes, and kindred animals, are of quite an ancient lineage, and, according to Professor Cope, "probably first appeared in the Upper Eocene epoch," but in the United States "no undoubted species of Canidæ has been found in beds older than Oligocene or oldest Miocene." Their remains have been obtained in the greatest abundance in the Middle Miocene, are not rare in the Upper Miocene, and "species accompany the Pliocene fauna everywhere." Twenty-five species of the family, representing nine genera, have been recognized by Professor Cope. It is possible however that several of these species are referable elsewhere than to this family. (*Am. Nat.*, vol. XVII, pp. 235–249.)

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NECROLOGY OF ZOOLOGISTS, 1883.

BARRANDE (JOACHIM), an eminent paleontologist, noted especially for his investigations of the paleozoic fossils of Bohemia, at Prague, in his eighty-fourth year.

BERTILLON (ADOLPHE), naturalist and statistician, died March 3, aged sixty-one years.

CARBONNIER (PIERRE), pisciculturist.

CHADBOURNE (PAUL A.), president of Massachusetts Agricultural College, died February 16.

FORBES (WILLIAM ALEXANDER), prosector to the Zoological Society of London, a learned zootomist and ornithologist. Died of dysentery at Shongo, on the Niger River, January 14, aged 28.

HEER (OSWALD), of Zurich, a noted paleontologist, born in 1809 at Lausanne. Died September 27.

KOWALEVSKY (WILHELM), professor of paleontology in the University of Moscow, a most acute paleontologist and systematic zoologist.

KNÖRLEIN (JOSEF), entomologist. Died at Linz, February 12, in the seventy-eighth year of his age.

LECONTE (JOHN LAWRENCE), an eminent zoologist, especially noted for his writings on the Coleoptera of the U. S., born in New York May 13, 1825. Died at Philadelphia November 15.

MÜLLER (HERMANN), of Lippstadt, celebrated for his studies on the relations between flowers and insects. Died of inflammation of the lungs at Prad, in Tyrol, August 25.

NILSSON (SVEN), a distinguished Swedish zoologist, died at Lund, November 30, at the age of 97 years.

PACINI (FILIPPO), professor of anatomy in the University of Florence, well known in connection with his studies on Asiatic cholera and artificial respiration.

PARKER (CHARLES F.), curator of the Academy of Natural Sciences, Philadelphia. Died September 7.

PETERS (WILHELM CARL HARTWIG), director of the Zoological Museum of Berlin, and a voluminous and esteemed author; born at Coldenbüttel, Schleswig, April 22, 1815. Died at Berlin, May?

SABINE (Sir EDWARD), president of the Royal Society of London, and who contributed in his early life to the literature of zoology. Died at London, June, 1883.

SCOTT (H. G.), Major-General B. A., the Superintendent of the construction of the Great International Fisheries Exhibition at Sydenham. Died April 16, aged 61.

SUMICHRAST (ADRIAN LUIS JEAN FRANCISCO), a Mexican naturalist and collector, born October 15, 1828, at Ivorne, Switzerland. Died September 26, 1882, at Tonala (Chiapas), Mexico.

TOLLES (ROBERT B.), a distinguished maker of microscopes, at Boston. Died November 18.

VALENTIN (GABRIEL GUSTAV), a physiologist of great erudition, at Berne. Died June?

ZELLER (PHILIPP CHRISTOPH), a very eminent entomologist, died of heart disease at Grünhof, near Stettin, March 27, in the seventy-sixth year of his age.

ANTHROPOLOGY.

By Otis T. Mason.

INTRODUCTION.

There are times in the history of every science when its advocates may pause and look around them to see what progress has been made. The labors prosecuted in a science so complex as the natural history of man must necessarily be of two kinds, those which explore to its lowest depth each particular part of the field, and those which reach far and wide to gather in the results of investigation in each area. Of this last class attention may be directed to a few works of importance.

In February of 1883 Dr. E. B. Tylor delivered two lectures at Oxford on the general subject of anthropology. The vice-presidential address before the American Association at Minneapolis was upon the same comprehensive theme.

Dr. Daniel Brinton, of Philadelphia, has taken in hand to publish a series of works on American anthropology. His address before the Congrès International des Américanistes at Copenhagen; his article on archæology in the American Supplement of the Encyclopædia Britannica; a paper before the Numismatic and Antiquarian Society of Philadelphia on European contributions to the study of American archæology; two volumes in Brinton's Library of American Literature; and several shorter papers on archæological subjects, all attest his energy and the obligation of anthropologists to his generosity.

Parts 25–27 of von Hellwald's classical work on the natural history of our species were published during the year. In Breslau appeared Encyclopædia der Naturwissenschaften; Handworterbuch der Zoölogie, Anthropologie, und Ethnologie; in Paris, Dictionnaire Usuel des Sciences Medicales; but the highest claim of anthropology to rank as a real science is presented by the apearance in Paris of Dictionnaire des Sciences Anthropologiques, including anatomy, craniology, prehistoric archæology, ethnography, manners and customs, laws, arts, industries, demography, languages, and religions. The editor-in-chief is M. Bertillon.

The importance of the study of anthropology to physicians, legislators, and sociologists is urged by several publications of great value.

In the following chapters the usual order is followed. Frequent references are made to authors, whose works will be fully noticed in the bibliography at the end of this paper. In the list of authorities the titles are given under one alphabetical list.

I.—ANTHROPOGENY.

J. W. Powell's annual address before the Washington Anthropological Society was upon human evolution. The greater part of the argument is taken up with the evolution of human culture. The speaker followed more elaborately the thought of Arthur Mitchell, that the course of human progress has been a war with the lower law of the survival of the fittest, waged by men in society, with especial emphasis upon the notion that without well-organized society man would have gone down in the struggle.

Anthropogeny is still vigorously studied through the insane, defective, and criminal portions of populations, in order to discover evidences of the reappearance of ancestral characteristics by atavism. These investigations are conducted in two widely divergent lines. In one direction they are prosecuted by anatomists especially with reference to protohuman cranial and cerebral characteristics; in the other, by comparative psychologists for the purpose of determining the pristine condition of mind, the phases of mental evolution, and the causes, social and otherwise, that produce those pitiable conditions.

Pre-eminent among the students in this particular field are Lacassagne, Lombroso, Corré, and Ferri. On the other hand, the brains and crania of distinguished men are called upon the witness stand, to testify as to the relation between brain size and weight with the quality and amount of intelligence.

Although the ancestry of man is at present looked for in some zoological group far back in Tertiary times, the older theory of man's direct descent from the apes finds its advocates. Among them is M. Borghese, who maintains that man could have descended from the apes. Hartmann is the author of a treatise upon the manlike apes in comparison with man.

Not only is the attempt made to find our immediate ancestor of our race in existing fauna, but also the analogues of all human arts and associations. This leads to some curious investigations, for instance that of G. Delaunay on animal doctors.

Not much is written nowadays about the location of man's origin. W. S. Duncan is the author of a paper on the subject in the Journal of the Anthropological Institute, but the most systematic and thorough discussion is by Count G. de Saporta on the peopling of the earth.

II.—ARCHÆOLOGY.

The Marquis de Nadaillac has produced a very learned work on prehistoric America, and, for one so far removed from the opportunities of personal examination, he has written a very remarkable book. The sympathies of the author are somewhat with the romantic school of interpretation, but the tone is far in advance of that which pervades the majority of archæological works by European Americanists.

Professor Putnam, in the administration of the Peabody fund, has shown the greatest activity in exploring the mounds. His method has been to take the structure entirely down, on the theory that the tumuli are not concentric series of conical shells with a core, but a series of horizontal layers. The finds at Madisonville, Ohio, were rich and unique, and their description and illustration form the chief feature of the annual report.

The Bureau of Ethnology has prosecuted archæological inquiries in two directions, in the mounds and in the pueblos. Dr. Cyrus Thomas, in charge of the former, made a wide exploration, with a view to completing the Smithsonian mound-map. His studies lead him to hold that the mound-builders cannot be separated ethnically from the modern Indians. Colonel Stevenson, exploring the pueblos, has not only gathered a rich harvest of ancient pottery and implements, but he has succeeded in finding a new variety of cliff-houses. Instead of an open shelter walled up, there is an excavation of every part—the windows, doors, and the entire interior—very similar to the ancient ruins of Arabia Petra. Dr. Thomas has also studied the manuscript Troano and other Maya inscriptions.

The Archæological Institute of America has divided its resources between two fields—Greece and New Mexico. The second annual report on the American School of Classical Studies at Athens announces that the course was opened by the director, Prof. W. W. Goodwin, October 2, 1882, in a roomy and convenient house on the Ὁδὸς Ἀμαλίας. The Bulletin published in January, 1883, describes the work at Assos in 1882, and also presents the report of A. F. Bandelier on his investigations in New Mexico in the spring and summer of 1882. The result of the last-named study is that "there appear to be but two types of aboriginal architecture in New Mexico, *the many-storied communal house*, and *the one-story* building of stone. The latter is found either in villages on the level ground and on gradual slopes, or clustering on the rocky shelves and scattered in recesses, like the so-called cliff-houses. The cave-dwellings appear as an incidental form, resulting from the ease with which the rock was hollowed out or from the existence of natural cavities, which, from their size and the security of their position, afforded advantages superior to those of independent buildings. The majority of cave-dwellings seem to be many-storied pueblos, scooped out of friable rock or built inside of caverns for protection. But there are also instances where the small-house type is reproduced in the shape of a little cavity or an isolated nook walled up in front."

Dr. C. C. Abbott announced the discovery of a human molar in the Trenton gravels, associated with the palæolithic implements previously reported. At the Minneapolis meeting of the American Association, Frances E. Babbitt exhibited quartzite specimens resembling the rudely wrought drift implements of the Delaware Valley.

The greatest interest has been felt repecting the sources of the jadoid implements and images met with in collections of American antiquities. Dr. A. B. Meyer, of Dresden, has given much attention to the subject, and his folio monograph is a work of great importance. Professor Baird has written a circular letter to explorers to be on the lookout for the natural source of supply. Mr. E. W. Nelson collected some beautiful objects in jade, while in Alaska.

Lucien Carr's chapter in the Kentucky Geological Survey on the mounds of the Mississippi Valley, historically considered, takes the ground that the identity of these people with the modern Indians is proved, that they are by no means ancient, but that the particular tribe which is the most direct descendant is not made out.

In the American Philosophical Society's Proceedings, Henry Phillips, jr., gives an account of the more important public collections of American archæology in the United States. The American Antiquarian, edited at Clinton, Wis., by S. D. Peet, is devoted solely to archæology, and much attention is paid by the editor to the animal mounds of the State.

It is impossible to follow the works of the English and continental Europeans in their archæological surveys. Fortunately their special journals are accessible. The vice-presidential address of W. Pengelly before the British Association is a résumé of cave exploration well worth reading. The archæology of the Caucasus has been studied and illustrated by Chantre, Bayern, and Virchow; and their astonishing results will quicken investigations in one of the early homes of the Aryan race.

III.—BIOLOGY.

The most interesting and important inquiry in human biology is heredity. The forces at work, the effects of consanguineous marriages, the transmission of genius and other traits, the co-operation of its laws with heat, light, actinism, pressure, moisture, atmospheric contamination, drink, food, resources, scenery, and natural security to produce, perfect, and fix racial and family characteristics—all of these and many other questions quite as important conspire to make heredity the focus of all biologic investigations.

Max Bartels, with German assiduity, has brought together in a monograph of nearly one hundred pages the literature and notices of men with tails. The paper is illustrated with modern examples. The same author has carefully studied Krao, the child ape.

The anomalies of the teeth, the anthropological significance of the wormian bones, and right-handedness will be found in the bibliography of this paper to have received careful study.

George Peckham, of Milwaukee, has prosecuted a series of observations on the growth of children, which are set forth in the annual report of the Wisconsin board of health.

Uniform craniometry.—In September, 1877, a craniometric conference was held in Munich (Correspondenzblatt, 1878, No. 7), and a second conference in August, 1880, in Berlin (Correspondenzblatt, Bericht über die XI, Allg. Versamml., pp. 104–106). At the thirteenth general meeting, at Frankfort, August, 1882, a perfected scheme was proposed. This is published in Archiv für Anthropologie, XV, pp. 1–8, 1884, and signed by sixty-seven of the most eminent anthropologists in Germany, Switzerland, Austria, Italy, and Russia.

The horizontal.—The line selected for the horizontal of the skull is that extending from the lower edge of the orbital cavity to the middle of the ear-cavity or the upper edge of the internal *meatus*.

The linear measures of the cranium are 16; of the face, 15. The capacity of the skull is taken with shot, if possible. The cranial indices are as follows:

Dolichocephaly	.75 and under.
Mesocephaly	.751–.799.
Brachycephaly	.80–.85.
Hyperbrachycephaly	.851 and over.
Chamæcephaly	.70 and under.
Orthocephaly	.701–75.
Hypsicephaly	.751 and over.
Prognathy	to 82°.
Mesognathy or orthognathy	83°–90°.
Hyperorthognathy	91° and over.

Other indices are based on the height of the face, orbital cavity, nasal cavity, and palate.

The following table is drawn up for the purpose of indicating the manner of reporting measurements:

	Indices.		Indices.
Number	....	Width of face	GB
Source	....	Zygomatic width	J
Sex	....	Height of nasal cavity	NH
Age	....	Width of nasal cavity	NB
Cranium:		Width of orbit	O_1
Capacity	C	Height of orbit	O_2
Length	L	Length of palate	G_1
Width	B	Width of palate	G_2
Width of forehead	B^1	Facial angle	PL
Height	H	Indices:	
Height of ear	OH	Length and height	L : B
Length of skull base	LB	Length and height index	L : H
Horizontal circumference	N	Breadth and height index	B : H
Sagittal circumference	S	Face	GH : GB
Lateral circumference	Q	Upper face	G^1H : GB
Face:		Nose	NH–NB
Height of face	GH	Orbital cavity	$O_1 : O_2$
Height of upper face	G^1H	Palate	$G_1 : G_2$

IV.—PSYCHOLOGY.

The last part of the human economy to yield to scientific treatment is the mind, or spiritual nature. Indeed it may fairly be said that no scientific society has yet taken up the study of mind as it has the study of objective phenomena. It was a long time before anthropology was divorced from mere biography of individuals and historic annals, which are mostly only biographies of peoples. Those who study the animals in order to spell out the hieroglyphics of human evolution are wont to take the extraordinary, spasmodic, and inexplicable actions of pets and trained animals as their illustrations. The same method would not hold in natural history. G. J. Romanes is almost alone in giving to the subject a careful consideration, though it may be from the point of view of a special pleader.

The relation of brain weight, texture, convolutions, and, we might add, the circulation of blood therein, to thinking as to its quality and amount—that is the field of true psychologic study, which may be prosecuted by profound examination of single individuals or by the combined exertion of thousands of observers. To this topic already much attention has been paid.

M. Alix has paid some attention to dreams, a subject of the greatest promise if rightly considered.

Cranio-cerebral topography is still a living question with many anatomists, and quite a showing of papers appears in the accompanying bibliography.

The question of the nature of consciousness and personality must always be one of the highest interest. Baussière, Cleland, and others have bestowed much attention upon it.

Several journals have sprung into existence devoted to a comparative study of mind. The American Naturalist has added a department of psychology. The Society of Psychical Research was organized in London during the year, and publishes a quarterly journal, entitled "Proceedings." Prof. Henry Sidgwick was the first president. The subjects considered were thought-reading, thought-transference, haunted houses, clairvoyance, mesmerism, muscle-reading, insanity, dreaming, and the divining rod. The Archivio di Psichiatria, &c., has reached its fourth volume.

V.—ETHNOGRAPHY.

Among the ethnologic works of a comprehensive character that of A. H. Keane, of Oxford, stands pre-eminent. Taking advantage of von Hellwald and the older ethnographers, his purpose is to arrive at an accurate analysis of the races of men by a careful scrutiny of the tribes. Richard Andree is the author of an illustrated monograph on ethnographic comparisons and parallels.

In special ethnography much good work is done. F. Boas is the author of a special study on the former distribution of the Esquimaux in the Arctic regions. It will be remembered that Boyd Dawkins hints an ancient southward residence of this people, as well as their uninterrupted circuit of the North Polar Sea. The National Museum at Washington has been able to secure the co-operation of the signal officers and other Government officials in Alaska especially, and the result has been an enormous addition to the number and variety of culture objects. Mr. J. G. Swan continued his investigations among the Haidas and other stocks of the northwest coast. The results of Bastian's researches in the same region form a beautiful addition to our literature.

Major Powell and the Bureau of Ethnology devoted much attention to the subject of unraveling the linguistic stocks of our western area, and it is believed that every tribe in the United States is sufficiently known to be properly relegated.

The colossal work of H. H. Bancroft steadily goes on toward completion. During 1883 the following volumes appeared in the new series: Vols. I, II, Central America; Vols. IV, V, VI, Mexico, 1516-1521; Vol. XV, North American States; and Vol. XVIII, California. The series when completed will contain the following works:

Vols. I-V.—The Native Races of the Pacific States.
Vols. VI-VIII.—History of Central America.
Vols. IX-XIV.—History of Mexico.
Vols. XV-XVI.—History of the North Mexican States.
Vol. XVII.—History of New Mexico and Arizona.
Vols. XVIII, XXIV.—History of California.
Vol. XXV.—History of Nevada.
Vol. XXVI.—History of Utah.
Vols XXVII, XXVIII.—History of the Northwest Coast.
Vols. XXIX, XXX.—History of Oregon.
Vol. XXXI.—History of Washington, Idaho, and Montana.
Vol. XXXII.—History of British Columbia.
Vol. XXXIII.—History of Alaska.
Vol. XXXIV.—California Pastoral.
Vol. XXXV.—California Inter Pocula.
Vols. XXXVI, XXXVII.—Popular Tribunals.
Vol. XXXVIII.—Essays and Miscellany.
Vol. XXXIX.—Literary Industries.

The history of the Pacific States is the central figure of this literary undertaking, the *native races* being preliminary, and the works following the history supplementary thereto. The territory covered is the western half of North America, from Panama to Alaska, including all of Central America and Mexico, and is equivalent in area to one-twelfth of the earth's surface.

South America, so long neglected, received some marked attentions in 1883. E. R. Heath publishes in the Kansas City Review an article on the dialects of the Bolivian Indians, which has received much praise. The best publication on South America, and one that will be read with great pleasure, is im Thurn's "Indians of British Guiana." The names of all the tribes are given, and excellent descriptions of the people and their arts. Bonney is the author of a treatise on the inhabitants of Colombia, and Bové on those of Tierra del Fuego.

The study of the elements in the present populations of Europe may be said to begin with Quatrefages's researches concerning fossil men. H. H. Howorth continued his ethnologic investigation into the proto-historic tribes of Germany and France.

The Revue d'Ethnographie, established by M. Hamy, passed through its second volume successfully.

No ethnographic field is receiving more thorough attention than Australia. The publication of the results of these investigations in the Journal of the Anthropological Institute has lifted that journal to the very first rank among our special journals. Mr. Sanger also contributes a paper on the aborigines of Cooper's Creek. Bastian's researches in Polynesia are noticed in Archiv. M. de Quatrefages is the author of a pamphlet in which he seeks to identify the Negritos with the Pygmies of the classic authors.

VI.—GLOSSOLOGY.

Since Mr. Darwin published his work on the expression of emotion in the animal creation and in man, much attention has been paid to the methods of speech that are not vocal. A paper by Bruce in the American Naturalist discusses this subject.

The question of a universal language is not yet within the purview of anthropology, but a universal alphabet is, and it would seem to be the next duty of philologists to come to some understanding in the matter. The study of deaf-mutes and of the phonetic revelations of the telephone by A. Melville Bell and his son, A. Graham Bell, are in the line of this study. Isaac Taylor has written a work on the origin and development of letters, and Gustav Oppert has attempted a classification of languages on the basis of ethnology.

Since Lazarus Geiger broached the theory that the absence of certain color names in ancient writers proves that the special color senses were not yet developed, many philologists have taken up the subject. The Société d'Anthropologie published a memoir by J. Geoffroy upon the knowledge and the names for color among the ancients. In the American Journal of Philology Thomas R. Price publishes a paper on the color system of Virgil, in which, discarding the wild speculations of Geiger, the author tries to give a rational definition of the color names used and to account for certain omissions about which much ado has been made.

Dr. W. J. Hoffman, after having studied the sign languages of the world pretty thoroughly, conceived the idea that the Eskimo and Indian pictographs were related in many instances to the sign language. A paper published by the Washington Anthropological Society is devoted to this comparison. The same author wrote about the Carson footprints, poisoned weapons, and tattooing. Horatio Hale is the author of two important works published during the year—Indian Migrations as Evidenced by Language, and the Iroquois Book of Rites. A. S. Gatschet published the following linguistic papers: The second part of his classification of the Yuma stock, a specimen of the Chumeto language, the Shetimasha Indians of Saint Mary's Parish, Louisiana, and the linguistic notes of the American Antiquarian.

The sketch of Robert Cust on the modern languages of Africa fills a very wide and disagreeable gap in our ethnographic knowledge. The author forestalls his critics by justly acknowledging that first efforts always come very short of perfection.

VII.—TECHNOLOGY.

Every phase of civilization has its technique; every motive at the foundation of human activities has its arts. There are arts of food, clothing, shelter; of beauty, science, and worship; there are arts of these arts; finally there are arts of destruction or consumption. In the new National Museum at Washington the anthropological objects are being arranged to illustrate these facts. Waterhouse Hawkins is the author of a treatise on comparative anatomy as applied to the purposes of the artist. Dr. Fletcher delivered a Saturday lecture in Washington on human proportion in art and anthropometry. Dr. Clevenger read a paper on anatomy and the sciences useful to the artist. William H. Holmes read a paper before the Washington Anthropological Society upon art in shell.

Several attempts have been made in our country and abroad to deduce the systems of metrology among various ancient and barbarous peoples by comparing the parts of their monuments and one structure with another. Such investigations are involved in so many disturbing elements that the results have been considered unsatisfactory. W. M. F. Petrie describes in the Anthropological Institute Journal the mechanical methods of the ancient Egyptians.

The second volume of J. König's great work on the chemical constituents of human foods and drinks has been published in Berlin. In the United States Consular Reports will be found a complete list of all the beverages used in Mexico. Many of these, of course, are importations or Spanish inventions; but quite a number are older than the conquest. Fruit of the agave, pulque, corn, and certain berries furnish the material for the staple native drinks. C. Beni, of Florence, gives the analysis of pulque.

One of the South Kensington Art Hand Books is by Hans Hildebrand upon the industrial arts in Scandinavia in Pagan times. F. A. Seely, examiner in the United States Patent Office, has commenced a series of investigations into aboriginal art by the processes employed in the Patent Office for tracing back inventions.

VIII.—SOCIOLOGY.

Two large volumes on dynamic sociology were published by Lester F. Ward, in which he seeks to group all industries and to classify the elements of society by means of the fundamental human wants and their supply. The principles of natural selection co-operating with the well-known laws of nature are deemed sufficient to account for all human phenomena. There is a high moral tone prevading the work and an earnest protest against the notion that materialism is necessarily a doctrine of *laissez faire.*

In the series of descriptive sociologies published by Herbert Spencer, the eighth part, relating to the social history of France, appeared during the year.

An interesting social problem is the life history and training of children among savages. M. Kulischer is the author of a carefully prepared treatise upon the treatment of children and youth on the lower levels of civilization. The bibliography in his paper is of great value.

J. Owen Dorsey published during the year two papers in his series of gentile systems, the gentile system of the Omahas and the gentile system of the Iowas. The same author has also discussed myths and legends of the Dakotan stock.

A. W. Howitt continues to publish learned papers on the Australian class system. It may be truly said that the systems of relationship among the aborigines of Australia and of North America are the best known in the world, thanks to the stimulus given to such studies by Mr. Morgan. The discovery of a minute division of the clans for the purposes of marriage and inheritance very much complicates the system as formerly understood.

By reference to the bibliography it will be seen that sociological studies have assumed a most varied character touching births, deformations, child growth, marriage, divorce, medicine, law, jurisprudence, and religion.

IX.—DAIMONOLOGY.

Foremost among the cultivators of this branch of anthropology in America are Major Powell, Dr. Brinton, and H. H. Bancroft. In the second volume of the Bureau of Ethnology Report are the following papers on Mythology :

Zuñi fetiches, by F. H. Cushing.

Myths of the Iroquois, by E. A. Smith.

Animal Carvings from the Mounds, by H. W. Henshaw.

In the last-named paper the relation of the subject to mythology is discussed. J. O. Dorsey, of the same Bureau, has added largely to our knowledge of the mythologies of the Dakotan stock. Mr. Bancroft's volumes are filled with references to the older authorities on the mythologies of the West Coast, Mexico, and Central America.

The Iroquois Book of Rites, published by Dr. Brinton and edited by Horatio Hale, is a good deed to science in that it saves one of those productions so likely to pass soon beyond recovery.

The increase of interest in folk-lore has made it necessary for the Folk-Lore Society to issue a monthly periodical.

X.—HEXIOLOGY.

The relations of mankind to the earth and its living forms are so varied that a correct apprehension of them would involve some information concerning the whole circle of sciences. For instance, Boulaert treats of the animals useful to industry, arts, and medicine; Braun, of the parasites of man; Buchan, of climate and race, &c. But far the most important and interesting work on the relation of our race to environment published during the year is De Candolle's "Origine des plantes cultivées." The work is reviewed in Nature, March 8, and in Silliman's Journal, by Asa Gray and J. Hammond Trumbull. The last-named review adds very much to the value of the volume, Dr. Gray correcting and adding to it some references to American plants, and Mr. Trumbull giving a charming chapter on Indian plant names.

XI.—INSTRUMENTALITIES.

One of the highest duties of the men in any craft or science is to bring to their work the best instruments and methods. All anthropologists recognize this, and many have brought to the problem their greatest ingenuity. We might divide these helps into those which aid the senses, those which facilitate operations, and those which aid the memory. A work of the greatest importance is the report of the British Association Committee on Anthropometry. The same committee published a few years since "Notes and Queries," a little volume which did much to give rational form to the studies of English travelers in various parts of the world. C. Roberts and Sir Rawson Rawson, on the committee, are names well known to us.

Mr. Francis Galton continued his researches into graphic methods of recording sociological problems. He devised a new scheme of rapidly and briefly noting any consanguineal or marital relation whatever, an apparatus for testing the delicacy of the muscular and the other senses in person, and tabular forms and directions for entering data concerning families. He also discusses the problem of the development of human faculty.

The publication in Archiv für Anthropologie of the contents of the great anthropological museums of Germany is another one of those pieces of thorough work which keep the Germans in the forefront of science. The name of Schaaffhausen is pre-eminent among those fostering this enterprise. Dr. J. S. Billings read a paper before the medical and surgical faculty of Baltimore on medical bibliography. The Index-Catalogue of the Surgeon-General's office, under the charge of Dr. Billings, has reached its fifth volume.

An anthropological society has been formed at Bordeaux; Dr. Azam, president; Dr. Testut, vice-president.

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American Association.—

[The American Association for the Advancement of Science met in Minneapolis August 15, 1883. Prof. Otis T. Mason was the vice-president of the section of anthropology, and delivered an address on the scope and value of anthropological studies, printed in the annual volume of Proceedings, in *Science*, and in *La Revue Scientifique*. The papers read were as follows:]

1. Archæological explorations in the Ohio Valley. Altar mounds and their contents. By Prof. F. W. Putnam.
2. Indoor games of the Japanese. By Prof. E. S. Morse.
3. The great mound of Cahokia. By Wm. McAdams.
4. Life among the Mohawks in the Catholic missions of Quebec province. By Mrs. Erminnie A. Smith.
5. Metrical standard of the mound-builders—by the method of even divisors. By Charles Whittlesey.
6. The mound-builders identified. By Prof. John Campbell.
7. An abnormal human skull from a stone grave in Tennessee. By Prof. F. W. Putnam.
8. Typical shapes among the emblematical mounds. The different attitudes exhibited by the same animal. By S. D. Peet.
9. Personal observations of the Missouri River mounds from Omaha to Saint Louis; considered from a geological standpoint. Their invariable association with the Loess and Terrace formation. By E. P. West.
10. Osage war customs. By J. O. Dorsey.
11. Some observations on the laws and privileges of the gens in Indian society. By Miss A. C. Fletcher.
12. An ancient village of the emblematic mound-builders. Caches guarded by effigies. Effigies guarding the village and sacrificial places not far away. By S. D. Peet.
13. A new stand for mounting skulls. By E. E. Chick.
14. Symbolic earth formation. By Miss A. C. Fletcher.
15. The correspondence between the prehistoric map of North America and the system of social development. By S. D. Peet.
16. The Charnay collection at Washington. By O. T. Mason.
17. Kitchens of the East. By E. S. Morse.
18. Methods of arrow release. By E. S. Morse.
19. Game drives among the emblematic mounds. By S. D. Peet.
20. Vestiges of glacial man in Central Minnesota. By Miss F. E. Babbitt.
21. High places connected with ancient villages; the religious structures common to villages in prehistoric time. By S. D. Peet.
22. A classification of the sciences. By J. W. Powell,

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PAPERS RELATING TO ANTHROPOLOGY.

AUSTRALIAN GROUP RELATIONS.*

By A. W. HOWITT, F. L. S., F. G. S.

I—INTRODUCTION.

There is probably no student of the development of civilized society who will be prepared to maintain that the social unit, during the long period over which history extends into the obscurity of the past, has been, as it is now, the individual. On the contrary, it will I think be readily admitted that the farther we go back the clearer it becomes that it was the group, and not the individual, which formed the basis of human society.

It seems strange that, although this principle of group relationship as the basis of social organization has been readily admitted as to peoples of the past, it should have been violently denied as existing among savages of the present day. The reason of this may be that the civilized man and the savage contemplate their social relations from two entirely different standpoints, though it might not be as difficult for the former to think after the manner of the latter as it is for the latter to fit himself mentally into the surroundings of the former. Training from childhood, with, perhaps, all hereditary tendency of thought, renders this next to impossible to the savage; but the civilized man has this advantage, that with largely developed mental powers he is able, where opportunity offers, and he cares to avail himself of it, to place himself on the standpoint of the uncivilized, and thus with more or less success to see the surroundings as the savage sees them, and to think of them with his thoughts.

This difficulty in projecting themselves, as it were, into the mind of the savage, has proved a stumbling block in the path of many anthropologists, who have studied the habits and beliefs of the lower races by means of the too often hasty and superficial statements of travellers, without having themselves any practical knowledge as to the modes of thought of the tribes in question; and thus they have not been in a

* Read before the Anthropological Society of Washington.

position to question the accuracy of the statements made as to fact, or to draw the true inferences which the facts justified.*

One of the strongest illustrations of the difficulty to which I have referred is shown by the determined refusal on the part of some English anthropologists to accept the classificatory system of relationship. The late lamented Dr. Morgan, who had practical acquaintance with the North American tribes, came to see that their peculiar system of relationship terms was founded on the idea of a group where civilized people have that of a single individual. He was thus led to institute inquiries which proved that this idea is common over the whole world in savage life, and he drew the general inference which might be drawn from the facts by persons accustomed to the mode of thought among the lower races. This, however, is so different from that of civilized man that most of the English anthropologists refused to accept his inferences and it is only now, when accumulated evidence continues to support his views, that the truth of the main generalizations which he made is beginning to be recognized.

In Australia observations may be made similar to those made by Dr. Morgan in America, but with this difference, that in the former country the native tribes are in a much lower ethnical stage, and are therefore so much nearer to the conditions under which the group system of re-

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* The danger to which such inaccurate statements of custom lead when received as established facts justifying generalization is strikingly shown by the well-known and often quoted passage as to Australian marriage in Collins's English Colony in New South Wales, p. 362:

"These unfortunate victims (the wives) of lust and cruelty * * * are, it is believed, always selected from the women of a different tribe from that of the males (for they ought not to be dignified with the title of men), and with whom they are at enmity. * * * The poor wretch is stolen upon in the absence of her protectors. Being first stupefied with blows, inflicted with clubs or wooden swords, on the head back, and shoulders, every one of which is followed by a stream of blood, she is then dragged away through the woods by one arm, with a perseverance and violence that it might be supposed would displace it from its sockets." In this manner the woman is said to be dragged to the man's camp, where "a scene ensues too shocking to relate."

Isolated cases of brutal violence such as this doubtless occur as acts of war, but no such practice is known to me as a custom in any Australian tribe. On the contrary, Mr. C. Naseby, of Maitland, New South Wales, who lived for fifty years in the Kamilaroi country, states as follows:

"When a young man has passed a certain number of Boras (initiations) he has a right to choose a wife from among the unmarried and otherwise unappropriated women of the tribe who are of the class permitted to him by the native laws. He claims the girl in the presence of her parents by saying "I will come and take you by and by," and they cannot refuse her to him unless he be specially disqualified—as for instance if "his hands are stained with the blood of any of her kin." And even in that case he may carry her off by force if he can in spite of their refusal. For this purpose he generally comes by stealth and alone. But if he be a very bold warrior, he sometimes goes openly to the girls' camp and carries her off, defying the bravest of her friends to meet him in single combat if they dare to stay him."

This places the practice stated by Collins in a very different light.

lationship may be assumed to have arisen. In Australia, moreover, aboriginal society has had a continental development, free from disturbing influences from without. It affords therefore an unrivaled field for inquiry; and here, if anywhere in the wide world, it should be now possible to trace out some of the causes which have been at the root of the classificatory system of relationship.

In this memoir I propose to draw attention to the connection which I find to exist between certain group relations of the Australian aborigines. In the term "group relations" I include not only those which are indicated by the terms of relationship, but also those shown by the groups formed in the aboriginal communities by the action of those social laws which have divided them into what, for the sake of convenience, have been termed "class divisions." For the purposes of this memoir I shall rely for my evidence mainly upon the custom of certain tribes of Central Australia, whose condition is socially* the lowest of any with which I have acquaintance.

II.—THE TRIBAL STRUCTURE.

An Australian tribe may be defined as a larger or smaller aggregate of people, who occupy a certain tract of hunting and food ground in common, who speak the same language with dialectical differences,† who acknowledge a common relatedness to one another, and who deny this relatedness to all other surrounding tribes. This tribal aggregate may be so small as to cover a tract of country less than fifty square miles, with under a hundred individuals, or it may extend over hundreds of miles of country and number thousands of souls.

Such a tribe, as a whole, occupies a certain tract of hunting and food grounds, but it is invariably divided into well defined local groups, each having its own portion of the common country. These are again divided into smaller groups, until the smallest unit consists of a few people of the same blood, under the direction and guidance of the oldest or most able of the elder men.‡ Thus a tribe is composed of a

* "Socially"—I use this term in a certain special sense—referring only to what I call the *socially* social organization. When I say that an Australian tribe is socially more advanced than others I do not mean that they have a better knowledge of the arts of life, but that their social organization is of a comparatively advanced type. And I take it that the line of advance is from group marriage to individual marriage, and from uterine descent to agnation.

I may note here that "individual marriage" does not necessarily imply monogamy. It is consistent with that form of polygamy under which a man may have more wives than one, he having an exclusive right to them, as against all the rest of his tribesmen.

† There are certain exceptions where, for instance, the husbands and wives are found to speak different languages, that is, different languages of the Australian stock, but this arises through the connubium between two tribes.

‡ In most tribes, if not in all, the old men constitute what may be called the Great Council of the tribe. For instance, in the Dieri, this council is composed of the heads of totems and of men of mark, such as warriors, counselors, orators, &c. The council has, among other functions, jurisdiction over breaches of tribal morality and offenses against the tribe. In short, it is the governing power.

number of local groups, and these are perpetuated in the same tracts by the sons, who hunt over the hunting grounds of their fathers. This has been termed by Mr. Fison and myself the "Local Organization."* But it is not the only organization of the tribe, for there is also what we have termed the "Social Organization," in which the tribe, as a community, is divided into two parts, which are quite distinct from the local groups just described.† Each of these two social divisions is, in many tribes, divided into two subgroups, and in all, except the most abnormal cases, there is a group of subdivisions to each class, or subclass, to which the convenient and well understood name of Totems may be applied.‡ These groups, subgroups, and totem groups have each a name, which is borne by every individual belonging to them. All the members of such a group are held to be parents and children, or brothers and sisters, as the relative ages of the individuals may determine. Thus we may distinguish between "own" and "tribal" parents, children, and brethren.

I use the term "primary classes" for the two principal social divisions; but it is certain that, in many cases, their designations are "animal names," and therefore the term "major totems" might be applicable to them. The tribe, therefore, is organized in two ways. On the one hand, it is divided *geographically*, either into what may be termed hordes with uterine descent, or into clans with agnatic descent; and, on the other hand, it is divided *socially* into classes with their subdivisions as above described. The two organizations are coexistent, and they are coextensive in their entirety, but the divisions of the one do not correspond with those of the other. For, while all the people who belong to any given *local* group are found in one locality alone, those who belong to any given *social* group are to be found distributed among many, if not among all, of the local groups. In order that we may clearly perceive the bearing of the facts as to marriage, descent, and relationship, which I shall place on record in this paper, it is very necessary to bear in mind this distinction between the local and the social organization of a tribe.§

* In order to avoid going over this ground, which would take up too much space, I may be permitted to refer to a memoir on this subject entitled, "From Mother-right to Father-right." Journal Anthropological Institute, August, 1882.

† Exceptions to this rule may be found in rare cases, where in certain advanced tribes the two organizations have come to be coincident; for instance, the Woiworung tribe of the Yarra River, in which the two totems of the community live in a number of local groups apart from each other. All the people in one locality are Eaglehawk, and in another they are Crow. It may be noted here once for all that the present tense is used in some cases where the past would be more appropriate, the tribes being all but extinct.

‡ Of course the word "totem" is, strictly speaking, the badge of a certain group. For the sake of convenience I use it also to denote the group which is distinguished by the badge.

§ This is a concise statement of what has been detailed more at length by Mr. Fison and myself in a paper entitled "The Deme and the Horde," communicated by us to the Anthropological Institute of Great Britain.

III.—THE CLASS ORGANIZATION.

In some communities there are only the two primary class-divisions, each with its group of totems. In others there are the two primary classes, each divided into a pair of sub-classes, and each of these pairs has a group of totems. In some cases this totem group is common to both of the two sub-classes to which it belongs; in other cases each sub-class has its own peculiar totems. In some exceptional cases the primary classes are wanting. In others the usual totem sub-groups are absent, but the primary classes, or their sub-classes, are themselves totems. Other exceptions are where the totems alone, or the classes alone, have survived. All these abnormal instances I have found to be connected with changes in the line of descent. The primitive and complete forms have uterine descent; and it is in cases where descent is counted through the male line that I find the most abnormal forms to occur. There are also intermediate cases. The changes in the class system, their variations, and their decay are therefore connected with the principle of agnation. To this subject I shall again refer. The decay in the class system of a tribe is, in fact, a symptom of profound changes in its social organization; and these changes, so far as I know, are invariably connected with the more pronounced influence of the local groups. The local organization becomes stronger as the social organization grows weaker.

The entire subject of the class organization, and the development of the class divisions and totems, is too large to be entered upon here; and for some further particulars concerning them I must refer to a brief memoir of mine, entitled Notes on the Australian Class Systems, which may be found in the Journal of the Anthropological Institute of Great Britain, for May, 1883. In order, however, to bring the class organization clearly into view, I subjoin that of the Dieri tribe of Central Australia, which will serve as the type of the less developed systems, and also as an illustration of the remarks I am about to make in this paper on the connection existing between the class groups and those indicated by the terms of relationship now in use.

Much of the evidence I am about to use will be taken from the customs of the Dieri and other kindred tribes, which, collectively, form a great allied group or "nation."* The letters and numerals, which are prefixed to the class divisions and totems in the following table, will serve for convenient reference.

*Independently of my own acquaintance with the Dieri and the allied tribes more than twenty years ago in their wild state, I am indebted to Mr. S. Gason for very full particulars as to the Dieri, in whose country he resided for six years as an officer of the South Australian mounted police, and of whose community he became an initiated member. As to the Kūnándabūri tribe, to which I refer, I have unfortunately much less information. For what I have, I am indebted to Mr. J. W. O'Donnell, formerly of Mount Howitt station, in that country.

TABLE I.—*Dieri class system.*

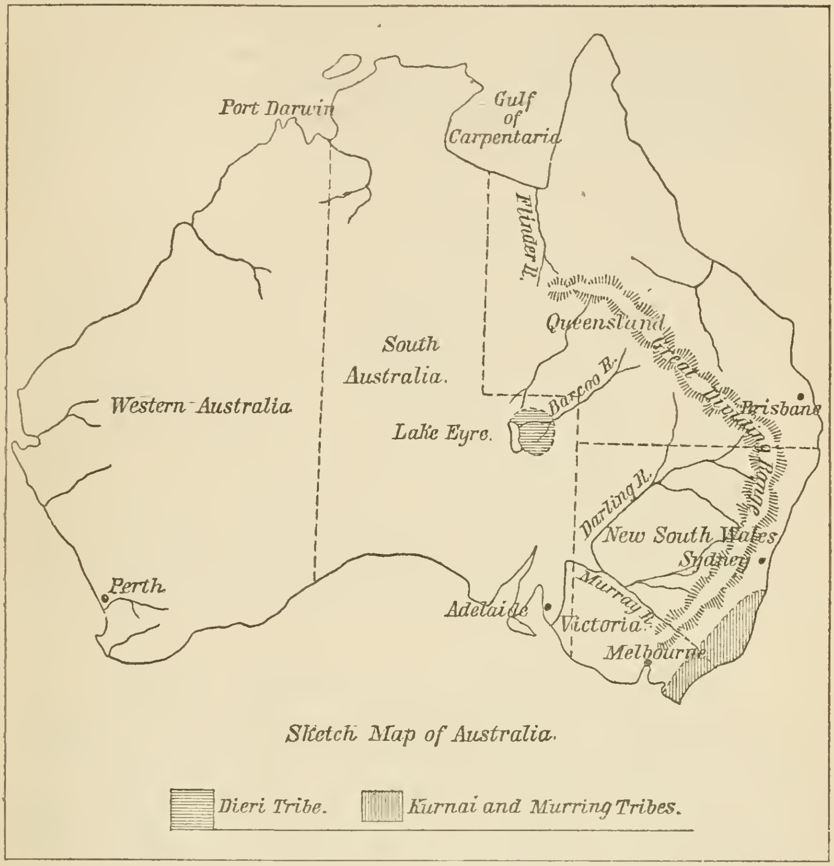
Primary divisions.	Totems.
A. Máttĕri	1. Karaura = eaglehawk. 2. Warūgati = emu. 3. Kintălā = native dog and thirteen other totems.
B. Kărărū	1. Tchūkŭrū = kangaroo. 2. Kauálka = crow. 3. Tidnamára = frog and sixteen other totems.

Every member of the community is either Matteri or Kararu. Each individual also bears one of the totemic names of the primary division to which he or she belongs.

This class system represents that of the Dieri, the Kunandaburi, and other kindred tribes, between whom there exists connubium. It also represents the systems which are found under various dialectic differences of nomenclature among tribes spread over a very large area in Central Australia. The members of one tribe know well which of their own divisions are the equivalents of those in neighboring tribes, even when the totemic names are not the same.

Before explaining the laws of these classes it will be well to say a few words about the Dieri and the kindred tribes making up the "nation" of which it is the most important member.

As shown upon the annexed sketch-map, the Barcoo River, in its numerous sources, the Alice, the Thomson, and many other streams, rises on the western fall of the Queensland Great Dividing Range, and thence has a general southwesterly course into the depressed region of Central Australia. Soon after passing from Queensland into the colony of South Austrália it begins to form a large delta, or a series of deltas, and its numerous branches water, and often partly submerge, a tract of country at least 20,000 square miles in extent. The various streams of this delta terminate in lakes, of which Lake Eyre is the largest. This delta country of the Barcoo—or, as it is called locally, Cooper's Creek—is one of the hottest and driest districts in all Australia—a country of sand-hills, of mud-plains subject to floods, of stony tracts, and of salt lakes. It is subject to great vicissitudes of climate, being in its extreme conditions a perfect garden of verdure after seasons of flood, while during long continued droughts it is little better than "a howling wilderness." This delta country on the eastern side of Lake Eyre is inhabited by the Dieri tribe. To the north, east, and south, and to the west also beyond the great lake—are other tribes allied to the Dieri by language, by custom, and by class system, all more or less intermarrying. Of these the Kunanduburi tribe is one of the farthest outlying to the eastward within the Queensland boundary on the main Barcoo River above the point at which the delta commences. Of all these tribes, as I have already said, the Dieri is the central and most important. Not only do its members consider themselves as being "the fathers of all the tribes,"* but these on their part regard the Dieri with mingled feelings of respect and fear.



Sketch Map of Australia.

The Dieri tribe may represent all the others. It is divided geographically into three sections, each of which takes the name of its principal locality, and these sections are again locally divided. Its social organization is based upon the division of the community into two classes, each with its group of totems.† Each totem is under the direction of a headman, who is the oldest of the name. Each man is what I may term the "totemic brother" of every other man and woman of his totem on the same level with him in his generation. An illustration will show how this works. When, for instance, a stranger arrives at a Dieri encampment from some neighboring tribe, the first question put to him is,

* Quoted from information supplied to me by Mr. S. Gason.

† The Dieri word for totem is Mŭrdū. This word has two meanings, one signifying "taste," the other "totem"; that is to say, one of those names of animals, birds, reptiles, fish, insects, or plants, which, according to the Dieri legend, the Great Spirit Mūramūra ordered the ancestors to assume when he instituted their class divisions.

"What is your totem ?"* This being ascertained, his totemic brethren take charge of him, protect him, and treat him with hospitality, even to the extent of providing him with a temporary wife of that totem with which his own intermarries.

These totems are strictly exogamous under the severe penalty of death. Thus, a man being A 1 (that is, Matteri and Eaglehawk; see Table I), may marry, according to the Dieri rule, a B woman of any of the B totemic divisions, and so on with A 2, A 3, &c., and *vice versa*, always provided that the parties do not stand to one another within certain close degrees to be hereinafter specified. Even casual amours between persons who are forbidden to each other, either by this nearness of actual kinship or by identity of class and totem, are regarded with the utmost abhorrence and are punished by death. Yet this rule differs somewhat in different tribes, for, among the Kunandaburi, the prohibition is relaxed upon a woman's marriage, when the *jus primæ noctis* includes all the men present at the camp without regard to class or kin.† Among the Dieri the rule is never relaxed on any occasion, and this tribe is, as I shall show, in some respects slightly in advance of the Kunandaburi, while both stand at the commencement of the long progressive series formed by all the Australian tribes concerning which I have hitherto collected data. At the other end of this series stand tribes such as the Kurnai, of Gippsland, whose class system has become almost extinguished, and whose local divisions have become agnatic clans.

IV.—THE RELATIONSHIP TERMS.—MARITAL GROUPS.

The terms denoting relationship which are used by the Australian tribes belong to the classificatory system of Dr. Morgan. After collecting and studying a great number from all parts of Australia, I have found that there are several types under which the relationship terms of different tribes may be arranged; and that they show a progressive change from a system of extreme simplicity to one, which, although still classificatory, has developed far more individual distinctions than our own descriptive system.

Looked at as a whole, these types show a progressive development, which is certainly connected with a progressive social change, indicated in most cases by the change in the line of descent. What I now propose is, not to enter upon a general discussion of the Australian relationship terms, but to point out the connection between them and the

* This question, "Minna murdu ?" can be put by means of gesture language, to which in the same way a suitable reply can be made. Thus it is possible to learn, at a safe distance, whether a stranger is friend or enemy, even more certainly than by using the well understood sign for "peace."

† This extreme and exceptional extension of the *jus primæ noctis* is given on the sole authority of Mr. J. W. O'Donnell, who resided for some years in the Kunandaburi country. I have not been able to obtain any further information on the matter.

class systems which I have described in the preceding pages. It will suffice for my purpose to show that the terms of relationship arise naturally out of thé relations of the class divisions to each other, and that these relations are those of group to group.

I find that the relationship terms of the Australian tribes fall into certain natural groups, of which I select three of the principal for illustration. These are the *marital*, the *parental and filial*, and the *fraternal;* and I take those of the Kunandaburi and the Dieri tribes for illustration.

TABLE II.

English.	Kunandaburi.	Dieri.
1. Accessory husband	Dilpa mali	Piraūrū.
2. Individual husband	Nūbaia	Nōa.
3. Husband's brother	Nubaia kodimali	Noa.
4. Sister's husband (F)	Nubaia kodimali	Noa.
5. Accessory wife	Dilpa mali	Piranru.
6. Individual wife	Nubaia	Noa.
7. Wife's sister	Nubaia kodimali	Noa.
8. Brother's wife (M)	Nubaia kodimali	Noa.

(M) means male speaking; (F), female speaking.

The first terms in these lists challenge attention. In all these tribes there are two kinds of connections, which we may term marriage. One where two individuals are allotted to each other permanently, often in extreme youth, by their parents. The other where a man and a woman are allotted to each other as "accessory spouses," each of whom may stand in the same relation to other individuals of the opposite sex.

The exact nature of this second kind of marriage I shall now consider; and I take the Dieri instance for illustration. The relation is called Pirauru,* and the various Piraurus are allotted to each other by the great council of the tribe in secret session, after which their names are formally announced to the assembled people on the evening of the ceremony of circumcision, during which there is for a time a general license permitted between all those who have been thus allotted to each other.

The following précis of Mr. Gason's valuable information shows the precise nature of this Pirauru relation:

1. Each Dieri man, or woman, is the Pirauru of some other Dieri woman, or man.

2. The relation of Pirauru may exist between men and women of different local groups, or of different tribes.

3. The relation of Pirauru may not exist between a person and those who stand to him or her in any one of the following relations: Father, father's brother, father's sister, mother, mother's sister, mother's brother,

* The only derivation I can give for this word is from Pira=moon—also used for the round wooden bowls made by the Dieri—and ūrū=circular. The great councils of the tribe are always held at full moon, and Pirauru may possibly be taken as having relation to the time when these couples are allotted to one another. I however offer this explanation with some diffidence.

brother's child, sister's child, brother, sister, or any of those whom we ourselves call "cousins," either on the father's or on the mother's side.

4. Nor may it exist between persons of the same totem, for these are regarded as brother and sister, or (the Dieri having uterine descent) mother and son, as the case may be.

5. A Dieri man, having passed through the Míndraí (peace) ceremony, may have a Pirauru allotted to him.*

6. The Piraurus being allotted to one another at each great council previous to the ceremony of circumcision, a man, or a woman, being already Pirauru, may thus acquire a new Pirauru relation in addition to those previously acquired. Hence in time any individual may come to have several Pirauru.

7. Seniority in the man regulates the temporary right to any given Pirauru. Thus, supposing an older man and a younger to be in camp together, and that the latter had with him a Pirauru, the former, being alone, the older man could lawfully claim the woman, if she were Pirauru to him also.

As the Piraurus cannot be of the same class name we have here a number of men belonging to one class married collectively to a number of women of the other class. Thus a number of A men (see Table I) are the Piraurus of a number of B women and *vice versa;* and this is clearly a form of group marriage, which, when the two classes meet at the tribal ceremonies, becomes what may be called regulated communal intercourse between the sexes. At other times, when the community is scattered over the tribal country, a man may be found having with him at one time one or more Pirauru, and at another time other women who stand in this relation to him; or a woman may be found living with several men who are Pirauru to her. To those unacquainted with the custom this presents the aspect of lawless license, or of polygamy, or of polyandry, but it is in fact group marriage.†

The terms Dilpa mali‡ and Pirauru signify the same relation, the one among the Kunandaburi and the other among the Dieri. They are the terms of relation between two groups, and these two groups in the widest sense are the class divisions A and B (Table I). Here, then, in a

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*Before being fully admitted into membership in the community a youth must pass through the following ceremonies: 1. Chirinchiri—knocking out two front teeth. 2. Kurawali wonkana—circumcision of boys. 3. Wilyaru—anointing with the blood of an old man. 4. Mindari—the peace ceremony, when the entire community assembles.

There is also an additional rite to which only certain individuals, selected by the old men, are subjected. This is *Kūlpi*, the slitting of the urethra.

†The Pirauru custom clearly accounts for the so-called polyandry of the Nairs. (See Mr. J. F. McLennan's Studies in Ancient History, p. 148.)

‡The term Dilpa mali I cannot explain. I am told that the word kodimali means "nothing," in the sense of negation of something of which Nubaia is the expression.

modified form, and in actual existence, is what I have elsewhere called the Divided Commune.*

Besides this form of group marriage there is also individual marriage in the tribes. This is the Noa relation, the features of which can be thus summarized.

1. The relation of Noa can only exist between a man and a woman of different class names and totems, who, moreover, are not within certain prohibited degrees of relationship to each other.

2. A woman becomes the Noa of a man most frequently by being betrothed to him when she is a mere infant, he being perhaps a young man. In certain cases she is given by direction of the great council as a reward for some meritorious act on his part.

3. A man may be Noa to two or more women, but a woman cannot be Noa to more than one man.

4. But a woman who is Noa to one man may also be Pirauru to several other men.

5. The right of the Noa overrides that of the Pirauru. Thus a man cannot claim a woman who is Pirauru to him when her Noa is present in the camp, excepting by his consent. It is not often, however, that the male Noa refuses to accommodate the Pirauru temporarily, for he is liable to have a refusal retorted upon himself. But he will more freely lend his Pirauru than his Noa. Such cases, however, are the frequent causes of jealousies and fights.

6. When a man is sent on a mission to another tribe he never takes his Noa with him. It is understood that, on such occasions the female companions of these "ambassadors" are to be perfectly complaisant to all the men of the visited tribe who do not stand to them within the prohibited degrees; and it is held that for this purpose a man's Pirauru is better fitted than his Noa. Yet this Pirauru is of course the Noa of some man who remains at home.

7. The relationship of Noa may exist between individuals of any of the allied tribes, always provided that there is no obstacle of class or other prohibition. Such arrangements between individuals of different tribes are often, perhaps most frequently, brought about by the great council, as tribal alliances, and are the subject of much diplomatic negotiation.

The Noa of the Dieri is the same as the Nubaia of the Kunandaburi. But the marital group of the latter has a most archaic simplicity, showing a group relationship even more extended in theory than that which

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* See Kamilaroi and Kurnai, passim. I may take this opportunity of saying that I doubt whether, even under an "Undivided Commune" there could have been anything more than a limited promiscuity, excepting when the whole community occasionally reunited. The general conditions of savage life on the Australian continent would not permit an entire undivided commune to remain united for any length of time in the same locality. The Dieri practice may show us, in a modified form, what might take place. The common Pirauru right exists, but it cannot be fully exercised excepting when the whole tribe assembles. Then, and then only, does the Pirauru group of A men (or the Pirauru group of B men), with its female Pirauru, temporarily resemble what one might suppose an undivided commune to be.

the Pirauru of the Dieri gives in actual practice. This, however, is in accord with the general customs of the Kunandaburi, who are the least advanced of all the tribes known to me. While, with the Dieri, the sexual intercourse of persons who, according to their notions, are too nearly related is forbidden under all circumstances by a death penalty; with the Kunandaburi, there is, according to Mr. O'Donnell, no such restriction on the occasion of the marriage of a betrothed girl. This gentleman also says that, though it is considered improper that there should be intercourse between women and their husbands' own brothers, or between men and their wives' actual sisters, such intercourse constantly takes place with little more than a mere pretense of concealment.* The Dieri would regard this as abominable—at least, if the Noa were present in the camp—and yet the third, fourth, seventh, and eighth relationship terms (Table II) show that, in all probability, it was once their practice, as it still is, in at least one of the tribes composing the group to which they belong.

In tribes such as those with which I have been dealing, the terms of relationship fit in more or less completely with the actual group relations of the class divisions and their members. The inference to be drawn theoretically from an inspection of the terms is that a group of tribal brothers have their wives in common, and that a group of tribal sisters have their husbands in common. When this is compared with the actual custom now prevalent among the tribes inhabiting the Barcoo delta, it is found, as I have already stated, that the contemporary generation† of each class division is composed of "brothers and sisters"; that the men of one class, who are thus "brothers" to one another, marry the women of the other class, who are thus "sisters" to one another; that at all times there is between the intermarrying groups a modified communal right, which becomes general among those who have been allotted to each other as Pirauru; and that the marital rights, which are inherited in common under the laws of the social organization, are controlled and restricted by the local organization through the great council of the tribe.

It now remains to be seen how far these conclusions are borne out by an examination of tribes in other parts of the Australian continent.

Of all the tribes which I have hitherto met with the least advanced socially (that is, as to their social organization) are those of Central

*Mr. Fison tells me that this was the case in some, at least, of the Fijian tribes. And, after this memoir was completed, information reached me from Mr. S. Gason that "the law allows intercourse" between these parties, but only in the absence of the Noa.

†The word "generation" is of uncertain meaning, and its use may be misleading. I do not use it as implying a line of ascendants and descendants. Nor do I use it in the common acceptation as "the present generation," which includes all those now living, as distinguished from those who are gone, and from those who are yet to come. Perhaps the best among several unsatisfactory definitions which suggest themselves is that I mean by it "all those on the same level in a generation." Thus, all the young people who are marriageable would be on the same level in the generation to which they belong.

Australia; the most advanced are those which are found along the southeastern coast-line. These can be taken as the two extremes of a series in which all the tribes I have examined can be arranged according to their social status. I am not prepared to show all the causes which have advanced the coast tribes far beyond those in the center of the continent, but this much may be ventured upon, that the social advance appears to be connected with a more favored climate, and the greater abundance and regularity of food-supply consequent thereupon.

The tribes which I have already described have a marked social organization with uterine descent. In the tribes with which I am about to deal the social organization has been profoundly modified, and in some cases even extinguished all but the faintest traces; while, in an equal degree, the local organization has gained strength, and taken to itself all the powers which the social organization formerly possessed. For comparison, I take the Kurnai and the Coast Murring tribes, which stand near the end of the series, at whose other extremity are the Dieri and Kunandaburi.

The Kurnia tribe inhabit Gippsland and the Coast Murring the country extending from the confines of Gippsland along the southeastern coast towards Sydney. For the purposes of this memoir the Shoalhaven River may be taken as their approximate limit in that direction. The two tribes touch at Mallagoota Inlet, where their extreme local sections intermarry.*

The Kurnai tribe is divided into five large clans,† which again are divided into local subdivisions, until the smallest group consists of only a few members. Of class divisions the Kurnai have none, and the only remaining traces of totems are two birds, the name of one of which is borne by all the males and that of the other by all the females of the tribe. Traces of the two great class divisions of the stock from which the Kurnai are probably derived—the classes Eaglehawk (Būnjil) and Crow (Waa, or Ngarūgal)—are found in the application of Būnjil to all the old men of the tribe, and in the extreme reverence felt for the crow. The Kurnai believe that it can talk their language, and that it is in the habit of warning them of approaching danger. In this tribe the class organization, so far as it affects marriage, is extinct. The local organization, however, has stepped into the place thus left vacant. It has assumed authority over marriage, and it regards all those who were born in the same locality as necessarily so near in blood as to be forbidden to each other in marriage. A man therefore is compelled by this rule to seek a wife in some more distant part of the tribal territory, and from certain local groups, to the exclusion of others. Moreover, in this tribe the remarkable custom of marriage by elopement has become developed to such an extent that only under exceptional circumstances can a man obtain a wife in any other manner.

* For further details as to the remarkable organization and customs of this tribe, see "Kamilaroi and Kurnai," Robertson, Melbourne.

† I use the word "clan" advisedly here, because this tribe has agnatic descent. The term "horde" I use for local divisions of tribes having uterine descent.

In this tribe marriage is individual, as in the Noa practice of the Dieri; but men are never known to lend their wives to others,* nor does anything like the Pirauru custom obtain. Nevertheless, there are certain occasions when a practice arises similar to that of the Dieri, but under the restrictions placed on the union of the sexes by *locality* and not by *class*. In the case of marriage by elopement, the woman becomes for one day, under the *jus primæ noctis*,† the common property of the bridegroom's "comrades." The faithless wife also becomes the common property of the men who pursue her, until she is taken from them by her husband or her brothers. On occasions such as the appearance of the Aurora Australis, the supposed impending danger to the tribe is believed to be averted by a temporary exchange of wives by order of the old men.

The coast Murring consists of several tribes, or rather, large clans, which have local names, but to which collectively the name of Murring (=men) is applied. These clans are again divided and subdivided down to the smallest groups of a few individuals, each under the direction of its oldest man. The large groups are governed by old men, who combine the attributes of age and of powerful "magic," and the oldest and most powerful wizard is the master (Bīamban) of them all.‡

In the Murring tribes the class system is not completely extinct. There are not the two primary classes, but there are numerous totems. These descend, not from mother to child, as in tribes having uterine descent, but from father to child, and in some localities they are borne in duplicate. They are scarcely regarded as names, but still they have a power over marriage, for no man may marry a woman of his own budjan (totem). The principal control over marriage is, however, in the local organization; for the rule is very strict that no man may marry in his own locality. He must obtain a wife from certain fixed localities at a distance from his own. In these tribes wives are obtained by the exchange of sisters—own or tribal—under the arrangement of the respective fathers. The only occurrence of any of the primitive forms of license with which I am acquainted, is when a visitor from a distance is provided with a temporary wife by the hosts. Also, in cases of elopement, when the woman is captured, she becomes for a time the common property of her pursuers. With these exceptions, marriage seems to be strictly individual.

I now give, in a tabulated form, the terms applicable to the marital group as used by the two tribes under consideration, for comparison with the Dieri and Kunandaburi terms given in Table II.

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* This applies, of course, to purely native custom as it prevailed before the incoming of the white men. The mere immorality resulting from the contact of the two races is not taken into account.

† "Comrades" (Brogan.) See a paper on the Kurnai Jeraeil, communicated by me to the Anthropological Institute of Great Britain.

‡ This "master" must not be taken as the equivalent of the "hereditary chief," found in more advanced tribes, such as the Fijians, &c.

TABLE III.*

English.	Kurnai.	Murring.
1. Accessory husband		
2. Husband	Bra	Tanamā.
3. Husband's brother	Bra	Nâjandŭri.
4. Sister's husband (F)	Bra	Najanduri.
5. Accessory wife		
6. Wife	Maian	Tanama.
7. Wife's sister	Maian	Najanduri.
8. Brother's wife (M)	Maian	Najanduri.

(F) means female speaking; (M) male speaking.

* The Kurnai terms are one of the two dialects spoken by that tribe. It is called Mŭkthang. Muk = true, superior, eminent; Thang = speech. Mukthang therefore is the language par excellence. The Murring terms are in the language called Tharawal, which is spoken by the coast Murring tribes adjoining the Kurnai. It is unintelligible to the Kurnai, as their speech also is to the Murring; and yet the border clans of the one tribe intermarry with those of the other. Here we find an easy explanation of the fact that among savages husband and wife sometimes speak different languages.

An examination of these terms shows, in those of the Krnai, an archaic simplicity which I can only account for on the supposition that they owe their preservation to the extreme isolation of the tribe, arising from the geographical features of their country, which render it extremely difficult of access. No distinction is drawn between the husband, his brother, and the wife's sister's husband. These terms do not fit the existing relations as marked by individual marriage, the exclusive right of the husband to his wife, the absence of the Piaruru practice, and the male line of descent. But they more clearly accord with the relations which arise on exceptional occasions such as those I have mentioned. The custom on these occasions is analagous to that of the Pirauru, and to this practice the relationship terms of the Kurnai apply, and indicate a possibility of its former prevalence as a custom.

In the Murring terms a distinction appears between the second and the third and fourth, as well as between the sixth and the seventh and eighth, indicative of individual marriage.

V.—THE PARENTAL AND FILIAL GROUPS.

I now return to the Dieri and Kunandaburi tribes for illustrations of these groups, which I take together as follows:

TABLE IV.

English.	Kunandaburi.	Dieri.
1. Mother's Pirauru		apiri waka.*
2. Father	urninu	apiri, or apini.†
3. Father's brother	kauali	apiri waka.
4. Mother's sister's husband		apiri waka.
5. Father's Pirauru		andri waka.
6. Mother	amundi	andri wandrini.
7. Mother's sister		andri waka.
8. Father's brother's wife		andri waka.
9. Son of Pirauru (M)		atamŭra waka.
10. Son of Noa (M)	karaga	atamura, or atamurini.
11. Brother's son (M)		atamura waka.
12. Wife's sister's son (M)		atamura waka.
13. Son of Pirauru (F)		atani waka.
14. Son (F)	worua	atani.
15. Sister's son (F)	worua	atani waka.
16. Husband's brother's son (F)		adada.

(M) means male speaking; (F) female speaking.

* Waka = little.

† Apini, according to Mr. Gason, means "my father" as "signifying a relation without doubt." It is evidently an abbreviation of apiri = father, and ani = I. A little difference exists between Mr. Gason's method of spelling the native words and my own. I have followed as nearly as possible the pronunciation which I remember to have heard from the natives themselves when I was in their country.

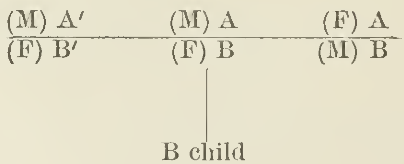
I regret that the Kunandaburi list is so meager, but unfortunately my source of information ran dry before my inquiries could be completed. There are, however, enough taken together with the previously given marital relations, to suggest a similarity to those of the Dieri. The third term, if further inquiry shows it to be correct, is a deviation.

The custom of Pirauru must necessarily produce doubt as to the paternity of children. A Dieri woman rarely admits that any particular man is the father of her child.* I have shown that it is the group of A men who cohabit with the group of B women (Table I) and *vice versa*, and that the whole group of women to which the mother of any given child belongs are also regarded as its mothers. But a distinction is drawn between the mother's Pirauru and her Noa. With the latter she habitually cohabits. She was specially given to him by her father, or by order of the great council. Hence he claims the right to dispose of her daughter in marriage, and her children call him Apiri=father, or Apini=father-to-me, while they call her Pirauru Apiri waka, that is to say, "little father." Here we can see the commencement of individual marriage, and of the more precise notions of descent which follow it.

The man's Piraurus are called the mothers of all the children of his Noa; that is, of all the children of the woman with whom he habitually cohabits. But they are the andri waka, that is to say, the "little mother" of those children, while each child's own mother is its andri= mother, or andrini=my mother.

Hence a man is the "own" father of all the children of his Noa, but the "little father" of the children of his Piraurus. It follows that if every woman is Noa, every child must have some Apini, *i. e.*, some "particular father," and *patria potestas* can begin.

Given the cohabitation of a group of A men with a group of B women, as I have shown it to exist, the men being "own" or "tribal brothers," it follows naturally that each one is the father in common of all the children. This we see expressed in the classificatory terms tabulated by me (Table IV). The "father's sister's husband" is not included in this group of fathers. He is kaka, not apiri. The reason of this will appear from the following diagram.†



The diagram shows why the father, father's brother, and mother's

* Informant, Mr. S. Gason.

† Explanation of diagram.—A and B are the two intermarrying groups. (M) A and (M) A′ are brothers, (F) A is their sister. (F) B and (F) B′ are the wives of (M) A and (M) A′. (M) B it the husband of (F) A. B is the child of (M) A and (F) B. (M) = male; (F) = female.

sister's husband are all "apiri," for they are of the same group, (M) A, which is Pirauru to group (M) B. The mother's brother and the father's sister's husband—who are the same group individual—are both Kaka, and form part of another marital group, (M) B.

I have said that in spite of the Pirauru system, and the consequent uncertainty as to actual paternity, there is, nevertheless, a tendency to attribute the paternity to the man who habitually cohabits with the mother of the child; that is to say, who is to her in the relation of Noa, which, indeed, is inchoate individual marriage. He is the "father" of the child, while the mother's accessory husband is only the "little father." Morever, he claims the right to dispose of the daughter of his Noa in marriage, though she may be *de facto* the child of any one of her mother's Pirauurus.

This rests upon a belief which is not peculiar to the Dieri. I have found it in every Australian tribe, without exception, with which I have acquaintance. This belief is that the child is derived from the male parent only, and that the mother is no more than its nurse. As a black fellow once put it to me, "The man gives the child to a woman to take care of for him, and he can do whatever he likes with his own child." This is so wonderfully like Apollo's well-known dictum in the Eumenides as to be positively startling when heard from the lips of an Australian black; but the foregoing is not the only instance within my knowledge in which the belief has been expressed by the aborigines. The subject well merits full discussion, but, as it involves the important question of the change of descent from the female line to that through males, I defer its further consideration to the penultimate section of this memoir.

I now offer for comparison with the parental and filial terms of relationship among the Dieri and Kunandaburi, those of tribes who are socially more advanced.

TABLE V.

English.	Kurnai.	Murring.
1. Father	mungan	banga
2. Father's brother	mungan	nadjung
3. Mother's sister's husband	mungan	kauang
4. Mother	yukan	minga
5. Mother's sister	yukan	minung
6. Father's brother's wife	yukan	minung
7. Son (M)	lit	wurun
8. Brother's son (M)	lit	wurun
9. Wife's sister's son	lit	wurun
10. Son (F)	lit	wurun
11. Sister's son (F)	lit	wurun
12. Husband's brother's son	lit	wurun

(M) means male speaking; (F) means female speaking.

I have found the study of the development of the terms of relationship used by the Australian aborigines to be one of extreme difficulty. When arranged in groups, as I have arranged them, the terms of one group do not logically follow out those of the antecedent group, as do the terms used by savage and barbaric tribes in other parts of the world collected and arranged by Dr. Morgan in his magnificent work on systems of consanguinity and affinity. For instance, it is rare to find that the terms of the filial group follow logically those of the parental group. As a general rule, the latter has departed farthest from simplicity. The Murring list is a case in point. (See table.) Nor have I found that the actual social status of any Australian tribe in the present day can be inferred from an examination of the terms of relationship alone. In all cases it is evident that the actual status of the tribe is in advance of the status theoretically deducible from the terms of relationship. This is significant and points to social development. The most extreme case within my knowledge is that of the Kurnai; and I have selected it partly for this reason, and partly because I am better acquainted with the customs of this tribe than with those of any other. It is a good example of the preservation of an archaic type under changed conditions.

In the Kurnai terms we have precisely the analogues of the Dieri; but, as I have already pointed out, the Kurnai have no Pirauru practice, and indeed would look upon such a custom with horror. Nevertheless, as I have said, they did on occasions permit a license which to my mind strongly points to its former existence with them as a custom. Moreover, the terms given for the parental group point to such a form of group marriage, and those for the filial group strengthen this inference.

The Murring, in their tribal organization, their individual marriage with a strong obligation of fidelity on the part of the wife, and their agnatic descent, much resemble the Kurnai; in fact, both these tribes may be said to stand nearly upon the same social level, but the former has relationship terms considerably more differentiated than those of the latter. Yet in these the filial group still retains the extreme simplicity found in the relations of tribes who have group marriage still actually existing, the only difference being that the Murring terms for "father's brother" and "mother's sister's husband" are differentiated from that for "father," as also are the terms for "mother's sister" and "father's brother's wife" from that for "mother."

In both the Kurnai and the Murring tribes, however, there is a distinction made between the terms of the parental group which is worth noting as indicating severally two processes of differentiation. While the Murring have separate terms to distinguish the father, the father's brother, and the mother's sister's husband, who, under the Pirauru practice of the Dieri, may all be married in the group to the same woman, the Kurnai make no distinction between these terms excepting by adding the word "brebba" to the term implying paternity. The "own father" is Mungan, while the father's brother and the mother's sister's husband are Brebba mungan; that is to say, "the other father." This distinction, however, is rarely used in ordinary parlance, though it comes out when particular inquiry is made as to the relationship.

VI.—THE FRATERNAL RELATIONS.

The class divisions, viewed in their Pirauru relation, produce two marital groups, and, as a necessary consequence, they also produce parental and filial groups. The Pirauru relation also creates, as a matter of course, a group relation between the children of the Piraurus. It ought to be found, and it is found, that the children of the Pirauru group recognize one another as brothers and sisters. Moreover, all the children of any given Noa are brothers and sisters of the Pirauru group to which that Noa belongs. But when, in any particular part of that group, a man habitually cohabits with his Noa and with a Pirauru, and the children of the two women are brought up together, Mr. Gason tells me that there is a recognition in this family of a superiority in the children of the former over those of the latter. This fact is of the very greatest importance, for it brings us to the dawning of birthright.

The fraternal group, as shown in the class divisions, embraces all those on the same level in a generation who are of the same class name, but more especially all those who are of the same totem, which is nearer to the individual than is the class. The "totems-men" succor one another as a matter of course in all tribes in which, as in the Dieri, the social organization is vigorous. Where, however, it has been superseded by the social organization, as among the Kurnai, it is the members of the local group who aid each other, and this bond is strengthened by the far-reaching relationships in this tribe, such, for instance, as that of "brother" In all these cases the individual recognizes and carries out the obligation laid upon him by the group of which he is a member.

As it seems to me, the division of the community into two primary classes and lesser divisions has evidently been brought about with intention* to prevent those connections between brother and sister, and other near relations, which are looked upon by the blacks with the utmost abhorrence. The prohibition extends beyond the children of the same parents, and prevents the union of those who are of the same class name or totem. The group relations which, as I have shown, spring naturally out of the class divisions and their laws, also forbid the marriage of all who are within the fraternal relations. But in the less advanced tribes I have met with an instance where the prohibition is not a perpetual injunction never, under any circumstances, to be broken. In the Kunandaburi tribe the prohibition is relaxed on the

* This is opposed to the commonly-received notion that the lower savages are mentally incapable of perceiving and dealing with such questions. But the fact is beyond dispute that they do perceive them, and discuss them freely among themselves, the women taking an active part in the discussion.

occasion of a girl's marriage, when, according to Mr. O'Donnell, her favors may be shared "by all the males present in the camp without regard to relationship." In the Dieri tribe, however, the prohibition, as regards intercourse between those who are within the fraternal relations, is never relaxed. No greater offense can be offered to a Dieri man or woman than to call him or her "Bñyūlū párchana," which means, according to Mr. Gason, "nearest relatives," or, in its understood sense, "incestuous intercourse between near relatives." Among such are all those who stand in the fraternal group relation to one another.* That this group relation is a real one to the Dieri is proved by the fact that such an offense is punished by the great council of the tribe with death.

In the more advanced tribes, where the social organization has given way and is more or less approaching extinction, if not utterly extinct, the fraternal group survives as long as a single totem remains in existence, as in the coast Murring. And, where the totems are gone, it becomes transferred in a modified form to the local group, whose members are then thought to be so "near to each other" in blood as to be forbidden in marriage. It is well to remember that this local group has, in all cases, even where uterine descent is strongest, been perpetuated in the same place from father to son by occupation, I may almost say by inheritance, of the hunting grounds.

The relationship terms of different Australian tribes, which I have collected and tabulated, show three types of the fraternal group.

First. All the descendants of several brothers or of several sisters are still brothers and sisters mutually; and this relationship descends in an ever-expanding fraternal group. Such an instance is that of the Kurnai tribe.

Second. The descendants of several brothers are differentiated from the descendants of several sisters; so that two fraternal groups come into existence, each of which is still fraternal within its own limits, but is not so towards the other group. Nevertheless, the prohibition as to marriage between the members of the two groups still obtains. The new relation thus arising, finds expression in a reciprocal term such as the "Kami" of the Dieri (Table VI). Taken in the widest sense, the contemporary generation "on the same level" in the intermarrying divisions A and B (Table I) may be said to be "potential spouses" to one another; but the marital privilege is restricted by what we may call an "inner regulation" when two "Kami," male and female, are the children of own brother and sister respectively.

Third. The fraternal relations tend to become restricted to the children of one pair. There is also a tendency to a multiplication of distinct-

*This prohibition includes not only "brother" and "sister," but also the "cousins" who are indicated by the term "kami." (See Table VI.) Although the kami belong, respectively, to the two intermarrying class divisions, the nearness of blood stops the marital right. We have here a prohibition counted through the male line in a tribe which has uterine descent.

ive terms, thus more or less differentiating from each other, the Kami numbered 9, 10, 11, 12, in Table VI. Such an instance is that of the Gournditch Mara tribe of Western Victoria.* It is instructive to note that the old fraternal terms still linger, attached to the children on the maternal side in accord with the uterine line of descent. The change has taken place on that side which leans towards agnation.

Although I have not found it possible to determine with any degree of certainty the social status of any tribe from an inspection of its relationship terms, yet on the whole I may venture to say that in general the type of system, according to which the terms are arranged, is correlated in some degree with the social position of the tribe using them.

These discrepancies between ancient custom on the one hand, as theoretically inferred from the terms of relationship, and present usage on the other, as ascertained by careful observation, render it most difficult to bring the facts briefly into order, and so to marshal the evidence as to show clearly to others that which an acquaintance with a large collection of relationship terms from many tribes enables me to perceive. To bring this out with the necessary clearness would require a detailed statement of all the evidence in my possession, and, this of course, is impossible within the limits of this paper. The subjoined table, however, will serve in some degree to illustrate the preceding remarks.

TABLE VI.—*Fraternal relations.*

English.	Kurnai.	Dieri.	Gournditch Mara.
1. Elder brother	Tundung	Negi	Wurti.
2. Younger brother	Bramung	Ngattata	Kokong.
3. Elder sister	Bau-ung	Kaukū	Kaki.
4. Younger sister	Lunduk	Ngattata	Kokoyar.
5. Father's brother's son	Tundung or Bramung	Negi or Ngattata	Wawurt.
6. Father's brother's daughter	Bau-ung or Lunduk	Kauku or Ngattata.	Wangya.
7. Mother's sister's son	Tundung or Bramung	Negi or Ngattata	Wurti or Kokong.
8. Mother's sister's daughter	Bau-ung or Lunduk	Kauku or Ngattata.	Kaki or Kokoyar.
9. Father's sister's son	Tundung or Bramung	Kami	Benangar.
10. Father's sister's daughter	Bau-ung or Lunduk	Kami	Kamutch.
11. Mother's brother's son	Tundung or Bramung	Kami	Benang.
12. Mother's brother's daughter	Bau-ung or Lunduk	Kami	Kamutch.

The speaker may be either male or female.

VII.—RESTRICTIONS UPON MARRIAGE.

In the far-reaching fraternal relations explained in the previous section there is an equally extended prohibition of marriage. The relationship, which is recognized between the persons constituting this large group of contemporaries, not only prevents there being any intermarriage between them, but even a casual amour is regarded with abhorrence; and, as I have already noted, it may be punished capitally under the moral law of the aborigines. But this restriction is not con-

* See Kamilaroi and Kurnai, p. 274. Since the publication of that work I am indebted to the most obliging inquiries of Mrs. Stähle for further information concerning the Gournditch Mara. I now learn that it has a class system almost identical with that of the Wotjoballuk noted in this memoir.

fined to the fraternal groups, for it necessarily also affects the parental and filial groups with which they are connected. These restrictions arise out of the relationships resulting from the action of the laws which regulate the class divisions of the community. Other equally stringent restrictions are connected with the local divisions of the people. I shall now briefly note what they are, and show how all these restrictions affect the choice of a wife, not only within the tribe, but even beyond it in neighboring tribes with which there is connubium.

1. *Prohibition arising out of the class and totem restrictions.*—The prohibition as to class divides the whole community into two halves, coinciding with those divisions, which, for convenience of reference, I have called A and B* (Table I). By this arrangement a man is restricted in his choice of a wife to one-half of the community. The women of this half are his potential wives, and he obtains either one or more of them according to certain circumstances which limit his inherited right. In some tribes the totemic regulations still further restrict his choice to one totem out of as many as perhaps a dozen which compose the class. As an illustration of the simpler case, I take the Wotjoballuk tribe of Northwestern Victoria.†

The social organization of this tribe is somewhat peculiar, and may be thus tabulated.

TABLE VII.

Primary class divisions.	Totem divisions.	Subtotems.
A. Krokitch	1. Hot wind*	Each totem has subordinate to it a number of objects, animal or vegetable, *e. g.*, kangaroo, red gum-tree, &c.
	2. White crestless cockatoo	
	3. Belonging-to-the-sun	
B. Gamutch	4. Deaf adder	
	5. Black cockatoo	Do.
	6. Pelican	

* I have omitted the original words as useless for my purpose.

Descent in this class system is uterine. A and B are the two great primary divisions, which, under different names, extend across the Australian continent.‡ The peculiarity in this Wotjoballuk system is that the primary classes divide into six subclasses which are totems, and that each totem class has associated with it a larger or smaller group of what I have called subtotems, but which might be appropriately termed pseudo-totems. They appear to me to be totems in a state of development. Hot wind has at least five of them White cockatoo has seventeen, and so on for the others. That these subtotems are now in process of gaining a sort of independence may be shown by the follow-

* In many tribes, as I have already noted, A and B again divide into four subclasses, *e. g.*, the well-known Kamilaroi Ipai-Kumba (A) and Murri-Kubi (B). But since this arrangement, though it extends over a vast area, is not found among the tribes specially dealt with in this paper, I do not take it into consideration here.

† Wotjo=men, balluk=people.

‡ I have now identified with each other the primary classes in their various forms from Mount Gambier to near the Gulf of Carpentaria; that is to say, practically across the whole north and south extent of Eastern Australia.

ing instance; a man who is Krokitch-Wartwut (Hot wind) claimed to own all the five subtotems of Hot wind (three snakes and two birds), yet of these there was one which he specially claimed as "belonging" to him, namely, Moiwuk (carpet-snake). Thus his totem Hot wind seems to have been in process of subdivision into minor totems, and this man's division might have become Hot wind carpet-snake had not civilization rudely stopped the process by almost extinguishing the tribe.

Marriage in this tribe might take place between a totem of one class and any totem of the other class. Thus a man of A 1 might marry a woman of B 4, or B 5, or B 6, and so with the other totems. The subtotems have no influence on marriage. In this tribe, therefore, the class law prohibits a man from marrying one-half of the women in the community.*

2. *Prohibition arising out of blood relationship.*—By the action of the primary divisions a man is restricted in his choice of a wife to one-half of the women. Of these again a certain number are ineligible by reason of their standing in some of the forbidden degrees of relationship to him. In the Wotjoballuk tribe with uterine descent, all the women standing to an aspirant in the relation of "father's sister" are forbidden to him, as also are all the daughters of these women. Nor would he be permitted to take the daughter of his mother's own brother, although, being of the class intermarrying with his own, she belongs to the group of women, who, according to the general class law, are his "potential wives." Further than this, by the class law itself, all the daughters of his father's brothers, as well as those of his mother's sister's, are held to be too near in blood to admit of a lawful union with them. It must be remembered that in this tribe marriages were settled by the elders, the girls being betrothed often in early childhood, so that those who made the marriages were not liable to be swayed by passion, but could calmly consider how far any proposed alliance was or was not admissible. It must also be remembered that the relatives which I have spoken of as individuals are in fact groups, and that individuals counted in these groups came into them through others—in other words, that they are "very far away" group relations. The prohibition as to some of these might be disregarded where all else was desirable; but otherwise they would certainly be insisted upon, and probably by the old women of the tribe more strenuously than by any one else.

3. *Prohibition arising out of locality.*—A further prohibition arises out of locality. Local proximity by birth is quite an insuperable obstacle to marriage in many tribes, in which a man is absolutely forbidden to

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* The four classes into which A and B divide in the Kamilaroi and many other tribes restrict matrimonial choice to one-fourth of the women. And, after the completion of this memoir, I received from Mr. Allan M. Giles, of Tennant's Creek, Northern Territory, an extremely interesting and valuable communication on the Waramunga tribe, which is divided into eight classes, demonstrably subdivisions of the four classes above mentioned. The Waramunga classes limit the choice of a wife to one-eighth of the women.

marry a woman of the same subhorde or sub-clan. However eligible she may be in other respects, the fact that both parties belong to the same locality is held by certain tribes, the Kurnai for example, to make them "too near each other," that is, too near in blood. Even in some of the tribes which have uterine descent and a vigorous class system I find this to be the case; and bearing in mind what the Pirauru practice really is, one can easily understand how all the people of any given horde may come to consider themselves, and with good reason, too nearly related to admit of marriage without mixing the same "blood" or "flesh."

In tribes where the classes and totems have been weakened, or almost extinguished the local organization in hordes, or in clans, has assumed an overwhelming preponderance, and the local restraints upon marriage are strictly enforced. The Kurnai tribe is a good instance. In it, as I have already said, the totems have become practically extinct; and the local groups have become so strictly exogamous that sexual intercourse between members of the same division of a clan is looked upon with the utmost abhorrence. In olden times—that is, before Gippsland was settled by the whites—these local groups must have been bound together in a most extraordinary network of relationships. For, as I have already pointed out, the Kurnai terms of relationship exhibit a most primitive type, and the parental and filial groups are of very wide extent and may be traced into surprising ramifications.* Moreover the filial relations were inherited, carrying with them fraternal relations in ever widening lines. Again, the children of brothers and the children of sisters' own or tribal, were brothers and sisters to each other as far as descents could be counted. It is not surprising that in such a tribe the difficulties in the way of any young man finding a girl among those locally eligible, who did not stand in some forbidden degree of relationship, should have been next to insurmountable.

Restrictions such as those I have now briefly noted are found in all Australian tribes, but in some more than in others. When one reflects upon the wide prohibition of class and totem of relationships, and of locality, and adds to these disabilities all the further restriction of blood feuds, one cannot feel surprise that the question of marriage between any given couple should be the subject of deep and careful consideration by the elders of the community, and that it should often prove an insoluble problem to those who seek to bring it about.† No wonder that under such conditions the young people of Australian tribes, being still further hindered by the practice of betrothal of infant girls, so often

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* I have often noticed that the whole Kurnai community appeared to be related. Every one seemed to be the father, mother, son, daughter, brother, or sister of every one else, but when special inquiry was made, the "tribal" relationship was distinguished from the "own" by more precise statement, as the "other (brebba) father," "other mother," &c.

† The "nation," consisting of the Aldolinga and at least three other tribes of Central Australia, affords a good instance of the extensive marriage prohibitions arising

take their own course, and cut the gordian knot of restriction by elopement. In Gippsland, where these restrictions were of exceptional extent, so as to form a net in whose meshes every individual Kurnai was almost certainly entangled, the solution of the difficulties raised by the nearly absolute impossibility of obtaining the consent of parents was found in the practice of elopement, which was the most prevalent form of marriage.

VIII.—THE CHANGE IN THE LINE OF DESCENT.

In a late memoir * dealing with the change of descent in Australian tribes, the practice of infant betrothal was assigned as probably the chief cause of the change. But I have come to see at the root of betrothal the belief which I have noted in a previous section of this memoir, "that the child is derived from the male parent only, and that the mother is no more than its nurse." This belief has been active in other directions. It has aided the local organization, whose perpetuation from father to son is its direct expression, to over-ride the social organization; and, together with betrothal, which produces the sense of separate ownership, it has tended to bring about ultimately individual marriage, with a change of descent from the "group of female Pirauru" to the individual male "Noa."

This belief in the renewal of a man in his son is not, nor has it been, confined to the Australian aborigines. It is probably as old as the time when men first began to speculate upon the phenomena within and without themselves. Dr. Hearn, in his valuable work, the Aryan Household,† shows that the "worship of the house-father" is founded on the very belief which I find among the Australian savages. It is found distinctly enunciated in passages of the classical writers, and it forms the central idea on which Æschylus has caused the third part of his majestic Orestean trilogy to turn. Often as the case of Orestes has been quoted, it seems to me that, as examined by the side-lights of Australian custom, there may be even yet some views of it whose significance has not been clearly seen. I may be excused for briefly considering it here, because it seems to me to raise some curious questions as to the existence of uterine descent among the Hellenic ancestors.

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out of the combined influence of class divisions and of locality. These tribes are divided socially into four classes, which cover at least sixty-four local groups. According to my present information (which is not yet complete) the matrimonial restriction arising out of the four classes is as usual, but in addition a man's choice is in every case confined to a few of the local groups. (Informant, Rev. H. Kempe.)

I have endeavored to show in the Dieri the prohibitions arising out of class and close relationship, and in the Kurnai those arising out of close relationship and locality. In the Aldolinga all these restricting forces combine, and result in the narrowing down of the matrimonial choice to an incredibly small fraction of the whole number of women.

* "From Mother-right to Father-right," by A.W. Howitt and Lorimer Fison. Journal of the Anthropological Institute of Great Britain and Ireland. August 1882.

† The Aryan Household. W. E. Hearn, LL. D. G. Robertson, Melbourne, 1878. See also De Coulanges, La Cité Antique, p. 37, Paris, 1876.

In the Orestean trilogy, of which the Eumenides forms the final and most striking part, Æschylus had apparently several objects in view. He glorified the institutions of the Athenian people by assigning a divine origin to their great council, the Areiopagos, doubtless as opposed to the "modernizing institutions;" he showed the perfect action of an ancestral curse, together with divine vengeance upon a doomed race, the impious house of Pelops, and those who had become engrafted upon it; and I venture to think that in the Euimenides he also gave a dramatic version of the change effected in past ages in the line of descent. The whole gravamen of the charge against Orestes is that he has shed the blood of his mother "being kindred." In reply for the defense Apollo delivers a dictum, which, he takes care to state, is derived directly from Zeus himself, and this dictum is confirmed by Athene, the embodiment of Divine wisdom. The words placed in the mouth of Apollo are those I desire to note. In the course of the prosecution of Orestes, the Erinyes declare their ancient jurisdiction to be over those who have shed the blood of kindred, and they claim the right to "hale below"* the accused, he having "poured out upon the ground the kindred blood of his mother."† In reply to this, Apollo, as counsel for the defense, raises a nice point, on which, as the mouth-piece of Zeus, he declares the law. He denies the authorship of the child to the woman, declaring that she receives the germ merely "as a bailee," so to speak. The sire, he says, is the author, for whom she preserves and nourishes the young plant, as for one to whom she is united by ties, which, though sacred, are expressly denied to be those of kinship.‡ (ξέένῳ ξένη.)

Here we have precisely the sentiment already quoted by me from my aboriginal informant, that "the man gives the child to a woman to take care of for him"; and this I recognize as being at the root of changes which have occurred in the social organization of the Australian tribes. Æschylus shows the uterine line of descent as being the foundation on which rested the jurisdiction of the Erinyes, "assigned to them at their birth," § and therefore of venerable antiquity. By the equally divided vote of the judges he shows men's minds halting half-way between the old views and the new, and he assigns the cause and the reason justifying the momentous change which was effected under a direct divine mandate through the mouth of the prophetic Apollo. It seems to me that these conclusions may be drawn from the language used by the *dramatis personæ*, and moreover that Æschylus may possibly have had such conclusions in his mind when composing the Orestean trilogy.

It has been a feature of the past history of mankind that great and momentous changes have been made under an alleged divine direction. Of old the lawgiver was the priest, and the priest declared himself to

* Eumenides, 257, Camb. Texts.

† *Ib.*, 623.

‡ Eum., 627 κ.τ.λ.

§ *Ib.*, 320, 329.

be the divine mouthpiece. In the course of time the office of lawgiver became separated from that of the priesthood, but at the time pictured by Æschylus the two offices were still united. In savage tribes, such as those of Australia, it cannot be said that there are either priesthood or lawgivers, in the modern sense of the words; but it is possible to see what I may call the germ of these offices, prepared under favoring conditions to develop into active existence.

As I have said, there is no priesthood in the Australian tribes; but in their wizards I can recognize those who, if I may use the expression, already stand at the threshhold of the temple, prepared to advance and take their place at the altar when the edifice shall be completed.

These men profess to be in communication with the ancestral spirits and with the great Supreme Being, the founder of their race, whose sacred ceremonies of initiation they conduct and of whose laws—the ancestral customs—they are the depositaries. Were I to find an explanation given by an Australian tribe to account for the change in descent in their class system, I doubt not I should find it attributed to a command from their Great Spirit, through the mouth of the tribal wizard. This, indeed, is almost implied by the statements which I have heard made by old men at initiation ceremonies, that all the institutions of the tribe were in the first instance established by him whom they speak of and reverence as the All-father of the tribe.*

It seems to me that the important bearing of this primitive belief is only now beginning to be appreciated. When its influence upon the development of early society, and upon the beliefs of the early world, is fully recognized, it will be found that its effects have not been confined to the development of the ancestral worship of our Aryan forefathers.

IX.—CONCLUSION.

The subject which I have dealt with in, I fear, but an imperfect manner, is one of the most difficult of those which are met with in studying savage society in Australia. In the Australian terms of re-

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* I find that the great Supreme Being, who, as the Australians believe, lives in a land beyond the vaulted sky, is known under many different names in the various tribes, perhaps under as many names as there are tribes. These names, being connected with the initiation ceremonies, are often too sacred to be uttered by the tribesmen save during the celebration of those "mysteries" from which the uninitiated are excluded. For instance, the Woiworung tribe of the Yarra River district called the "Great Spirit" Bunjil; the Wiradjeri tribe of the Lower Murrumbidgee call him Baiame, and the Murring of the mountains and of the coast call him Dáramūlún. But these names are not for common utterance. They are generally reserved for the secret ceremonies of initiation, and all these tribes usually and in preference speak of the Great Being by words meaning in their several languages "our father." The Kurnai of Gippsland know him only by this name (Mungan ngaura) and utter it, when compelled to do so, with reverential awe. I have seen Australian blacks, when referring to their Supreme Being, do so by gesture, thus avoiding the utterance of his name.

lationship there are many anomalies which cannot be explained without a competent knowledge of the dialects in which they occur, and of the customs of the tribes using them. Such a knowledge is not to be looked for in any one investigator. The present memoir must, therefore, be looked upon as no more than an attempt to "prospect" the rich field which has so long awaited examination. How far I may have succeeded in the attempt I will not venture to surmise, but will leave it for the consideration of anthropologists.

I think, however, I may venture to say that I have shown good grounds for accepting the following conclusions:

1. The class divisions and totems are groups held together by common descent.

2. The class divisions and the totems form in the aggregate two exogamous intermarrying divisions of the community.

3. The marriage relation between these two exogamous divisions was probably at one period the common co-habitation, as occasion, food, supply, and other conditions allowed, of a group of males belonging to one division with a group of females belonging to the other division; and that even now this communal marriage exists in a somewhat limited form.

4. The marital relations, being those of group to group, the terms of relationship which arose and were used, necessarily expressed this relation of group to group, as well as of the individual to the group, and of the individual to the individual.

5. The filial relations of one generation to the preceding generation are those of group to group, and are clearly brought into view by the Pirauru practice, under which the children are necessarily the children of a male group, and not of an individual.

6. The conditions of 3 and 5 necessarily require those terms which I have tabulated as the "fraternal."

The evidence, which I have endeavored to state with clearness, is, I I feel, very incomplete, and therefore wanting in that entire unity which I should have liked to give it. But, looking at the facts which have been ascertained, I venture to submit that the systems in use among the Australian tribes indicate relationships which have been, and are, fully as real to them as ours are to us; that the terms have arisen under social conditions whose survival we may now distinctly recognize as still existing in the least advanced tribes, and that they have been developed and modified under the influence of changing social conditions, just as language, laws, religions, and even society itself have been developed and modified.

The Australian evidence, as far as it has been systematically collected and examined, supports in the main the views enunciated by the late Dr. Lewis H. Morgan. He was subjected to violent attacks by certain critics, who held views to which his own, if accepted, were fatal. This confirmation of his conclusions will be gratifying to all who, like myself, admire his single-hearted search after truth, and who feel a sincere respect for his memory.

MOUNDS OF SANGAMON COUNTY, ILLINOIS.

By JAMES WICKERSHAM, *of New Tacoma, Wash. Terr.*

If depth in the earth is a standard by which to judge the age of the relics of a race, there have been some found in Sangamon County, Illinois, which may with safety be referred to a very great antiquity.

At many places along the Sagamon River are what are called "sand bluffs." They are stratified, the strata being composed of sand, gravel, or clay, and varying in thickness from an inch to 3 or 4 feet. These bluffs are of more recent origin than the clay and stone bluffs along the stream. They have, however, the same forest covering. About 4 miles northwest of the city of Springfield are some of these bluffs, from which great quantities of building sand are obtained. The pit to which attention is particularly directed is situated on the west side of the Carpenter's Mill wagon-road, and about 100 yards southwest of the Sand Hill school-house. In this pit, at a depth of about 15 feet, is a stratum of clay from 12 to 20 inches in thickness. A workman engaged in loading his wagon with sand from immediately underneath this layer of clay came upon some bones of a reddish color, and two pieces of stone of a peculiar shape. He recognized in the bones the skeleton of a human being. In being removed from its sandy bed the skull was crushed to pieces, but some of the larger bones of the body were carefully placed under an overhanging bank out of the way. With the bones were found two stones, one an ax of common pattern and of good workmanship, now in possession of the writer, and the other is described as triangular in shape, and "with some funny marks cut on it." A boy who was assisting the workman brought the stone ax home, and the writer received it from his hand; the other stone was placed with the bones, and they have unfortunately been lost by a "slide" in the pit. Inquiry among other workmen brought to light the fact that several of them had found arrowheads or spear-heads in the pit. Of so little importance did they deem them, however, that but one could be recovered, which was given to the writer, and is now is his collection. This is a spear-head about 5 inches in length. The barbs and a small part of the base were broken off when struck by the spade; otherwise the head is in good shape and shows superior workmanship. It was found on a layer of clay, some 2 or 3 feet lower in the pit than the skeleton, but not immediately under the skeleton, nor by the same workman. Three different theories have been advanced to account for the presence of these objects at so great a depth: (1) That they were carried from the surface by a "slide" in the banks of the pit; (2) that they were buried from the surface by a prehistoric race; and (3) that they were deposited in the bluff during the period of its formation.

There are many Indian cemeteries along Sangamon River, and at first it was believed that a "slide" of the banks of the pit had carried from near the surface the skeleton and weapons of one of these ancient inhabitants of our country. The workman who made the discovery said that he first removed the layer of clay, and then found the skeleton in the sand under it; and the boy who was assisting him, and who was present, corroborated his statement. Workmen who found arrowheads or spear-heads were positive that they had not been carried by a slide to where they were discovered. They were lying in the sand just above a layer of clay, and, in one instance, in the clay. Being under level ground, and quite a distance from a bank or hill of any kind, it is impossible that they could have been deposited by a slide of the earth prior to the opening of the sand pit. It is not likely that they were buried from the present surface. If nothing but the skeleton and accompanying stones had been seen, this might have served as an explanation; but at different places in the pit, and at different levels, other objects were found. It is not probable that they were buried singly at such a depth. After a careful examination the writer is firmly convinced that the third theory is correct, viz, that the objects were deposited in the bluff during the period of its erection, or growth.

ROSS MOUNDS.

On the north bank of the Sangamon River, in Cooper Township, on the SE. ¼ of the SE. ¼ Sec. 5, is a group of mounds of more than ordinary interest, from the fact that an attempt was made by the builders to protect a tract of land by mounds on all its sides easily assailed by an enemy.

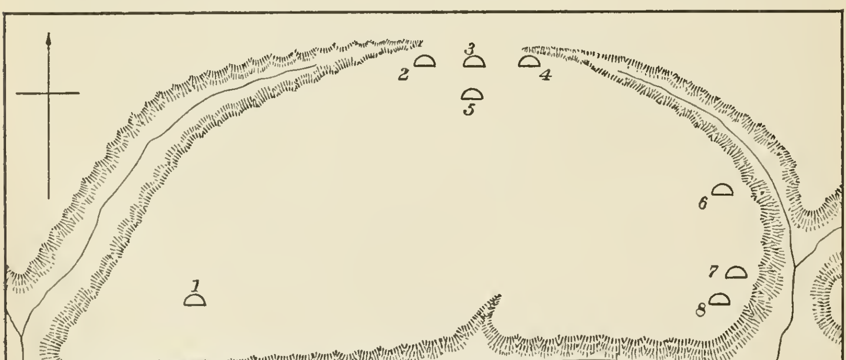


FIG. 1.—Ross Mounds, Sangamon Co., Ill.

The south face of the bluff along the river is almost perpendicular, and it would be difficult for an enemy to make a successful attack from this direction. Consequently no mounds are found here. At the western point, however, an ascent might be more readily made, and here we find a mound. The northwestern face, along the spring branch, is also very steep and easily defended. At the east end the bluff would be easily ascended, and here were built three mounds. But the point most liable to attack, and the hardest to defend, the point at which an enemy might rush across level ground into the encampment, lies between the heads of the two little spring branches, and was defended by four mounds. At all other points, except where the mounds are placed, the bluff is so steep and hard to climb that a few resolute men on top could repulse a host. Opposite the mounds an entrance to the high level ground would be easy. Mounds 1 to 6 are oblong, 1, 5, and 6 having the greatest length north and south, and 2 to 4 the greatest length east and west. These long mounds are about 20 feet in width, 50 feet in length, and 18 inches height. Mound 7 and 8 are round, 7 having a diameter of about 30 feet by a height of 18 inches, while 8 has a diameter of 50 feet by a height of 2 feet. The bluff is covered with heavy timber. The immediate neighborhood was known to the Indians and early settlers as good hunting grounds. No exploration was made.

OLCOTT MOUNDS.

About a quarter of a mile above the junction of Horse Creek and South Fork, on the east bank of the latter, in Rochester Township, on the SE. ¼ of the NW. ¼ Sec. 20, is a group of mounds. The following is a sketch of the location and surrounding natural features:

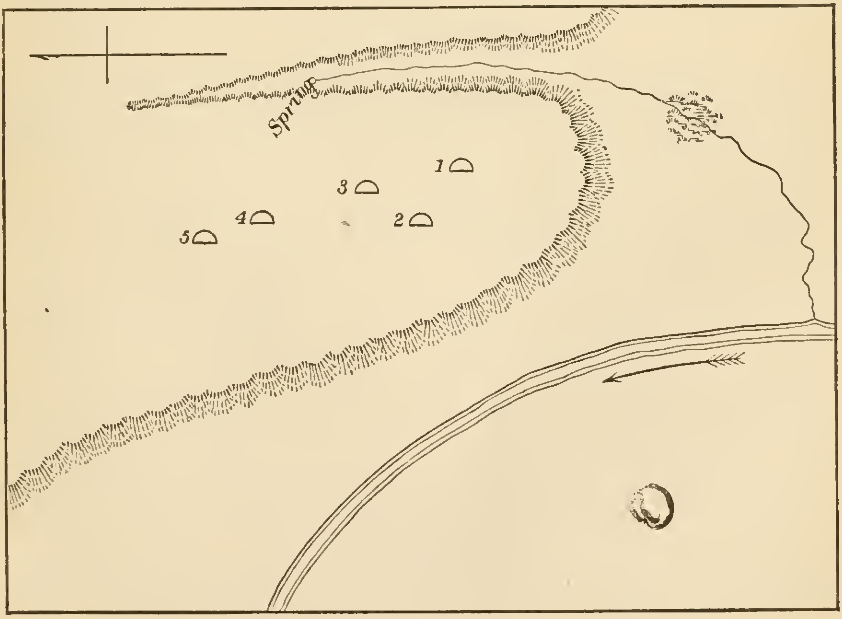


Fig. 2.—Olcott Mounds, Sangamon Co., Ill.

Mounds 1 to 3 are longest north and south (30 by 50 feet), and from 16 to 18 inches in height. Mounds 4 and 5 are round, 4 having a diameter of 50 feet and a height of 4 feet, while 5 does not exceed 40 feet in diameter nor 3 feet in height. The bluff on which the group is located has been cleared of heavy timber for several years, and is now used as pasture land. The writer assisted in exploring mounds 1, 2, and 5; but no archæological objects were found. Upon a former excavation, in mound 4, Mr. Olcott discovered, at the level of the bottom of the mound, a skeleton in such a decayed state that only parts of it could be removed. The skull was broken into small pieces. The body had been buried at full length, with the head to the west, in the center of the mound. Nothing was found but the skeleton. It was impossible to determine where the material was procured for the erection of these mounds. Usually depressions near by indicate the spot, but no such depressions appear in the neighborhood of this group. No particular arrangement of the material was observed. The location of this group placed the builders between a good spring and a river of clear water. A quarter of a mile to the northeast was the open prairie; and a like distance to the southeast was a peculiar spring, now known as the "Old Lick Spring," where the buffalo congregated to lick the ground, leaving a hole 6 or 7 feet deep by 50 feet in diameter. The "early settlers" were in the habit of repairing to this spring, and salting a log and then lying in wait for deer. It is not improbable that the mound builder may have supplied the family larder in a similar way centuries before. The center of the "lick" is a quagmire several feet deep, covered with a tough growth of moss.

DAWSON MOUNDS.

On the east bank of the South Fork, 2 miles south of its juncture with Sangamon River, in Rochester Township, on the SE. ¼ of the NE. ¼ Sec. 4, are two groups of mounds. The following plan shows the number and relative position:

Mounds 1 to 4 are on the bluff, 30 or 40 feet above South Fork, while mounds 5 to 10 are on a similar bluff above Rochester Creek. These bluffs are almost perpendicular on the faces next to the streams, while in the center they slope smoothly down to a spring branch. The ax of the "pale-face" has not yet invaded the woods on these bluffs, except to clear the roadway passing between mounds 2 and 3. A peculiarity of the mounds in these groups is that they are not round, but have, generally, the greatest length from north to south, although mounds 6 and 7 have their greatest length east and west. They will average 40 feet in length by 20 feet in breadth, and from 18 to 20 inches in height. No excavation was made by the writer, but in mound 10 was a large hole, showing quite plainly that some person had explored therein at a recent date. Some years ago, while the road leading through 1 to 4 was being worked, human bones were thrown from one of the mounds, but from which one it could not be ascertained. The

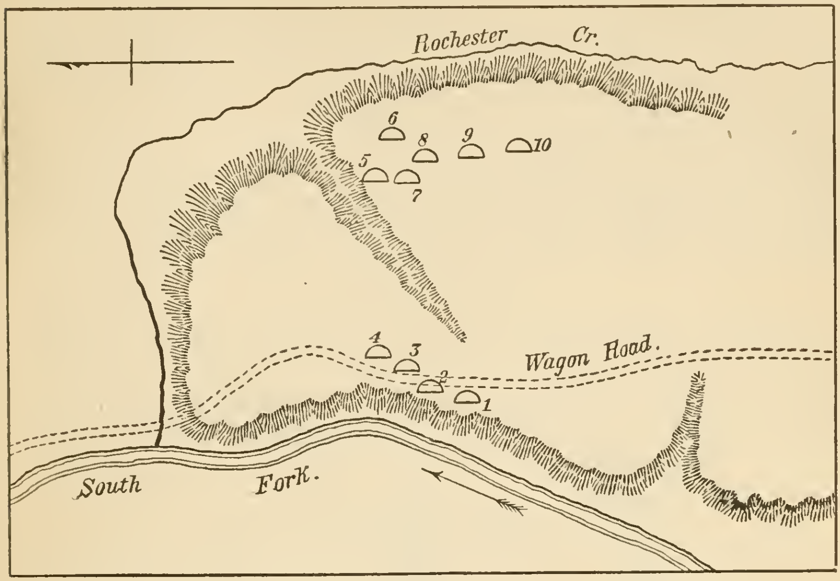


FIG. 3.—Dawson Mounds, Sangamon County, Illinois.

builders of these structures were in the neighborhood of everything necessary to savage life, good hunting, fishing, tillable land, drinking-water, and fuel.

M'CLERNARD MOUNDS.

A mile and a quarter south of the junction of South Fork and the Sangamon River, on the east bluffs of South Fork, on the SE. ¼ of the

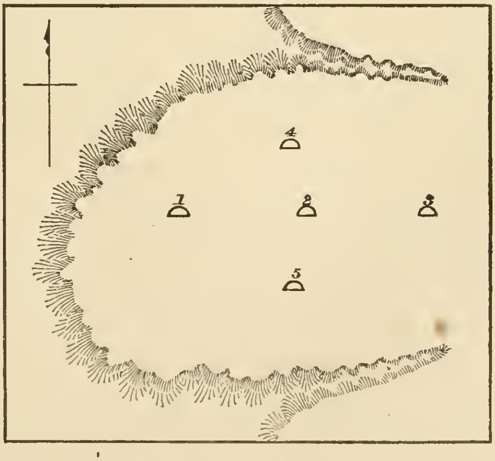


FIG. 4.—McClernard Mounds, Sangamon County, Illinois.

SE. ¼ Sec. 33, in Clear Lake Township, is a group of five mounds. It lies on a hillside sloping toward the stream, and a quarter of a mile to the east of South Fork. The following plan shows grouping location:

Mounds 1 to 3 are round, 50 or 60 feet in diameter, and 18 or 20 inches high. Mounds 4 and 5 are about 50 feet long, by 30 wide, and 18 inches high. Lines drawn through the center of 4 and 5, from end to end, would meet in the center of 1. These mounds are 100 feet apart. No exploration was attempted. The ground is in cultivation as grass land, but the mounds are still quite distinct. Back on the bluff, to the east a short distance, was the prairie; to the west a quarter of a mile, South Fork; on the north and south small spring branches.

WATSON MOUNDS.

A quarter of a mile south of the bridge, where the Clear Lake wagon-road crosses Sangamon River, in Clear Lake Township, on the SE. ¼ of the SE. ¼ Sec. 21, is a group of four mounds. The following sketch will show the location of the mounds with regard to each other, as well as to the surrounding natural features:

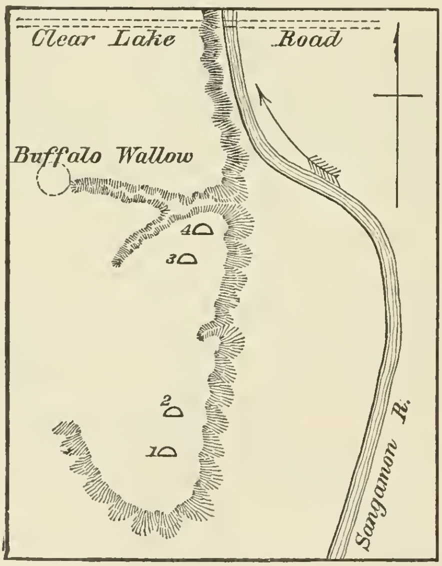


FIG. 5.—Watson Mounds, Sangamon County, Illinois.

Mounds 1 to 3 are round, 1 and 3 being probably 30 feet in diameter by 18 inches in height, while mound 2 is about 40 feet in diameter by 18 or 20 inches in height. Mound 4 is about 40 feet long, east and west, by 20 feet in breadth, and 18 inches in height. Mounds 1 and 2 are probably 50 feet apart; 2 and 3 are 150 yards apart; 3 and 4 about 100 feet. No excavation was made. The mounds follow the line of the bluff north and south. The ground at the south end of the bluff has been in cultivation for several years, but the mounds are still quite distinct. The eastern face of the bluff is almost perpendicular. Between the bluff and river is low, marshy ground, but the river bends in to the bluff a little farther up. Mound 4 is in the timber, but tillable land, springs, and the river are near.

LYON MOUNDS.

Up Sugar Creek, about a mile from its junction with the Sangamon River, are two mounds. They are situated on the east bank of Sugar Creek, on a bluff 30 or 40 feet high, on the SE. ¼ of the NW. ¼ Sec. 28, in Clear Lake Township. The following sketch will give some idea of their situation:

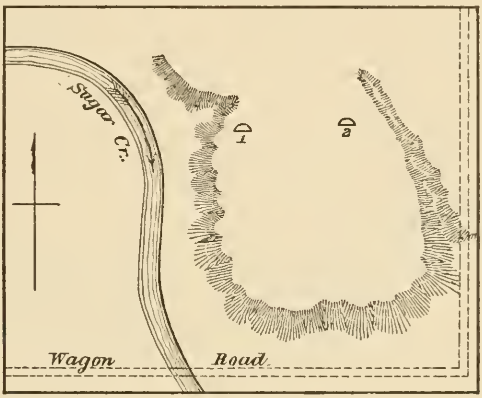


FIG. 6.—Lyon Mounds, Sangamon County, Illinois.

Mound 1 is 50 feet long, north and south, and 30 feet wide; mound 2 is 70 feet long, east and west, and 50 feet wide; they are each 16 or 18 inches high, and are 180 feet apart. No exploration was made. The timber has been removed from the land, but the ground has not yet been explored. The builders of these mounds found in their vicinity an abundance of good water, hunting, fishing, and tillable land.

FARR MOUNDS.

On the north bluff of Sugar Creek, about 2 miles above its junction with Sangamon River, on the NE. ¼ of the NE. ¼ Sec. 29, in Clear Lake Township, is a group of nineteen mounds. The following plan (Fig. 7) shows the manner of grouping:

Mound 1 is 80 feet, and mound 2 is 100 feet long; they are each 40 feet wide and 2 feet high. Mound 5 differs from other mounds in that a projecting arm from the northwest side connects it with a smaller mound. All the other members of the group are round, and range in diameter from 20 to 50 feet, and in height from 10 inches to 2 feet. Mounds 1 and 2 are on the southern hillside and in the woods. The others are on land that has been in cultivation for twenty years, and stand on the top of the bluff. The writer made an excavation in 1, but found nothing.

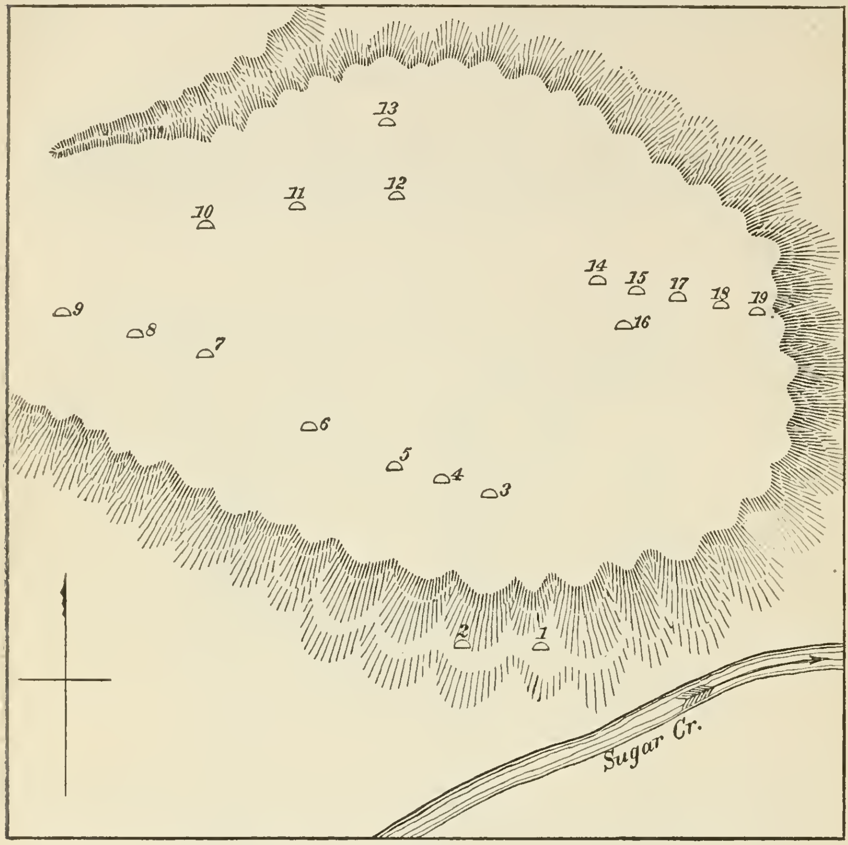


FIG. 7.—Farr Mounds, Sangamon County, Illinois.

No particular arrangement of material was noticed. On mound 2 is a white-oak stump, 3 feet in diameter, and a standing white-oak tree 18 inches in diameter. On the end of the bluff where mounds 14 to 19 stand have been found some very large stone axes, weighing 9 or 10 pounds. To the north of this group, a quarter of a mile or less, was the prairie; on the north side of the bluff, springs; on the east, a spring branch; on the south, Sugar Creek.

MUD LAKE MOUND.

At the south end of Mud Lake, in Clear Lake Township, on the NE. ¼ of the NE. ¼ Sec. 17, is a mound that may with some propriety be called a "connecting link" between the mound builders and the modern Indians. It is situated on the bluff 40 or 50 feet above the water, and about the same distance to the westward of the lake. Originally the bluff was covered by a heavy growth of timber, but it has now been cleared, and will no doubt soon be in cultivation. Only one mound was found, the diameter of which is about 30 feet, and the height 18 inches. The material used in its erection seems to have been camp rubbish, broken pottery, bones, shells, &c. Near the mound are several depressions in the earth from 4 to 8 inches in depth and about 30 feet in diameter. In the memory of the "oldest inhabitant," Indian wigwams have stood over similar depressions. It is not unreasonable to conclude, then, that this mound once stood in the center of an encampment of Indians, by whom it was erected through the daily accumulation of rubbish, bones, shells, &c.

RICARD'S LAKE MOUND.

Between Spring Creek and a small lake known as Ricard's Lake, in Gardner Township, on the SW. ¼ of the NW. ¼ Sec. 25, is a mound situated on a ridge. The lake is about 200 yards south of the stream, and the mound is midway between the two. The diameter of the mound is 50 feet and the height 5 feet. The material with which it was built was taken from the surface of the earth immediately around the mound. If any particular arrangement of the material was attempted it was not apparent in the hasty and very imperfect excavation made. At a depth of 3 feet, at the center of the mound, two bowls of rude pottery were found. They were side by side, and though the settling of the dirt, after the completion of the mound, had broken the bottom and sides somewhat, it had not overturned them. What they may have contained when first buried could not be ascertained from the inspection given after exhumation. The excavation was not carried deeper, and no other relics were discovered. The ridge on which this mound is located has never been cleared, although some of the larger trees have been cut for lumber.

CONVERSE MOUNDS.

On the west side of Spring Creek, and about a quarter of a mile from its junction with the Sangamon River, in Springfield Township, on the SE. ¼ of the NE. ¼ Sec. 10, was, at one time, a group of mounds. They were situated probably 100 yards back from the stream, on a broad hillside sloping toward the south and east. The ground has been cleared of the forest, and under cultivation so long that almost all traces of the mounds have been lost. A resident of the vicinity, however, assured the writer that before the land was cultivated, and even for some years afterward, they were quite prominent. No plan of the group could be made.

REISCH MOUND.

On the bluff west of Sangamon River, and a half a mile down the stream from the mouth of Spring Creek, in Springfield Township, on the NW. ¼ of the SE. ¼ Sec. 3, is a small mound. It is quite probable that there was a group of mounds here, but the land has been under cultivation for a number of years, and all traces of other members of the group have disappeared. The one mentioned escaped destruction by being too far out on the point to be easily plowed over. This point has, however, been prepared for cultivation, and this solitary mound will soon "join the innumerable caravan" of mounds that disappears through plowing. The diameter of this structure is about 30 feet and the height 2 feet. An excavation to the bottom was made, but nothing except a few pieces of charcoal was found. The material of which it was constructed was scraped up from the surface near, and no arrangement, apparently, was followed in its construction. It was built in the woods near the prairie, spring water, and good tillable land. A fine flint hoe was found by the writer near it, besides several arrowheads. Many stones may be picked up on the bluff, having one smooth surface, and showing the action of fire.

MISCELLANEOUS.

It is believed that not more than one-third of the mounds of this county have been described in the foregoing papers. All have been given, however, that have been visited by the writer. He has been informed that there are many more along the streams in the county, and particularly along South Fork, and Horse, Sugar, and Lick Creeks. On the farm of Benjamin F. Caldwell, in Chatham Township, on Lick Creek, is a group of twenty-five or more. On Cantrall and Richland Creeks, in the north part of the county, there are groups; also on the east shore of Clear Lake, in Clear Lake Township. In fact, wherever high land is found near good running water a search will, in most instances, reveal earthworks of the Mound Builders. From the writer's knowledge of the county he is of the opinion that there are probably one hundred and fifty mounds along the lakes and water-courses within its borders. They are singularly barren of relics of the builders, and, as compared with the prodigious works of this race found near the large streams of the Mississippi Valley, they are small indeed; still they are interesting as part of a great system which could only be incompletely studied without some knowledge of its poorer and smaller numbers. From the absence of any description it might be supposed that there were no work-shops, ancient camping places, or cemeteries in this county, but, on the contrary, there are many of each. On every spot of high ground, near good water, may be found greater or smaller quantities of flint chips, sometimes in such quantities that bushels of them may be collected. One field is known near the Sangamon River, where wagon-loads of chips may be easily picked up. They are from the peculiar dark stone out of which all the axes of this country were made, and a spring branch on one side of the field reveals the fact that the stones were taken from its beds and banks. Thousands of pretty smooth ones yet remain there. Most of the work-shops, however, were at ancient camping places, and white flint was used for arrows, as the flakes show. On these spots will also be found blackened stones, arrows, pestles, mortars, axes, &c., showing that here once stood an aboriginal encampment. Each plowing of the ground reveals relics, most of which are carried to the house and "given to the children to play with."

Of relics found in this county may be enumerated: Axes, stone and copper, arrows, spears, pestles, mortars, pottery, pipes, hoes, spades, knives, whetstones, "picks," stone pendants, and flat oval stones with holes at each end. While the mounds of this county are very poor in relics, the ancient camping places are rich. In the writer's collection is an ax found on the field mentioned that weighs 9½ pounds, and is of perfect form. A few miles farther up the river one was found that weighs 10½ pounds; it is now in the Illinois State Museum. Near a spring on the South Fork of the Sangamon a gentleman dug up a handsome little copper ax, which is in the writer's collection. It is the only piece of copper that has so far been found in the county. Axes occur of all sizes known to collectors. Arrow and spear heads range from three-quarters of an inch to 6 inches in length. The writer has one pestle, one mortar, two hoes, and a fine spade. The latter was found by a Mr. Dawson, about 100 yards south of the "Dawson Mounds," and is 13½ inches in length by 5½ in breadth. It is quite smooth at each end, showing that it was used a great deal. A stone pick was found about a mile north of Springfield. It is about 6 inches in length, shaped like the common pick without a hole, however, and was probably fastened in the usual way by a withe. Only one end of it was ever used. In the writer's collection is also a plummet of Missouri iron ore, but it was found on Lily Lake, in Fayette County, Illinois.

MOUNDS IN SPOON RIVER VALLEY, ILLINOIS.

By W. H. ADAMS, *of Elmore, Ill.*

On the north side of Spoon River, 75 yards distant, 80 rods west of the east line, and 20 rods south of the north line of Sec. 12, T. 11 N., R. 43 E., of the fourth principal meridian, is a round mound about 30 feet in diameter, called by those in the neighborhood a "hog-back." On the highest point of the hog-back, at the surface, is some evidence of fire. The evidence of a former fire increases very rapidly. At a depth of 12 to 16 inches I found five skeletons, nearly all the bones of which were calcined by fire, and many of them entirely consumed. One of the skulls lay to the north, one to the northwest, one to the southwest, one to the south, and one to the northeast. With the bones were fragments of sandstone burnt red. At or near each skull, and nearly on a line between the point of the shoulder and ear, was a water-worn pebble, except in one instance, and that was an angular piece of flint. The pebbles had not been acted upon by the fire, so that they must evidently have been placed there after the intense heat of the fire had subsided. From the appearance of the earth, one would be strongly inclined to believe that the fire in this instance had been one of unusual intensity. From the position of the skulls to each other the feet of one body would reach to his neighbor's head, if laid at full length. One of the skulls was rather thinner than those we usually find in other mounds. Some of the teeth evidently belonged to a person of great age. Other of the teeth were very small, but I cannot say that they belonged to an infant. The skulls were in fragments, the largest piece obtained being about 2 inches square.

On another "hog-back," east of the one described, commencing on Sec. 12, T. 11, R. 4, E., extending across the NW. corner of Sec. 7, T. 11, R. 5, and also some distance on Sec. 6, T. 11, are thirteen common round mounds, varying in height from 18 inches to 5 feet. As far as examined these are burial mounds, and in one mound I found nineteen skeletons. This mound was 45 feet in diameter, and 5 feet in height. The bones in it were in a fair state of preservation. I opened four or five of this group, and in each were found pieces of trap-rock from 1½ to 2 inches square, pieces of burnt sand-rock, small water-worn pebbles, which I supposed to be jasper or something of that character, and in the largest mound a very small fragment of red pottery.

On the high bluff between Spoon River and Walnut Creek, on the south line of the SE. ¼ of Sec. 6, T. 11 N., R. 5 E., are three mounds of some importance. The first is a common round mound, 3½ feet high, with a base diameter of 40 feet. This mound is 3 rods north of the sectional line between Sec. 6 and 7, and 60 rods west of the east line of Sec. 6. The land is owned by Mr. Henry Jacques. I opened this mound at the apex, and at a depth of 2 feet found quite an amount of ashes; also one piece of trap-rock of irregular shape, about the size of a small boy's head, and a hornstone arrow-point of the leaf-shape pattern. Eight feet east of this is a mound 62 feet long and 19 feet wide, with the greatest length from southwest to northeast. I made a cross-cut of this mound at the middle, and in the center found a bed of charcoal, 10 inches deep, intermingled with ashes. I also made an opening near the east end, and found nothing. Twenty rods east of this, on the sectional line, is an oblong mound, measuring 64 feet from west to east and 47 feet from north to south, with an apparent height above the surrounding level of 3 feet. I made an opening in the center of this mound, 4½ feet in diameter, and at a depth of 2 feet I found some ashes and fragments of stone, which had been polished, and 3 inches of yellow clay. This clay has the appearance of its having been rammed or packed while in a plastic state. Below the packed clay is a thin stratum of red paint, and below the paint, ashes and paint intermingled. In this material we found fourteen arrow-points made of hornstone, all of the leaf pattern except one, and this was 3½ inches in length, with notches at the heel, and had the appearance of having been used; also a small piece of galena. Six of the arrow-points lay with their points to the west, one to the southwest, one to the east, and one to the north.

There was a slight depression on the surface above the deposit. I made an opening 9 feet east of the center, in which we obtained a copper awl or needle, 3½ inches in length and three-sixteenths of an inch square, thick in the middle and sharp-pointed at each end. This copper implement was inclosed by some material, which, under a microscope of low magnifying power, has the appearance of being the bark of a tree. This tool lay with the points southwest and northeast. I also found a white flint spear-point or lance-head 4 inches in length and 1½ inches wide, without notches at the heel. We found the flint implement some 10 inches southwest of the copper, which was surrounded by the same red material as the first.

I made an opening 14 feet west of the center of this mound, and at a depth of 3 feet 8 inches I found a copper needle or awl, rounded and pointed; three copper beads one-fourth of an inch in diameter and three-sixteenths of an inch in length; one piece of copper tubing or bead 1 inch in length, and one-fourth of an inch in diameter; one piece of tubing or bead three-sixteenths of an inch in diameter and 1 inch in length; one piece 1⅝ inches in length and one-fourth of an inch in diameter; and five other pieces very like those described; also a small fragment of a tooth, but I was not able to determine positively the animal to which it belonged, but think it belongs to a human being; also several small flint pebbles.

There are traces of a breastwork or fort commencing at the southwestern part of this mound, about 6 to 12 inches in height. Commencing at the mound it extends 120 feet to the southwest, thence 67 feet south, thence south-southeast 106 feet, thence to bluff of Spoon River (bluff 40 feet high), 130 feet from bluff to mound in a straight line SE. 186 feet. All the arrow-points were finely finished, and far superior to those found on the surface of the ground. This mound is 42 rods west of Spoon River. The bluffs here are composed of the usual yellow clay, and contain very little sand. On the northeast corner of the NW. ¼ of the SE. ¼ Sec. 5 are three common round mounds, standing in a triangular position to each other, with the largest to the north, the next in size directly south of it, and the smallest to the east.

On or near the southwest corner of Sec. 4, T. 11 N. of the base line 5, east of the fourth principal meridian, are a series of common round and long mounds of more importance than any yet discovered in this part of Illinois. Commencing at a point near the foot of a long bluff and sloping to the south 40 rods north of the south line of Sec. 4, and 10 rods east of the west line, are three common round mounds. For convenience we have numbered these mounds commencing with the most westerly. (The distance is from center to center of round mounds, and from end to end of long mounds.)

From 1 to 2 is 39 feet from center to center; from 2 to 3 is 30 feet from center to center; from 3 to 4 is 50 feet from center to center.

This mound, 80 feet long, with a cross at the end of 33 feet in length, is 2 feet high. The cross is 10 feet wide. The main or principal mound is 15 feet wide. From No. 4 to No. 5 is 123 feet. No. 5 is a common round mound 3 feet high, with a base diameter of 40 feet. From No. 5 to No. 6 is 53 feet. No. 6 is 98 feet long, 2 feet high, 18 feet wide, with the greatest length from southwest to northeast. From No. 6 to No. 7 is 75 feet, west-northwest of No. 6. No. 7, is 104 feet long, 2½ feet high, and 18 feet wide, with the greatest length from southwest to northeast. From No. 7 to No. 8 is 100 feet. No. 8 is 140 feet long, 3 feet high, and 20 feet wide. Fifty feet from the south end of this mound is a black-oak tree 3 feet in diameter, and standing in the middle of the mound. This mound is 100 feet west of the bluff of Spoon River. The bluff is 40 feet in height at this place and very precipitous.

In company with Mr. W. J. Morris, I made a cross-cut in this mound to the original soil. At every spadeful we would bring up flint chips, and we found several pieces of trap-rock, some of them polished on one side. In accordance with the usual rule here, of computing sixteen growths to the inch, I measured on one side of the center of the tree. (This is the rule here for black oak.) Around the mound when the leaves are off are great quantities of flint chips.

We made a slight examination of Nos. 6 and 7, and found nothing excepting traces of ashes and charcoal. On opening No. 3, at a depth of 2 feet I found ashes, at 2½ feet, 6 to 8 inches of charcoal and ashes, at 3 feet hard-packed earth. At 3 feet 3 inches I found two skeletons with all the bones very much decayed excepting the teeth, and these were not worn by the owner for probably thirty years. I opened 2 and 1 and found nothing. All the mounds have the appearance of having been built at the same time and by the same people. Spoon River at this point is 100 feet wide. I found no depressions from whence the material of which these mounds are built was taken.

ANCIENT RELICS AT DAYTON, OHIO.

By Aug. A. Foerste, *of Dayton Ohio.*

The country west of Dayton is subject to inundation on the part of the Miami River during the spring freshets. The city recently constructed levees to protect the land within its corporation, which includes some corn-fields extending for a mile along the west bank of the river. For this entire distance, the construction of the levee necessitated the removal of about 2 feet of the surface earth for quite a distance on either side of the embankment. Fragments of pottery were here found by Mr. Chester Kiehl, and were readily identified as being Indian work. This gentleman invited a few acquaintances to assist him in his excavation, which led to some interesting results.

The pottery was found at an almost uniform distance of 3 feet beneath the original surface of the earth, associated with the bones of the buffalo, the deer, and the elk, known to have been common in this valley. Several human skeletons have also been found, which, at first, led to the belief that a burial-ground had been discovered, but the following facts induce an opposite opinion: The heaps of ashes were found at a uniform depth, and usually contained the pottery, which was mostly in fragments. The skeletons were found at the same depth, but were extremely few in number when compared with the number of ash-piles and pottery and implements found in their vicinity, since the latter would necessarily fall under the head of articles buried with the dead to be of use in the other world; however, there were too many relics, too scattered, to appear to have been buried there. This was probably an ancient village, the tribe of which perished or left, and the place was afterwards covered by the heavy sediment of the river during inundation. The skeletons are probably those of a later race buried here, or those of the old inhabitants whose bodies remained on the ground after some great warfare.

The removal of earth for the levee considerably lightened the labor of excavation, and resulted in the finding of more relics than would otherwise have been attainable. Some idea of their antiquity may be gained by learning that they were found 2 feet beneath the surface and that more than 2 feet must be added to this depth to make allowance for the removal of earth for the neighboring levees.

A large number of mussel shells, belonging to the species of *Unio verrucosus*, Barnes, were found with holes cut into shell, large enough for the introduction of a finger. The valves in this condition were probably used as earth and sand scrapers, taking the place of shovels, probably also as skin scrapers, for which they are adapted. Placing the finger through the hole, and the back of the valve against the palm of the hand, it can be held with ease and firmness. Some of the scrapers had become calcined by exposure to fire, and were found in an imperfect condition throughout the ash layer.

The carapax of the lady turtle, *Chrysemys marginata*, was found in several instances, the plastron having been removed. In this condition it could be used as a drinking cup, the handsome green color variegated with yellow and red making it a pretty object. Near Cincinnati, the shell of this turtle has been found pierced by two holes, which undoubtedly enabled the Indian to use it as a pretty, although cumbersome, ornament.

A few arrow-heads made of chert were either triangular in shape or of an elongated form arising from a square base. They are made of a chert common at Flint Ridge, in the southeastern part of Licking County. This station, belonging to the lower coal-measures of the Carboniferous period, consists of a layer of limestone containing many quartz crystals and nodules of chert. The latter were sought by the Indians far and wide, who came to this station and mined for the chert, employing it for their arrow and spear heads. Holes and excavations still exist, pointing back to a time when this was the common center, for hundreds of miles, of the Indians hordes, intent on the material so useful in gaining their sustenance and asserting their sway among the native tribes. It was therefore not an unexpected discovery to find that the arrow heads above mentioned belonged to the same class of cherts as those found at Flint Ridge.

A few of the bone implements commonly in use by the Indian tribes were found. One of the heavy implements made from elk antlers, usually called awls, had the larger extremity hollowed out for a distance of about 2 inches, and four holes were drilled into this end from opposite sides, so that the instruments could be conveniently fastened, by means of a thong, to a belt or to the wrist. If this instrument, 10 inches long, with a coarse point, was indeed used as an awl, another implement of bone, of the same length, but long, narrow, and quite flat, showing at one end that it had once been longer as well as pierced, may have formed the needle by means of which the hide was sewed together after the awl had done its work. This needle was evidently made from the rib of some animal. Another piece of bone, pointed at one end, may be called an awl or an eyeless needle. It was only 2 inches long. A fractured bone, pointed at one end and about 4½ inches long, could scarcely have been anything but an awl. Quite a singular implement, made of an antler point, rounded and smoothed as well as hollowed out at the larger extremity, is without doubt an arrow-point, and the points are found in Ohio of any size between 1 and 4 inches. This suggested the idea that although the pointed instruments made from elk antlers are ordinarily to be considered as awls, the peculiar specimen above described may have been used as a spear-head, the holes being useful in fastening it to the spear-shaft.

Marginella apicina, a marine shell, found only in the Gulf of Mexico and the neighboring Atlantic, was found about the neck of one of the skeletons. About thirty of these handsome little shells were picked up which had once formed a necklace in connection with some shell beads immediately to be described. The *marginellas* had been pierced by rubbing the apex of the shell obliquely on some stone until the chambers of the shell were exposed, after which they could be readily threaded.

The rest of the shell beads show more artistic skill. They are small, round, and made from some larger shells, probably the common *unios* of the river. The largest were only one-eighth of an inch large, and the smallest about one-tenth of an inch. Of these beads about one hundred and seventy-five were found. They were generally flat at the ends, the plates of shell structure extending lengthwise, the sides were either imperfectly cylindrical or a slight attempt was made toward rounding them off as in modern glass beads. The interesting feature is the manner in which the holes are drilled. They consist of two concave openings, one from each end, having the opening towards the center of each bead, the narrowest diameter showing that the holes were drilled from both sides, the openings meeting in the center. If the hole had been drilled from one side alone the form of the opening would have been that of a hole large at one end and smaller at the other.

The only Indian skull which was at all well preserved presented the ordinary features of an Indian head. It had a flattening of the occiput on the left side of the head, in which it differs from ordinary cases of compression where the flattening is regular and exactly on the back of the head, not towards either side. Skull flattening is now known to be a common practice among the lower types of men; it is even practiced at present near Marseilles, in France,* where it is probably a relic of barbarism dating back to the Huns, who themselves obtained it from an Asiatic source. The practice is said to be of Mongolian origin, and is mentioned by early Greek and Roman authors. The flattening in the present instance was caused by the cradle-board, to which the Indian in his infancy, while his skull was still soft, had been tied. The pressure of the hard board upon the soft head caused the flattening. The cradle-board is a well-known factor in the Indian's life, and is frequent in illustration of the Indian squaw with her dusky pappoose.

The pottery fragments were quite abundant, especially so in the ashes and in their immediate vicinity. The pieces seemed rarely to belong together, and no entire pots were found, which would lead to the inference that the fragments were the remains of pots accidentally broken, the larger pieces being thrown away, the smaller ones remaining in the ashes, so that the broken pieces can rarely be restored. The pottery of Indians is well known to have been the work of their women. Its quality varied considerably, but in general it may be said to have become ruder in proportion to the distance of the tribes from Central America, the great aboriginal art center. Ohio art is of quite a low character, ornamentation being usually restricted to simple geometrical figures consisting of parallel lines, either straight or curved, which meet each other at various angles. The vast majority received no ornamentation whatever, and attempts at figures, human or of animals, are exceedingly rare. No attempts at glazing were made; in a few specimens a gloss is found, due to vitrifaction of the silicious element contained in the clay used. No attempt at coloring is apparent, the variation of color being due to the soil and materials used, and accidental rather

* Smithsonian Report, 1859.

than intentional. The colors are confined to red, caused by oxides of iron; grayish-white, due to the use of "blue clay"; and a very dark brown, the clay not being pure, but mingled with vegetable materials.

The custom of burial in vases seems not to have been practiced by the Ohio savage, so that the pottery all belongs to the *akeek* type. The *akeek* is a vessel rounded at the base and destined for use as a sand bath, being placed in the heated sand and ashes, over which a fire had previously been kindled. The *akeek* had, therefore, no use for legs, and did not receive any. The edge of the pots generally flared out a little, but, to aid the Indian in removing his akeek, he thickened the lips at various parts of the circumference and allowed it to project a little; this served as a handle. The large and coarser pottery, destined to be hung over a continued fire, was pierced by holes not far from the edge, generally two holes a few inches apart, accompanied by a similar set on the opposite side. In some cases little handles are attached near the lip of the pot, through which cords might be passed. Usually these are four in number and are placed at equal distances on the edge of the *akeek*. In this manner the *akeeks* were readily suspended from the apex of a tripod formed by branches of trees. In vessels not intended for suspension these handles are reduced to one or two, which allow a passage of the finger through the ring formed by the handle. In those destined for suspension, the handles as well as the holes usually do not readily admit the passage of a finger, these having evidently been designed only for cords. The necks of all these pots are contracted; many necks end with this contraction, but most of them flare out again into something of a lip. A very unique pot, or drinking cup, of the former type was found with a depth of about 3¼ inches, which contracted at the mouth to only 2½ inches. Its average thickness was about five-sixteenths of an inch, but in order to form the lip the edge had been thinned out by pressure between the edge of the fingers until it was only two-sixteenths of an inch in thickness. The finger marks are still visible. In some cases no attempt at a distinct lip was made, the edge of the pot being merely smoothed and rounded off. The height in civilization reached by the Indians here concerned, however, seemed to require at least a *rim* to his pot, even if all other ornamentations failed. This was formed by doubling back the edge of the pot for a short distance so that it formed a somewhat broad ring about the upper edge of the pot. This was either left plain or ornamented with the rest of the vessel.

Ornamentations are usually plain, and even the most elaborate works show but little knowledge of proportion in drawing. It may be divided into incidental and intentional. The incidental art, although not evincing any skill on the part of the Indian as far as artistic matters are concerned, was none the less effective, and led to a principle in their art which showed considerable taste. I refer to the matter of relief. The Indian without the aid of a potter's wheel, and relying mainly upon his hands as a potter, took recourse to many a device to form his clay. Common in the south was the molding of his work over a gourd and then burning out the gourd by means of fire. In the north the clay was often molded in a bag made from the coarse fibers of some plant, probably from the fibrous bark of some tree. On burning the vessels impressions were left of the bag, sometimes even of the nature of its woof. In a fine specimen found at our diggings even the individual fibers have left their impress; on the other hand a piece found about 7 miles away, in a southeasterly direction, along the same river, shows very plainly a series of parallel threads a short distance apart, crossed vertically by an abundance of threads which are placed side by side. This is the plan of some "mound builder's" cloth found in the same neighborhood, and illustrates the manner of work. Baskets of willow and of wood splinters are said to have been used. Some few pieces of pottery found with the rest may have been molded in this manner, but the impressions left are not plain enough to determine this with certainty. On the other hand bark impressions are very common, some of which might possibly belong to bark-basket work, but a careful study makes me believe that most of the bark impressions were made in order to make the pot look more beautiful than it would with a plain surface. Basket work would require that the impressions should occasionally cross each other, which they rarely do. Again, these impressions commonly appear about the necks of pots, a place which derives its shape from the hand, as may be seen from the delicate curves there necessary, at least in the finer pots, and it would be too much to assign this delicateness to the forming baskets, especially as the neck is generally smooth, owing, no doubt, to contact with the fingers while the neck was being molded. Again, the bark marks appear on the rim of the vessels, a place usually formed, not in contact with the basket, if there be any, but by the fingers.

The edge of the vessel, according to modern notions of pottery, is fashioned last, and after the neck has been contracted. After the edge is turned over to form the rim, the inside surface thus exposed forming the rim on the outside, should manifestly have no back markings, but the contrary is the case. Again, the handle, fashioned by hand and afterward stuck on, often has bark markings on the outside of the curve, sometimes within. I have been thus explicit in order to show that much of this bark-marking is a matter of art, not of accident, and that the object was the beautifying of the pot. At any rate, a specimen was found in which an attempt of bark imitation was made by means of some sharp-pointed instrument, which made the surface look more handsome than a mere bark impression would have done. The lines of this instrument intersect each other at angles impossible in bark impressions of the character here represented.

The idea of relief having once been gained, it could readily be applied in other ways, the most successful being the work on the pots found at La Porte, Ind., in which a relief is produced by the punches of a square-pointed stick; against this the lines, curved and of various pattern, stand out more beautiful by far than if cut on a plain surface. The idea of bark impressions which led to their use as a matter of relief, did not forbid the drawing of figures on a plain surface when taste seemed to require it.

The geometrical figures on pots are mostly confined to the neck and its border or rim. In many cases a mere stick may have been used to cut in the lines, but in the best work the clay seems to have been gouged out by some pointed instrument, probably by a pointed bone which had first been fractured so as to expose the hollow interior, and then smoothed down so as to leave a groove at the end. A hollow stick was also effectively used to make small circular dots by way of ornament; these often left a little elevation in the hole, owing to the softness of the pith. The figures themselves may readily be reduced to a few simple plans as far as pots discovered near Dayton were concerned. A common form is to have various oblique lines met by other oblique lines at an angle usually not far from 90 degrees. Another figure was to have a series of parallel wavy lines crossed by others of the same character. The use of a single wavy line is very rare, and in the case discovered was accompanied by a series of dots. The ornaments of the border are somewhat similar, allowing also a very effective one, made by pressing a stick obliquely against the edge of the rim, as many ladies ornament their pies. The dots made as described above were placed wherever they were thought to be effective, and often without any particular arrangement. Little more can be said of this pottery, excepting that the clay was mingled with fine gravel-sand, pounded quartz rocks, pounded gneiss, containing abundance of mica, more rarely with pounded shells. This practice is well known to have been done with a desire to prevent cracking and fracturage during the baking process. The finest and thinnest pottery is about one-eighth of an inch thick, and contains only fine particles; the coarsest and thickest pottery is often one-half of an inch thick, and contains coarse pieces of quartz, sometimes an eighth of an inch to three-sixteenths in diameter.

MOUNDS IN BUTLER COUNTY, OHIO.

By J. P. MacLean, *of Hamilton, Ohio.*

Butler County, Ohio, is situated in the southwestern part of the State, and joins the State of Indiana. Through it passes the Great Miami River in a southerly direction. It contains numerous remains of that people known as the "Mound Builders," among which are not less than two hundred mounds, varying in height from 18 inches to 43 feet.

These mounds and the general surface of the country have afforded not less than two hundred thousand implements belonging to pre-historic times, and every succeeding year adds to the number. When it is considered that the county contains but 291,000 acres, including waste land caused by streams and wood-land, the yield of implements must be regarded as remarkable. The plow turns up a vast number every year, as though the supply was undiminished.

The tumuli, located on the second and third river terraces, have never been systematically explored. The plow has been instrumental in turning out many relics from the mounds, and curiosity-seekers have obtained many specimens by digging into them, but without taking note of the layers forming the tumuli. Most of the relics have been taken near the surface of the mound, and consist of arrow and spear heads, axes, pestles, mortars, pottery, &c. A mound* situated in Fairfield Township was partially taken down; and in removing the earth there was found a thin copper breast plate,† $5\frac{1}{4}$ inches long, and $3\frac{5}{8}$ inches wide at one end, and $4\frac{1}{2}$ inches at the other. Near the center are two perforations an inch apart, broader on one side than on the other. The implement was hammered out cold. One side is partially covered with verdigris. From one of the three mounds on the commanding hill in section 9, Saint Clair Township, there was plowed up, in 1855, four copper hatchets, 6 to 9 inches long, and 4 to 2 inches wide. From a mound (location not now known) James McBride procured the representation of the head of a bird,‡ somewhat resembling the toucan. It was made out of clay, and seemed originally to have been attached to some vessel.

A few of the mounds have been entirely removed and the contents noted. In grading for the Cincinnati, Hamilton and Dayton Railroad, it was found necessary to cut through the large mound in section 11, Madison Township. This mound was not only cut in two through the center, but the grade of the road-bed went below the original surface of the ground. At the bottom of this tumulus and under the apex were found human bones and chert implements. With the bones was found cloth. The cloth had the appearance of having enveloped the skeleton. The fabric was composed of some material allied to hemp, and the separation between the fiber and the wood was as thorough as at this day by the process of rotting and hackling. During the year 1881 I examined some of this cloth, then in the possession of Thomas Doner, a druggist, of Dayton, Ohio. I found the thread to be coarse, uniform in size, and regularly spun. In grading for a roadway in Wayne Township, it was found necessary to cut away the greater portion of a mound in section 24. At the base of the mound occurred a human skeleton in an extended position. Lying upon the chest of the skeleton was a spear-head, composed of blue chert, nearly 6 inches in length and 2 inches in width

*Ancient monuments of the Mississippi Valley, Plate xxx, No. 1.

†Figured in "Mound Builders," page 164.

‡Ancient monuments, page 194.

just below the barbs, the whole being symmetrical. Mr. Richard Brown removed a mound in Ross Township, and beneath the mound and under the original surface of the ground he found a badge of authority* composed of cannel-coal. It is perfectly symmetrical and finely finished. The two wings are divided into halves by a ridge extending the whole length of the implement. At the corners of the wings are knobs. At the center it is narrow, thick, and arched, but broad at the wings; the extreme length being 8¼ inches and the greatest width 3⅞ inches. Near the center are two perforations 1½ inches apart, the greater diameter of the perforations being on the under side.

Many skeletons have been taken from the mounds. In some cases several have been found together, forming a circle, the crania being at the center. The cranium taken from an ash-pit in a mound in Liberty Township fell into my possession, and in due time I presented it to the Smithsonian Institution. It was in a perfect state of preservation, and exhibited all the characteristics constituting Indian crania.

Under the direction of the Smithsonian Institution, I undertook the examination of some of the tumuli during the summer of 1883. The first to examine was the group located on Sec. 21, Ross Township. This group is figured in "Ancient Monuments," page 170. Although I had visited this group on a previous occasion, I had yet never examined them carefully until July 25, 1883, when, in company with Hon. W. H. Harr, judge of probate, I commenced an exploration. The mounds as represented in "Ancient Monuments" are not as we found them. We noticed that *f*, *e*, and *d* (see Fig. 1), are still to be seen, although *f* has been plowed down; but as the composition of the mound is different from the surrounding surface it is plainly visible. As to *b* and *c* there is no trace whatever. The soil gives not the least indication that there had ever been there two mounds. If composed of either clay or ashes or both, it would seem that some trace would be left. Years of cultivation would as easily have obliterated *f* as *b* and *c*. There is no just reason why *g* and *h* should have been left out of the plan, for evidently they constitute a part of the group. When surveyed originally the five small mounds surrounding the large one ranged from 4 to 10 feet in height; the largest of the five would now hardly reach 4 feet. The mound *g* is 449 feet easterly south of the largest of the group, and has an altitude of 7 feet, by 65 feet diameter at the base. At a distance of 220 feet southeast of *g* is the mound *h*, 6 feet high by 50 feet diameter at the base.

This group is located 6 miles southwest of Hamilton, on an irregular tract of land, constituting the highest point in the township. Declivities present themselves on every side. The largest mound of the group is 26 feet high, and from its summit a fine view, extending many miles in every direction of the surrounding country can be obtained. About

* Figured in "Mound Builders," page 167.

the year 1820 a shaft was sunk into this mound by treasure-seekers, in hopes to find a chest of money. The tunnel was started on the north side about half way up the slope, and ran downwards at an angle of thirty-five degrees for a distance of 30 feet, when the center was reached, from which point it was carried eastwardly several feet. It was related at the time of the excavation that the center gave the appearance of having once been a hut formed of leaning timbers. Within this vault were found a stone back-wall, coals, ashes, and human bones. The mound is now being removed in order to make fills in the field. The material is being taken from the east side. At this point is a perpendicular side of 10 feet. The explored earth shows a large percentage of ashes, the face having a whitish color.

After taking a complete survey of the mounds we concluded to open mound *c*. Into it we dug a trench 32 feet long and 3 feet wide, and sinking it to the original surface or undisturbed earth. We commenced at the east side and ran the drift west, bearing a little to the south. Six inches below the surface of the mound we struck a bed of fine ashes. At the southwest side we came upon a circular bed of ashes 44 inches in depth. Within this bed and irregularly distributed were small pieces of charcoal and occasional small burned limestone pebbles. Near the bottom of the bed, or 50 inches below the apex of the mound, were two separate pieces of fire-baked clay, both of which appeared to be regular in shape but were destroyed by the pick. One of them had been regularly bored, the aperture not extending through, and point-

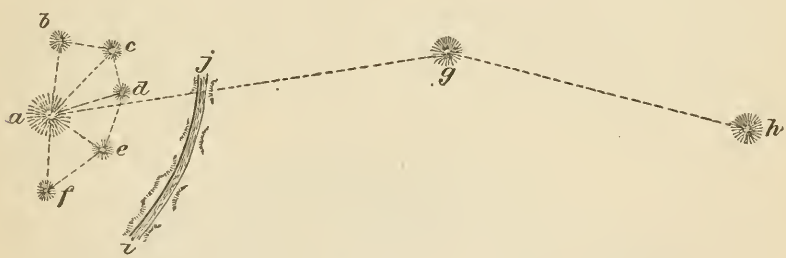


FIG. 1.—Group of Mounds, Ross Township, Ohio.

ing at the bottom as though bored by some large gimlet. Near by was a burnt limestone 6 inches wide, 7 long, and one-half thick. No other stones, save pebbles, were seen. That this mound had never been opened before was witnessed by the innumerable traces of roots which we saw everywhere in the trench.

The mounds *g* and *h* presented evidence that they had been recently opened. Upon inquiry we learned that they had been excavated during the fall of 1882. No relics were taken from either mound. Below the apex, and upon the original surface of the ground, occurred in each an altar, composed of stone, 3 feet in diameter and circular in form, with a depression in the center. In the center of the altar of *g* was a large broken bowlder, covered by a layer of fine ashes. Within this bed of ashes was a large charred piece of wood.

A ditch, *j i*, is easily traced, which seems to have escaped all previous observers. Whether it was the intention to carry this ditch around the cluster of mounds, or was simply a depression left after excavating for the earth in order to construct the mounds, it would be difficult to tell. Between the mounds *c* and *g* there is quite a depression extending from the northeast to the southwest, as though it had been purposely hollowed out. The ditch does not seem to be accidental, for it is not only placed a little above the deepest part of the depression but its curve is regular. It might be fair to conclude that the ditch was an afterthought, and it was the final intention to carry a circular wall around the group, excluding *g* and *h*.

In Ancient Monuments of the Mississippi Valley, Plate xi, Fig. 3, is a representation of an earthwork washed by the Great Miami, a description of which occurs on page 30. In the diagram is a mound marked "10 feet high." On the 7th and 8th days of August, 1883, with sufficient help, I opened this mound. A general survey of the inclosure shows it to be rolling, with prominent knolls here and there. The whole field was matted with a very heavy growth of clover. The land is exceedingly fertile. From the productions of this one field, a large family of children was brought to the years of maturity. The soil is black loam mixed with sand. At almost any point fragments of pottery may be picked up. This pottery is composed of burnt clay intermingled with crushed fragments of the shell of the *unio*.

The mound does not lie in the place it is put in Ancient Monuments, but is farther removed from the river. The excavation was commenced from the north side at the point *y* (Fig. 2), and carried to the bottom of

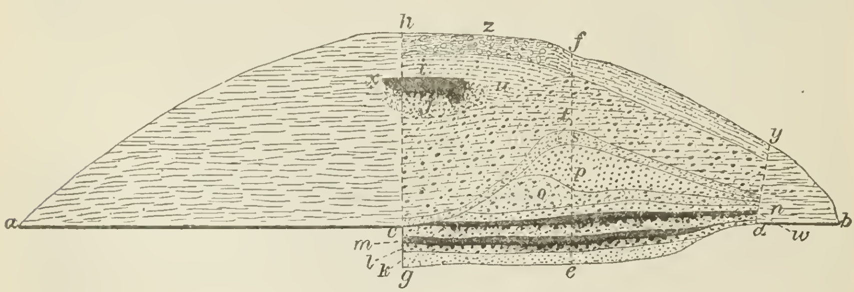


FIG. 2.—Mound in Fort, Ross Township, Ohio.

the mound *d*. The trench is 35 feet long, 4 wide, and at the center of the structure 9 feet deep. Before commencing the mound proper, the builders scooped away the earth, forming it in the manner of a basin. Immediately upon this basin was placed a layer of sand containing charcoal. Over this was placed a layer of charred bark 1 inch in thickness. The fiber of the bark was very coarse, and in places gave evidence that large sheets had been peeled from the tree, then charred, and, unfolded, spread upon the previous layer. The charred bark was continuous, though not extending out as far as *d*. This charred bark was found to be rotten. The first measurements were taken at *f e*, the depth of the trench at this point being 8 feet, the point being removed from the place of beginning 17½ feet. Upon the layer of charred bark was one composed of fine charcoal and sand 6 inches thick, *c*. Over that was placed a layer of charcoal 1 inch thick. Overlaying that was a deposit of fine-grained sand 4 inches thick, which in turn was covered by a layer of sand and ashes, *o*, 7 inches deep. Thence a deposit of sand 16 inches thick, *p*, over which was a layer of ashes 2 inches deep, *s*. Upon this was a formation of ashes intermingled with sand 30 inches deep. Over all was a layer of made soil more or less mixed with sand.

From *h* to *f* as we descended careful observations were taken. Upon the top of the mound and extending through the layer of made soil were loose limestone, some of which were as large as one man would wish to handle. All showed evidences of fire. The next course was composed of ashes containing both soil and sand, *u*. Within this formation was the altar *i*, composed of burnt limestone 3 feet in diameter and circular in form. Upon this altar were charred fragments of the horn of a deer. Other bones of the deer also occurred, none of which had been split open. With these remains were a fragment of pottery and an implement made of bone and one of horn, the last being charred. Some of the stone had been so thoroughly burned as to break in pieces on being lifted from the bed. Immediately below the altar was a layer, *j*, of red and matted ashes. From this point and extending to the bottom, and resting upon a layer, *s*, of ashes was a bed of ashes mixed with charcoal and sand. At various points in the excavation occurred fragments of bowlder, which had been broken after being polished. More of these fragments occurred near the center and bottom than at the surface. Similar fragments may be picked up in the adjoining field. No bones occurred elsewhere than on the altar, save in one instance. About eight years ago a relic hunter took out a human skull at *x*. What was done with it, or what were its characteristics I was unable to learn.

The walls of the inclosure, within which is the above mound, removes a natural elevation, which has been taken for a tumulus. It is a gravel mound, and belongs to the drift period. From the apex of this elevation some twenty years ago, were taken five human skeletons. The skeletons radiated from a center, the heads forming the inner circle. The remains were in a good state of preservation. No one took pains to secure them.

It might be well to notice, in order to be of service to investigators in other departments, that we saw clover roots extending into the mound perpendicularly a distance of three feet. Also 7 feet below the apex of the mound we saw a nest containing the common brown ant.

The next objective point was a mound close to a fort* on section 12, Ross Township, marked *a* in Fig. 3. This mound was examined on

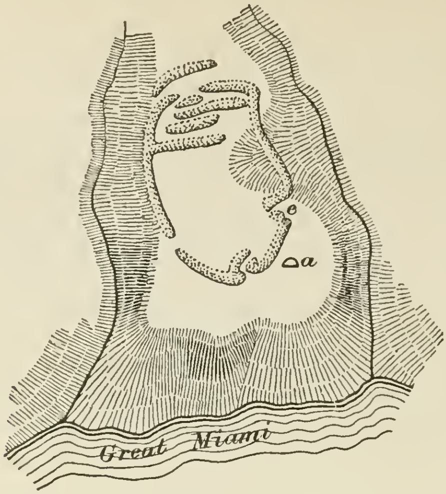


FIG. 3.—Fortified hill, Butler County, Ohio.

August 14, 1883. It is located 400 feet south of the gateway *E*, and is semi-circular in form, the concave part facing east. It is 70 feet long and 32 feet wide at the base. Its summit is 30 feet long and 12 feet wide. Until quite recently it was covered with forest trees, but not of large growth. At the northern extremity I sunk a trench at *c d* (Fig. 4), and ran it into the mound in a southerly direction a distance of 16

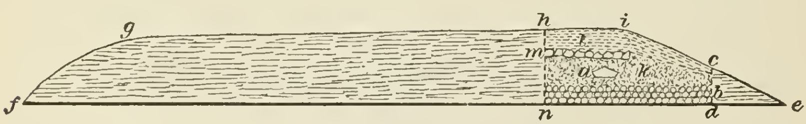


FIG. 4.—Mound on fortified hill, Ross Township, Ohio.

feet. At *h n* the depth was 5 feet. In the work we were constantly impeded by roots and masses of rootlets that everywhere occurred. The mound was covered by clay and compact soil to a depth of 2 feet. Under this was a layer of burnt limestone irregularly placed together. Under the limestone we came upon at *a* a portion of a human skeleton, imbedded in the layer or bed of ashes marked *k*. The skeleton was in an extended position, the feet pointing toward the northwest. It appeared to be lying partially on the right side, with the left arm thrown over the body. I worked with great care in order to obtain these bones whole, using my pen-knife entirely in lifting them from the bed, but succeeded only in obtaining the right humerus entire. The left femur had been broken off near the lower extremity.

* Ancient Monuments, Plate vii.

The bones secured were the femora humeri, the left radius, pelvis, and fragments of ribs. No cranium or backbone could be found. None of the bones would admit of scientific investigation, save the right humerus and left radius. The former is 12⅝ inches in extreme length.

Under the ash-bed were three layers of partially burned limestone, the three layers being 15 inches thick. The stone was regularly put together having the edges to fit so that no break appeared. Nothing occurred between the three layers. The bottom layer was placed upon the original surface of the ground. The stone was of good quality and still could be used for building purposes.

OTHER EXPLORATIONS.

I personally opened three mounds in Franklin Township, Warren County, Ohio. One of these occurred on section 23, northwest quarter, on the land of James McLane. The mound is removed 2½ miles from the Great Miami and located on the side of the rise of ground from the second to the third river terrace. It has a commanding view of the country to the northwest, and from which a light on the great mound at Miamisburg could be seen. The mound, to my certain knowledge, has been plowed over for the last twenty-nine years. It is low, and covered with a clayey soil mixed with sand. The apex is not over 2 feet above the general surface. Under the made land I struck an ash-bed 3 feet thick, considerably mixed with charcoal. In this bed I found a barbed spear-head, 3 inches long, made out of a bluish-gray chert.

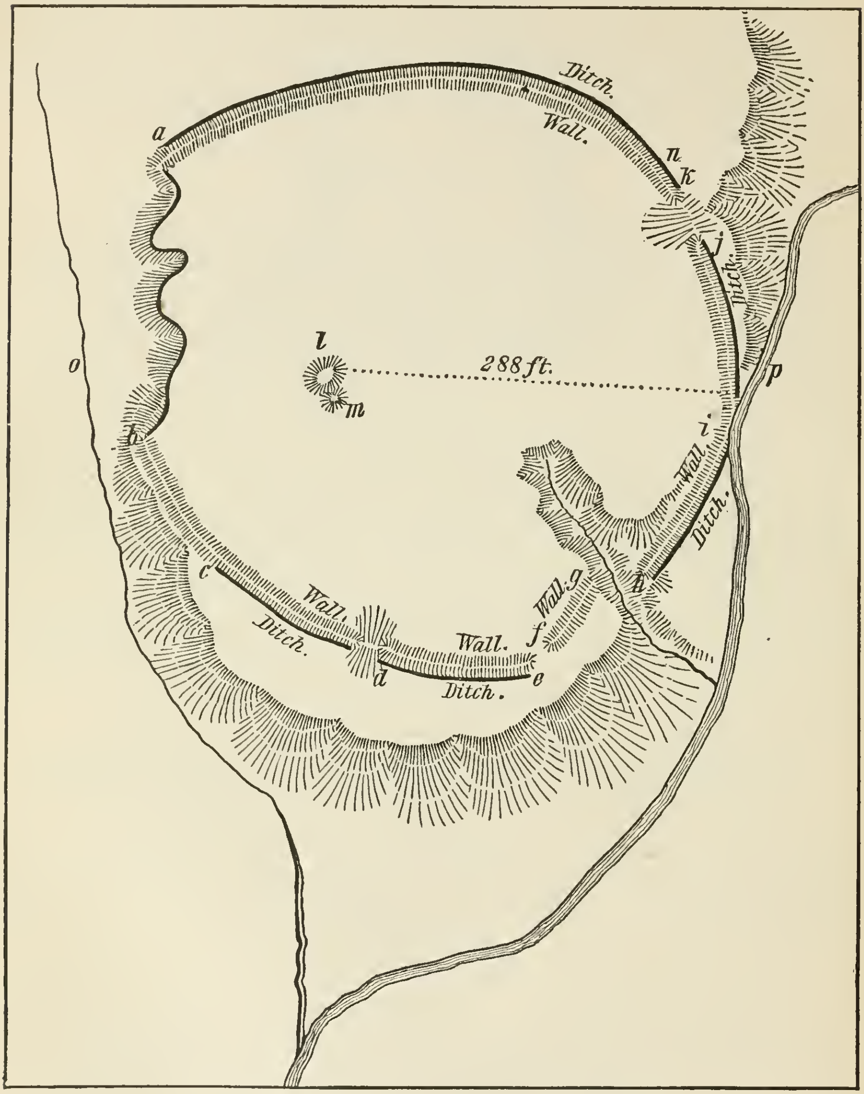
On the southwest quarter, section 22, on the land of George McLean, between the Franklin and Red River turnpike and the township line, are two mounds, one 6 feet and the other 4 feet in height. Both of these I opened, but in each was only an unstratified ash-bed, mixed with charcoal.

The three mounds above described are isolated. There is no evidence that they were used either for signal or sepulchral mounds. From the two latter a good view of the country in any direction could be obtained, although located upon the third river terrace. Had they been placed one-sixteenth of a mile farther north, a commanding view of the Great Miami River would have been obtained.

AN EARTH-WORK IN HIGHLAND COUNTY, OHIO.

By J. P. MacLean, *of Hamilton, Ohio.*

In company with Lafayette Ferris, on the 21st of July, 1883, I made a survey of an inclosure in Salem Township, Highland County, Ohio, located 1½ miles southwest of the village of Pricetown. It is covered with forest trees of the same variety and growth as those found in the immediate vicinity. On top of the embankment, at the point *n* in the figure, is a beech tree, measuring 10 feet in circumference at 3 feet above the ground. On the larger mound, *l*, is a decayed stump of what was once a large tree. From *a* to *b*, in a straight line, is a distance of 447 feet. Along this side of the inclosure is no artificial elevation.



Sketch of earth-work in Highland County, Ohio.

The small stream *o* once washed against this side and formed an irregular embankment 12 feet high, with a steep declivity. From *b* to *c* the artificial embankment skirts along the brow of the hill, has no accompanying ditch, and extends a distance of 192 feet. On the exterior of the embankment, from *c* to *d*, is a ditch 312 feet long. At *d* is a wash which has taken place since the work was abandoned. From *d* to *e* is a distance of 192 feet. The wall *f–g* is removed inwards, owing to the irregularity of the land. It is 48 feet long and has no accompanying ditch. The gateway *e–f* is 25 feet wide, and that at *g–h*, 64 feet. At the latter gateway the land rapidly descends, and there is a small stream passing through it. That this is not a washout is proved by the fact that the wall *h–i* with its accompanying ditch, extends down the declivity a distance of 14 feet. This would also show that the depression, for the most part, was there at the time when the wall was constructed. From *h* to *j*, is a distance of 424 feet. At *i* the stream *p* has encroached upon the wall, carrying a portion of it for a distance of 15 feet. The stream at this point is 32 feet below the embankment, presenting a perpendicular face, and is still encroaching upon the inclosure. At *j–k* is another washout. From *k* to *a* is a distance of 480 feet. The entire embankment has an average height of 3 feet and a base 24 feet in width. The accompanying ditch is 16 feet wide, with an average depth of 14 inches. At a distance of 288 feet from *i* is the large mound *l*, 6 feet in height and 60 feet in diameter at the base. It is encroached upon by the small mound *m*, 4 feet high and 42 feet in diameter at the base. The former has been partially opened, but no relics have been discovered.

MOUNDS IN BERRIEN COUNTY, GEORGIA.

By William J. Taylor, *of Alapaha, Ga.*

The Alapaha mound is situated 5 miles northeast of the town of Alapaha, on Alapaha River, on lot of land No. 328, fifth district of Berrien County, Georgia. It is 38 feet across, 6 feet above the level, and somewhat oval in shape. In the center of the mound was a burial vault 6 feet deep, 3 feet wide, and 6 feet long, north and south. Two bodies were deposited in this vault with the heads pointing south. From the appearance at the time of exploration the bodies had been deposited in the vault and then covered up with a large quantity of ashes and pine coals. The bones were very much decayed, and no implements were found with them.

The Withlacoochee mound is situated 5 miles south of Nashville, on lot of land 278, in the tenth district of Berrien County. The dimensions are 18 feet base diameter and 3 feet in depth. No relics were found in this mound, and even the bones were so far decayed that it was impossible to tell the mode of burial.

Reedy Creek mound is situated 10 miles northeast of the town of Alapaha, on Reedy Creek, on lot of land No. 24, in the fifth district of

Berrien County. There was a vault, or dug hole, 5 feet long, 3 feet wide, and 1½ feet deep in the center of the mound, in which the bodies were burnt and afterwards covered. On this covering was a burnt mass 3 feet deep and 20 feet in diameter. This had been covered up and the burning process repeated. The dimensions of the mound were 48 feet base diameter, and 6 feet in depth. No relics were found.

The French Ferry mound is situated on lot of land No. 415, in the tenth district of Berrien County, 10 miles south of Nashville, 7 miles southeast of Adell post-office. These two mounds are 1 mile down the river from the ferry, in a red-oak thicket, on a hillside facing south. The earth for the structure was obtained 30 yards diagonally up the hill. The work was built around a pine stump. No. 1 is of yellow sand mixed with gravel and rock. In the middle was a mass of charcoal mixed with the earth. No relics were found.

MOUNDS AND SHELL HEAPS ON THE WEST COAST OF FLORIDA.

By S. T. WALKER, *of Milton Fla.*

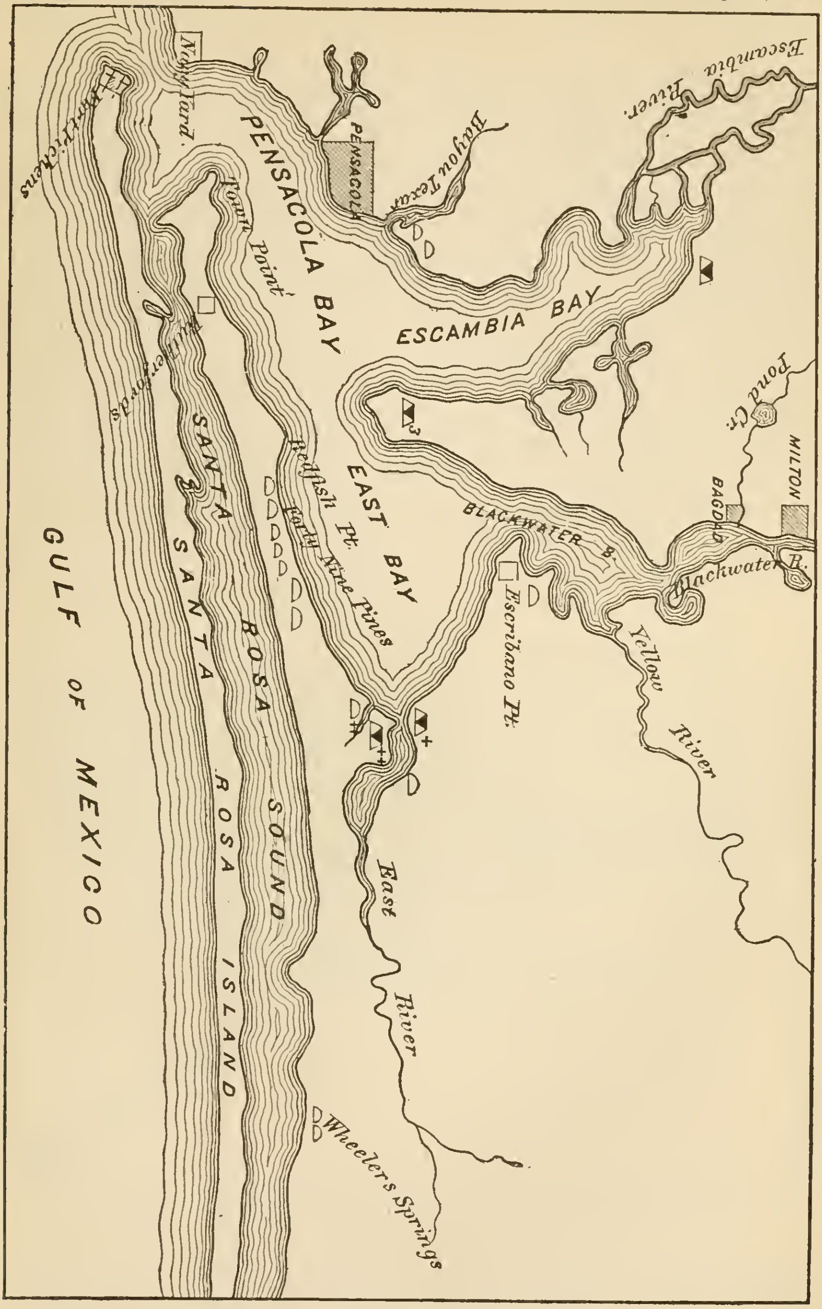
During the past two years the explorations of the mounds and shell heaps on the western coast of Florida have been continued, and many of the principal remains left by the aborigines between Hillsborough County on the south and Pensacola Bay on the west have been located, thus connecting the work with that done in 1879, a full report of which may be found in the Smithsonian Report for that year. These explorations were necessarily confined to the coast lines, or to such points as could be reached by the rivers. In no case, however, were they pushed very far above the influence of the tide.

On the accompanying map of Pensacola Bay and vicinity (Map 1) all the principal mounds and shell heaps may be seen at a glance. The mounds are generally quite small and were nearly all erected for domiciliary purposes. The shell heaps are also small in comparison with those of Tampa Bay. The long residence of white men in this portion of the State has tended to obliterate all traces of aboriginal occupancy except the larger mounds and shell heaps, and, besides these, but little remains of their works excepting an occasional arrow-head or a fragment of broken pottery. This is especially the case in the immediate neighborhood of Warrington and Pensacola.

It is probable that there was a large Indian population around the northern end of Escambia Bay and about the mouth of Escambia River, as many relics have been obtained in that region.

At the former site of the old village of Florida Town, in the vicinity of Ferry Pass, a large stone mortar was found weighing 157 pounds. This singular utensil is formed out of a coarse sandstone which is still quite

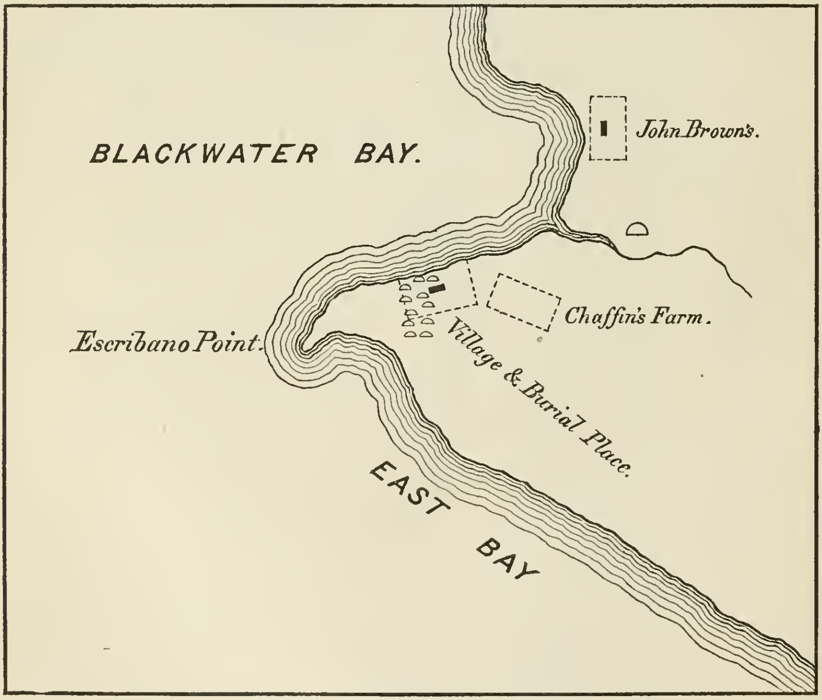
S. T. Walker. Florida. Smithsonian Report; 1883.



Map 1.—Pensacola Bay and vicinity, Florida.

abundant at Acadia, about 4 miles east of the place where the mortar was found. The marks of an iron or steel tool are plainly visible on this mortar, and seem to point to the agency of the white man in its manufacture, while its peculiar shape is characteristic of the savage artisan. Mr. Silas Jernagin, from whom this interesting relic was obtained, first saw it in the year 1828, at the house of a person who stated that it was found in a neighboring hammock many years previous to that time. As the latter person is dead, the precise facts in relation to its discovery cannot be obtained. The mortar is now in the Smithsonian Institution, and competent archæologists may be able to decide the matter. It was probably fashioned by an Indian, who had obtained an iron tool from the Spaniards, and who had gotten some idea of stone-cutting from communication with them.

At the head of Escambia Bay there are numerous small shell heaps, but no large mounds are encountered until a place is reached 1 mile north of Garcon Point, the southern extremity of the peninsula dividing Escambia and Blackwater Bays. Here are three large shell heaps situated



MAP 2.—Escribano Point, Florida.

in a small field about 200 or 300 yards from the water. They are quite regular in shape, and were probably used for domiciliary purposes. No relics were obtained here except a few fragments of broken pottery. A short distance from these mounds is a burial place, but as the evidences of its Indian origin were wanting, it was not disturbed, on the supposition that it was formerly a Spanish burial place made by early settlers.

No other Indian remains are on this peninsula excepting a small mound in Gilotown, which is of doubtful origin, as extensive digging brought to light no evidences of Indian occupation. At Escribano Point, however, on the eastern shore of the bay and about 7 miles below Milton, there is abundant evidences of a large Indian population. This point was in every way suitable for aboriginal settlement, as the numerous oyster beds in the vicinity afforded an inexhaustible supply of that favorite food, while the existence of shoal water along the shore for several miles was peculiarly favorable for shooting and spearing fish. It is quite probable that there was a large town or village at this place, and that large numbers of people resorted to it for the purpose of obtaining fish and oysters. Immense quantities of broken pottery are strewn over the ground, and all the usual evidences of Indian occupation are present; but the most important circumstance in connection with Escribano Point is the discovery of a new and singular mode of burial, which was practiced by the former inhabitants of this region. Fig. 1 gives a pretty good representation of this peculiar mode of bur-

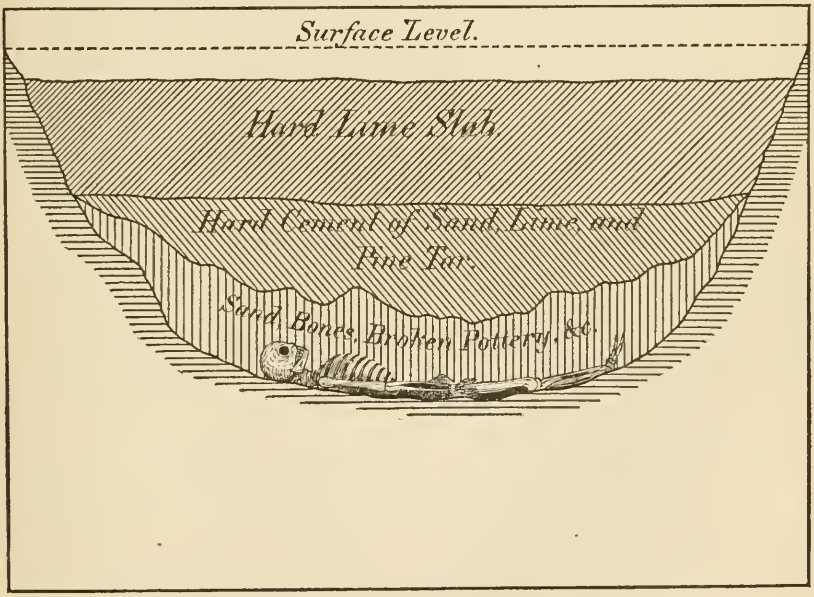


FIG. 1.—Mode of interment at Escribano Point, Florida.

ial in section. It seems that the body was first deposited in a grave four or five feet in depth and covered with earth. Upon this, oyster shells and pine wood were piled in large quantities; the heap was then set on fire, and the lime resulting from the burning of the oyster shells mixing with the sand, formed, when melted, a strong slab of cement over the grave. The rosin from the wood also assisted in the formation and the penetration of the loose sand to a depth of two or three feet below the lime formed a very effective covering for the grave.

These slabs are of all sizes, from 6 to 12 feet in diameter, and are from 2 to 4 feet in thickness. Evidences of intense and long-continued heat are plain in every case. The slabs are from 6 inches to 1 foot below the present surface of the soil, and were accidentally discovered in plowing the field. Ten or twelve were located by sounding with an iron rod, all in the area of 2 or 3 acres. Some time previous to the exploration above mentioned a complete skeleton had been washed out of the bluffs on the northern shore; but portions of the indurated sand slab are still in sight in the bank, and many fragments lay in the water at the base of the bluff. One of these pieces had some rude carvings of arrow or spear-heads cut into the surface. The fragment having these marks upon it seemed to be formed by the union of pine tar or pitch with sand, and was quite soft.

The field in which these graves are located was in cultivation at the time, and it was almost impossible to dig without disturbing the growing crop. Fortunately a grave was found at the intersection of two walks, and the penetration of the cement discovered portions of a human skeleton, very much decayed, and quantities of broken pottery. The work, however, was extremely laborious, owing to the hardness of the cement and its great thickness. The tenant on the place stated that he started a well near his door, and that on penetrating a slab he came upon a human skeleton, whereupon he filled up the well and dug in another place. About half a mile north of Escribano Point there is a small sand mound, but it contains no relics.

From this point the waters of East Bay continue very shallow for a considerable distance from the shore; oyster banks are numerous, and the beach is covered with shells and broken pottery. At the mouth of East River the shell heaps increase in size, and there are several quite large and of irregular shape. On the north bank of the East River, and about 1 mile from its mouth, there is a small earth mound 4 or 5 feet high and about 75 feet in diameter. The mound is situated within a short distance of the Mormon church, and as religious services were in progress at the time no examinations were made. On the opposite bank of the river, beginning in the field of Mr. Axelson, there are hundreds of shell heaps of various sizes, which extend along the shores for nearly a mile. No doubt this is the site of an ancient village. Immediately in the rear of Mr. Axelson's residence, on the slope of a hill, at the foot of which is an excellent spring, is a large quadrangle formed by shell banks, which evidently marks the site of an Indian village. Numerous arrow heads and other relics have been obtained here, and no doubt many more will be brought to light as the lands are cultivated.

Westward, along the shores of East River, are found great numbers of small shell heaps of all sizes in the hammock.

West of the mouth of the river, near the residence of Colonel Hooper, is the site of another village. This was situated on the banks of a small bayou, and numerous small mounds mark the position of many houses or wigwams. Excavations in these mounds revealed the situations of their fires and fragments of pottery and the usual refuse of culinary operations. Some years ago several skeletons were unearthed here by the plow. Altogether there is conclusive evidence of there having been a large population at the mouth of East River, and that there were probably two, or perhaps three, permanent villages located there.

Proceeding still westward along the peninsula between Pensacola Bay and Santa Rosa Sound, the next mounds are about 4 miles east of Redfish Point. Upon the bluffs here are two mounds, each about 12 feet high, constructed entirely of sand. Two days spent in digging revealed no objects of interest. Between these large mounds and Redfish Point many low circular mounds are scattered along the center of the peninsula. These mounds are mere elevations from 2 to 4 feet high, with bases from 50 to 200 feet in diameter, and, judging from the nature of the country, which is low and marshy, they were intended for residences.

About 1½ miles east of Redfish Point, at a place called Forty-nine Pines, are two earth mounds, one of which is 5 feet high and 80 feet in diameter; the other has every appearance of having been left in an unfinished condition. The larger mound was trenched carefully, but no objects of interest were found. There are many small shell heaps in the vicinity, and several objects were obtained from persons living near. From this place to Town Point, the western extremity of the peninsula, there are but few traces of Indian occupation.

Santa Rosa Sound is a stretch of water 35 miles in length, connecting Pensacola Bay and Choctawhatchee Bay. The sound is very narrow, and does not exceed 2 miles in width at the widest part. The traces of aboriginal residence along this body of water are nearly all confined to the mainland side. If Santa Rosa Island ever contained any mounds, the shifting sands have long since covered every trace of them. In proceeding east the first shell heaps are met with at Dr. Rotherford's place, about 2 miles east of the old Government Live Oak Plantation. Immense beds of shell and the usual indications mark this as the former residence of a large population. The slopes of the hills are covered with irregular beds of shell from 2 to 6 feet in thickness, which occupy an area of several acres. The beds contain large quantities of broken pottery and numerous implements made of shell. At this place was secured the first specimen of a clay image found in this section, a fragment of a rude imitation of a bird's head.

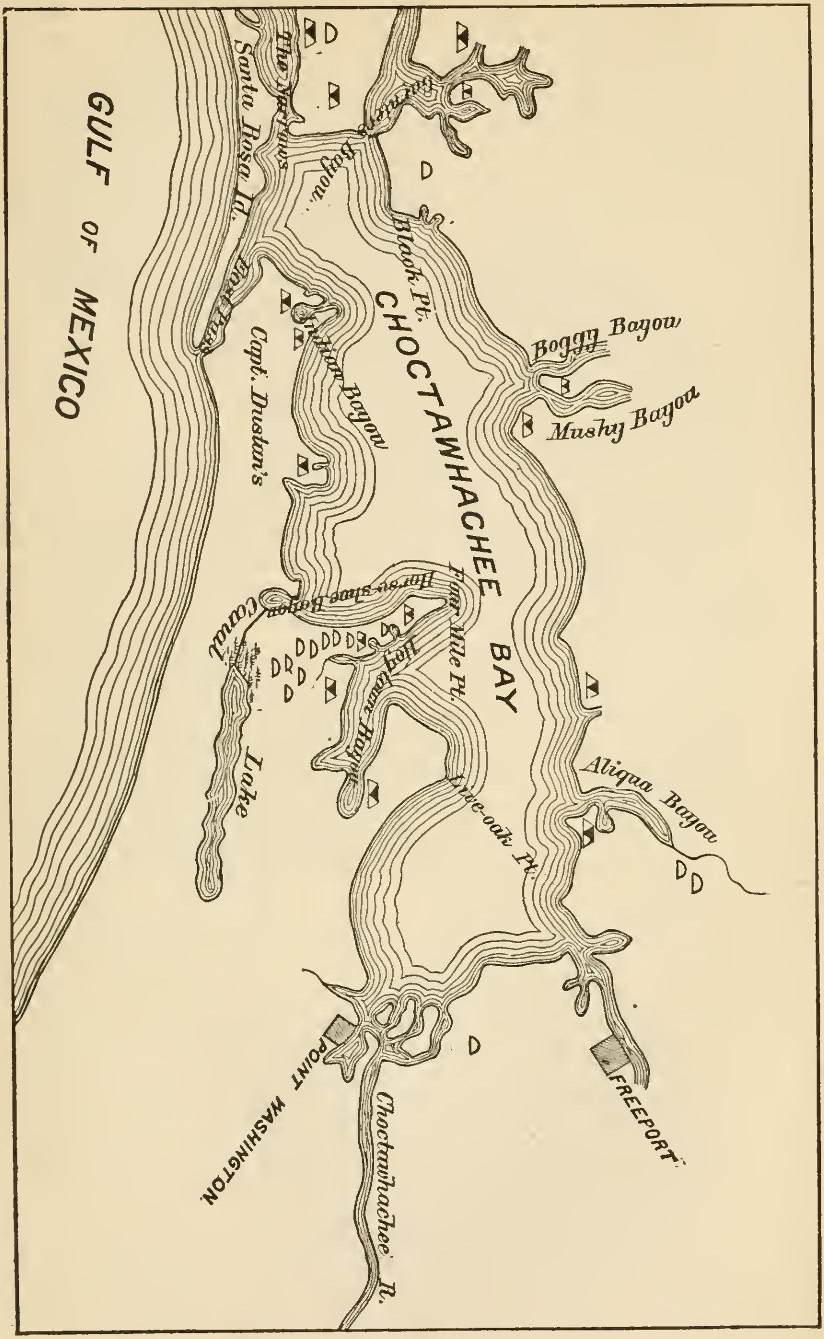
Shell heaps occur at various points between this place and Wheeler's Spring, 6 miles west of Mary Esther post-office. At Wheeler's Spring two earth mounds of small size are found, neither of which is of special interest.

Having thus briefly described the principal remains around Pensacola Bay and vicinity, let us turn to Choctawhatchee Bay, a map of which is presented. It is almost certain that the aborigines lived around these waters in vast numbers. Every cove and headland that is habitable was occupied; all points possessing unusual advantages for hunting and fishing were densely peopled, and at several points towns of considerable size existed. There is hardly an acre of ground on the entire coast line of this bay that does not contain some evidence of aboriginal existence or occupation. These people seem also to have advanced somewhat beyond their brethren of less favored regions in the arts, for it is here that we find the first attempt to model images or figures in clay. Some of these figures are extremely rude, but others are no mean representations of the objects they are intended to imitate. The object of these images or the uses to which they were put is not evident. Most people who have expressed an opinion of them regard them as idols or objects of worship, but it would better accord with Indian customs to regard them as family totems.

The southern shores of Choctawhatchee Bay and the region about the Narrows where Santa Rosa Sound leaves that bay were peculiarly suited for the support of a large population. From these points the Gulf shores are easy of access, and the shoal waters of the bay and sound furnished inexhaustible quantities of fish and oysters. Several large fresh-water lakes inland were swarming with fish, and game is still plentiful throughout the entire region. Two points seem to have been selected by the aborigines as sites for large towns, and both were located on points or peninsulas surrounded by shoal water, a condition necessary for this peculiar mode of fishing.

The first and larger of these two towns was situated on the northern shores of Santa Rosa Sound, where it enters Choctawhatchee Bay. The sound here is only about one-fourth of a mile in width, and navigation is obstructed by numerous bars and shoals, which were once covered by oyster beds, though at present the oyster is entirely extinct in both bay and sound. On the east is Choctawhatchee Bay, and northwest lies a large branch of Garnier's Bayou. Several bold springs of excellent water break out of the bluffs, and a small fresh-water stream empties into the sound here and once passed through the center of the town. The largest mound and shell heaps are situated near this stream and in the neighborhood of the finest of the springs. The position of the largest domiciliary mound in this portion of the State is marked by a large shell heap on the bluffs above the largest spring. This shell heap, which was converted into a fort by the Southern army during the civil war, is about 12 feet high, with a base about 200 feet in diameter. About 400 yards nearly due north of this heap, situated in a dense thicket of bushes and small trees, is the mound in question. It is cov-

S. T. Walker. Florida. Smithsonian Report; 1883.



MAP 3.—Choctawhachee Bay, Florida.

ered with a growth similar to that around it, and so dense and tangled is the growth of vines, briers, and bushes upon it that it is difficult either to measure or explore it. Its estimated height is 25 feet, its length 250 feet, and its width 135 feet. The measurements were taken along the top, which is nearly level; of course, the base is much greater. The sides are very steep, and on the south side is a sloping roadway leading to the top.

Many excavations have been made from time to time by curiosity-seekers, and during the civil war Dr. Sandrum, of Milton, Fla., who belonged to the company which was stationed at the shell fort, made explorations through a period of eleven months. I cannot learn that anything of importance has been found excepting human bones in the shell stratum beneath the sand. Dr. S. S. Forbes, of Milton, also visited this mound in company with some gentlemen from the North, and made several large excavations in it. He reports the finding of human bones in the shell stratum, but the skulls were so decayed that preservation was not possible. Dr. Forbes also obtained several clay figures representing human and animal heads, some of which he kindly gave to the National Museum. The old cuttings made by former seekers were explored, and several new ones made, with but little reward in the way of relics excepting human bones and teeth on the shell stratum, but not in it.

The top stratum of this mound is composed of sand to a depth of 5 feet; beneath this is a layer of shell from 2 to 3 feet in thickness. On the latter, but not in it, human bones were found, thus indicating that the bodies were deposited on the shells and covered with sand. A critical examination of the shell stratum was made, and from the evidence it afforded the conclusion was reached that the mound was originally much lower, and that the shell deposit was an accumulation of kitchen refuse; that it was for a time a place of residence and used as a place of burial, and afterwards that the stratum of sand was added and the place once more fitted for residence.

The facts which favor this view are, first, that the shell stratum contains the bones of bears, deer, birds, turtles, and fishes, the usual accompaniments of Indian feasting, while the upper and lower stratums are composed of clean sand; second, that the depth of these human remains in the earth is unusual and not at all in keeping with what we already have observed in Indian burials; and lastly, the pits or excavations from which the earth used in forming the mound was taken show in a very marked manner that the material was not all removed at the same time, some being mere depressions in the soil, while others are sharply defined and comparatively recent.

The formation of this mound being by a series of additions to the original work may prove a key to the construction of many of the larger mounds heretofore described as being composed of "alternate layers of sand and shell" (see Smithsonian Report for 1879, pp. 296 and 405), and will remove the greatest difficulty in the way of our admitting them to

S. T. Walker. Florida. Plate I.

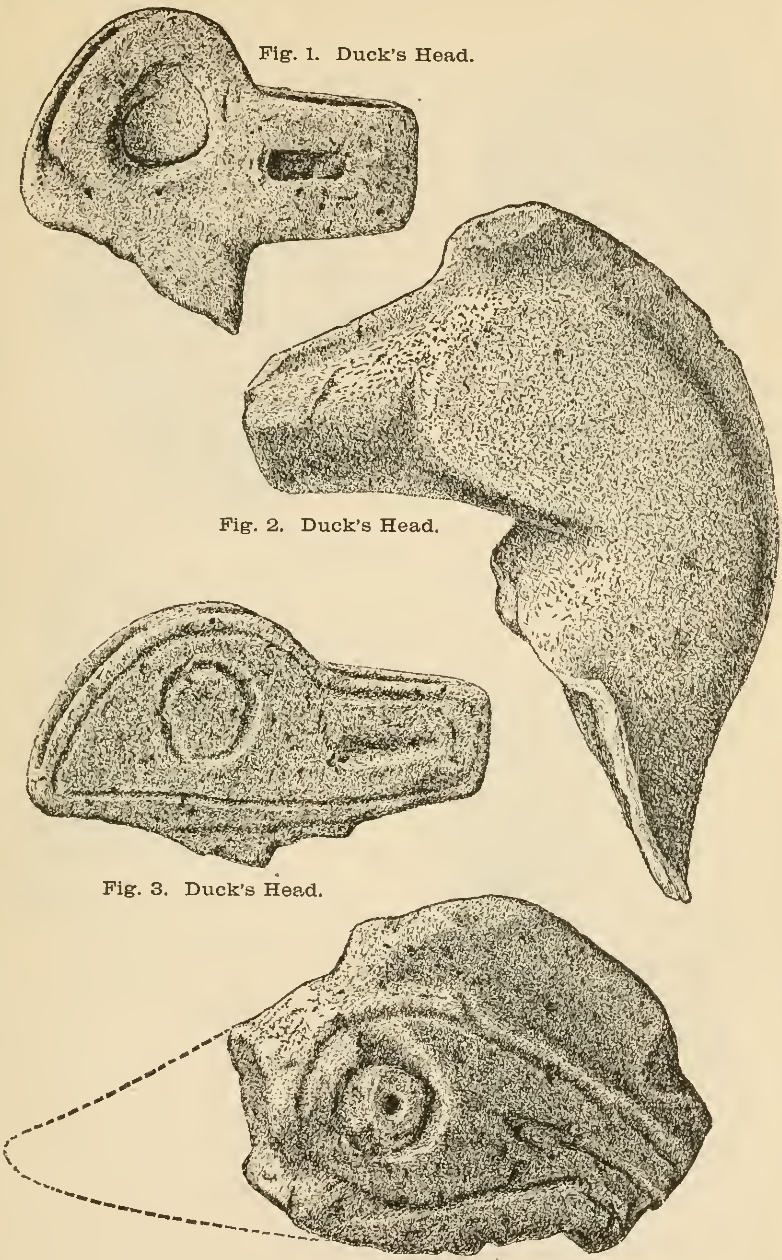


Fig. 1. Duck's Head.

Fig. 2. Duck's Head.

Fig. 3. Duck's Head.

Fig. 4. Fragment of Duck's Head.

S. T. Walker. Florida. Plate II.

Fig. 1. Human Head.

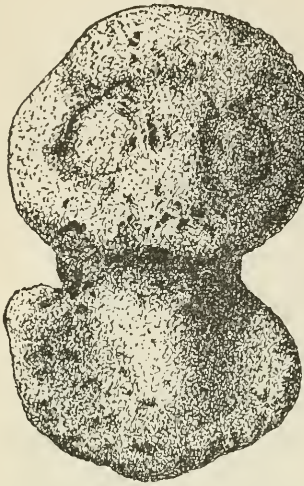
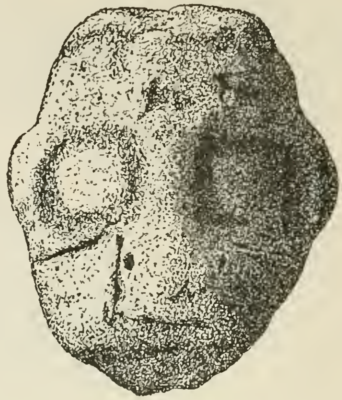


Fig. 2. Human Head.



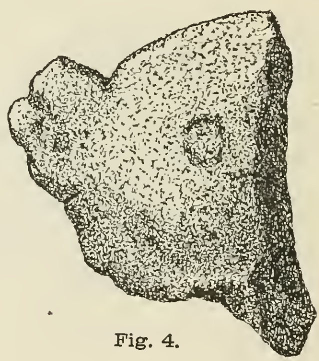


Fig. 4.

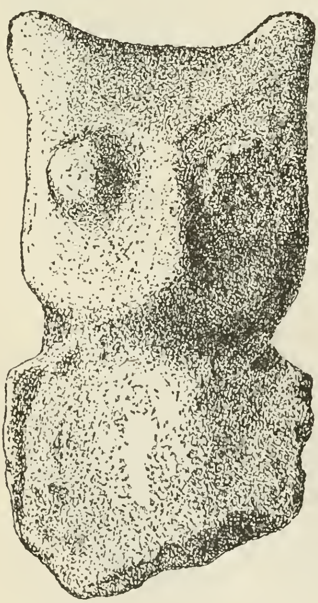


Fig. 3. Owl's Head.

have been constructed by the modern Indians, viz, their inadaptibility to concerted and continued effort. For if the large mounds were the gradual growth of ages and varied by successive additions, by many generations, we can readily understand and accept the theory of their being the work of the modern Indian.

West of the great mound are many small circles of shells covered with soil, from 40 to 60 feet in diameter, and the earth is covered with fragments of broken pottery. Over a space reaching from the great mound to the beach, one-fourth of a mile in width, and extending along the beach for nearly a mile, are shell heaps of all shapes and sizes, from a mere bed a foot in thickness to large heaps 12 and 15 feet high. In the fields, the crops are growing in beds of shell, and the furrows are full of broken pottery and fragments of clay figures. The latter are generally representations of the heads of birds and animals, though human heads and busts are not uncommon. Many are extremely rude, rendering it difficult to catch the particular form intended to be figured, while others are pretty fair imitations of the objects copied, and are quite creditable specimens of aboriginal art. They are composed of the same material of which the pottery was made, viz, black, red, or blue clay with a mixture of some white material resembling pounded shell. Some are composed of a reddish clay and afterward covered with a finer material, nearly black, which give the object the appearance of being glazed. In other specimens the body is formed of black clay and covered with red. As before remarked, the majority of the images represent the heads of animals and birds. Of the former the wolf or fox, the squirrel, and the beaver seem to have been the favorites, while the duck or goose is often copied among the birds, though the serpent and the owl were not forgotten.

In Plates I, II, and III, may be seen rough copies of several of these images, which will give an idea of the most common forms, from the rudest up to the best hitherto obtained. These images are not found in the mounds or graves, but scattered about the fields, on the surface, or in the piles of shell, along with broken pottery. It is somewhat strange that these images are only found on the shores of Choctawhatchee Bay and Santa Rosa Sound. In all the explorations along the west coast of Florida they have not been found, nor have any been heard of in any other portion of the State. Westward, however, they exist. Dr. George Taylor, of Mobile, has several which he obtained from the shell heaps on Bon Secour Bay, near Sand Island light, and they are said to have been found in the shell heaps, along the Mississippi coast.

Many hundreds of these images have been recovered on Choctawhatchee Bay, and while a few have found their way into the National Museum, many have been destroyed or are in the hands of private parties. Others will doubtless be found as the lands are brought into cultivation.

S. T. Walker. Florida. Plate III.

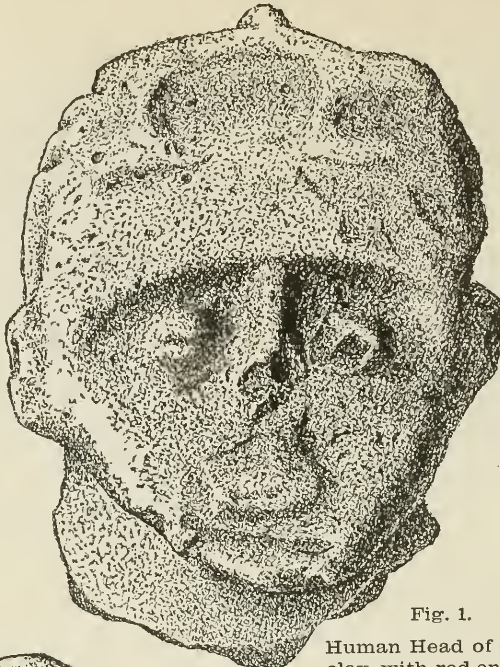


Fig. 1.
Human Head of dark clay, with red enamel.

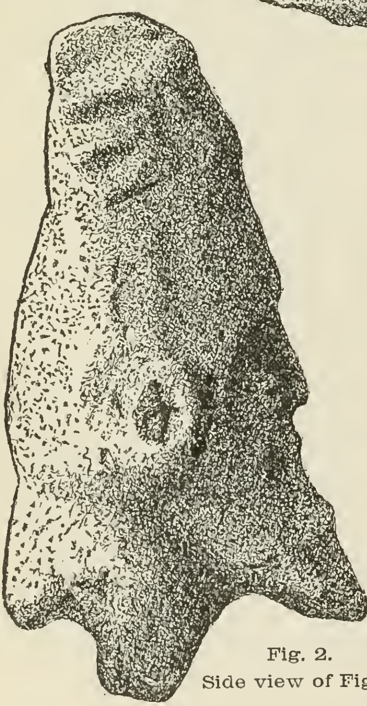


Fig. 2.
Side view of Fig. 1.

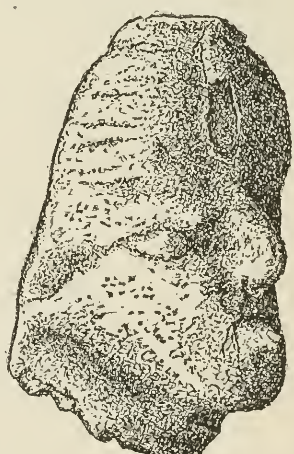


Fig. 3.
Human Head of red clay, with black enamel.

Passing over for the present the mounds, &c., intervening, a second great area of ancient population was about the center of the bay and on its southern side, where a point 3 miles in length extends north between Horseshoe and Hogtown Bayous, while on the south and between the point and the Gulf lies a large fresh-water lake, 7 miles in length and with an average width of a half-mile. The peculiar advantages of this point for an Indian town may be seen at a glance, viz: Fishing and hunting facilities unequaled and capable of easy defense in case of an attack. Evidences of a dense population once occupying this vantage ground begin one mile south of the extreme point and extend on both shores and down the center to the lake. These evidences consist of shell banks and heaps along the shores, and of low mounds along the center of the point. Some of the shell heaps are of immense size, while others are mere piles containing a few bushels. The mounds a short distance from the beach, and extending the whole length of the point, are slight elevations, and often five or six are placed in a straight line. Those measured were from 1 to 2 feet high and from 30 to 60 feet in diameter. The general surface of the country is low and flat, rendering it necessary to have elevations for houses.

The most important and interesting of all the aboriginal remains in this vicinity, however, is a canal leading from the head of Horseshoe Bayou into a large fresh-water lake, about 1¼ miles southeast of the bayou. This canal is about 14 feet in width at the top and 6 feet at the bottom. Its original depth was probably from 6 to 18 feet. At present it is not much over half that depth. At ordinary times the canal is dry, but during wet seasons the waters of the lake find an outlet through it to the bay. Excepting a slight angle at one place its course is straight, and the natural advantages of the ground were disregarded in order to reach the desired point by the shortest route. It enters the lake through a marsh, which at a time previous to the cutting of the canal, was probably a part of the lake, and this being drained by the canal, the ancient engineers were forced to continue their work through the marsh until deep water was reached. The lake, which is nearly 7 miles in length, contains immense numbers of fish, and the canal was cut for the purpose of reaching it in canoes, as these must otherwise have been transported overland at great expense of time and labor.

No burial places have been discovered in this region. Many clay images, however, of large size have been picked up at Mr. Henry Raddick's place on Four-Mile Point. These were all lost or destroyed by the children, as their value to science was not known.

Besides these two main centers of population, numerous smaller settlements existed at various points along the shores of Choctawhatchee Bay. Indeed, there is not a habitable spot that was not occupied, and there is not a point or cove without the characteristic shell heap. The most important of them are all correctly marked on the accompanying map, and a detailed description of each of these would involve a repetition that would be both tiresome and unnecessary. They present no peculiarities of structure or shape, and much labor expended in exploring them brought no new facts to light. The earth mounds were all probably domiciliary, and the shell heaps are the usual debris of feasts.

Nearly all the shell heaps are composed of oyster shells, which are very large, and it is a fact worthy of note that the oyster is at present extinct in Choctawhatchee Bay. Most of the heaps are covered with soil from 1 to 2 feet in thickness. From data obtained from the shell heaps of South Florida I have calculated that it requires at least fifty years to produce a stratum of soil 6 inches in thickness. From this it will appear that some of these heaps were completed from 100 to 200 years ago.

From this series of explorations the following facts seem to be pretty well established:

1. That promiscuous mound burial was practiced only to a limited extent in this locality.

2. That the races formerly inhabiting this district were further advanced in civilization than those of South Florida.

3. That it is probable all the large domiciliary mounds were built by small additions through many successive generations, and hence may have been partly the work of the modern Indians.

STONE MOUNDS OF HAMPSHIRE COUNTY, W. VA.

BY L. A. KENGLA, *of Washington, D. C.*

The mounds or graves described in this paper are situated on the eastern side of the South Branch Mountain, Hampshire County, West Virginia, about 1½ miles from the mouth of the South Branch River, on the property of Mr. Charles French. According to early accounts, the entire region between the Blue Ridge Mountains and the Ohio River was held by the Massawomee Indians.* The immediate locality (Fairfax Grant) was, however, the hunting ground of the Tauxenents, a band, perhaps, of the above-mentioned powerful tribe.†

The settlement of this district by the whites drove this tribe across the Alleghanies; and, after their departure, the country seems to have been a border line of warfare between the Delawares of Pennsylvania and the Catawbas of Virginia. This narrow and rough valley, from the mouth of the river to Moorefield, Hardy County, West Virginia, and probably far beyond, is replete with traditions and evidences of many a stubborn struggle—not only between contending tribes, but also between the Indians and the intrepid pioneers of West Virginia.

The locality of these mounds, known as "Shin Bottom," was also the

* History of West Virginia, page 34. De Hass.

† "Jefferson's Notes" on Virginia, page 152.

theater of contending, bloodthirsty savages. In close proximity to the graves there is a great bowlder standing on the side of the wood, to which a very interesting tradition is attached. It is called "Indian" or "Painted Rock." On its eastern face there is a figure, supposed to represent a man in the act of throwing a tomahawk. One can easily distinguish the rude outlines of a human figure, but the hand and tomahawk have been rendered obscure by the frequent violence of curiosity seekers. The lines are clear, strong, and of a dim red color. The tradition, as given by the inhabitants, is in substance as follows:

"At this point two hostile tribes, probably the Catawbas and Delawares, met and fought a terrible battle, in which all, with one exception, were killed, on the conquered side, and he succeeded in making his escape. Exasperated at this the victors, to complete their direful work, followed, brought back, and killed the unfortunate wretch, and with his own blood traced this figure on the rock."

The same account is given by Mr. Samuel Kercheval in his "History of the Valley," but with the variation that this warrior made a safe escape by jumping into the river and swimming with his head under water till he reached the Cohongornton, North Branch of the Potomac. (Page 48.)

The upper portion of this rock protects the side upon which the figure is sketched, from destruction by the elements. The South Branch of the Potomac was called Wappatomaka by the Indians. Throughout this entire range of mountains Indian mounds are numerous, and a comparatively unexplored field of archæological treasures awaits development.

The frequency of stone graves may in some degree be accounted for by the abundance of material suitable for their construction, by their proximity to fields of contest, to village sites, and to a most abundant hunting ground. They are found in much greater proportion in this than in any of the neighboring ranges. Their position cannot be restricted to any particular locality, for they are found on either side, on top, at the foot of the mountain, and in various places throughout the valley; sometimes on the river bank or on some small stream, or even in the central portions of the bottom lands. They are, however, less numerous on top of the ridges than in lower situations.

These stone graves are quite numerous in the vicinity of the "Indian Rock." In shape, both external and internal, they resemble modern graves; and since they contain an inclosure like a coffin, the term grave is very applicable to distinguish them from the earth mounds. They vary much in size, the smaller being mainly confined to the low lands while the largest are more frequently found on the tops and sides of the mountains. Those of any considerable dimensions are generally flat on top and the smaller convex. The stone of which they are made depends upon the locality; those opened were constructed of gray sandstone. The upper layers consisted of pieces as large as our street granite paving blocks, which gradually increase in size as the interior or "coffin" of the mound is reached. The "coffin" is made of large bowlders of the same stone. These stones are rarely spherical, but range from a few inches square to a weight of several hundred pounds.

No. 1. The first grave examined was situated midway on the side of the mountain. It was built in a small hollow or ravine, down which in wet seasons water flowed. Within 40 or 50 yards there were three others, two of which were opened and examined.

It (1) was very large, about 50 feet in length, 25 in width, and from 4 to 5 in height. It was flat on top and extended lengthwise north and south. The excavation was commenced on top at the southern extremity. After working downwards and northwards through the mass of rock for the distance of 3 feet, we came to some very large bowlders. Taking these as a guide we continued to work along the western side towards the north end of the mound. All the rock that remained at the north end and over the body of the "coffin" or cavity was next removed, and the earthy débris cleaned away. From the south end of the "coffin" was then removed the large rocks with which it was filled.

Then began the examination of the dark earth with which the floor was covered. The mass of the material was decayed wood-earth together with a small quantity of light colored clay. At the lower end were found one long bone and more fragments, presumably leg or thigh bones, and at the north end a fragment of a skull. No pottery or stone implement of any description was exhumed. The sides of the casement for the remains were constructed of large bowlders 1½ foot high, placed closely together throughout the entire circuit. Beneath there was a floor of flat stones, and at the upper end one was raised about 2 inches above the rest, near which the fragments of skull were found.

No. 1 B. As yet only half of the first mound had been torn away, and encouraged by the find, though we mainly directed our attention to the discovery of stone implements, the destruction of the remaining mass was begun.

Commencing on the east side of the grave just opened we soon reached another wall of large bowlders, running in a direction parallel to and placed directly alongside of the wall of the former. Upon removing the stones from the sides and central portions as before, the excavation of the coffin was commenced. But a most careful search was ineffective in bringing to light any relics. The absence of all human remains may be possibly attributed to the position of the mound, which was such that a very large quantity of water annually passed through it, rendering the decomposition of the bones more rapid.

No. 2. About 20 yards to the right, when looking down the mountain and facing the east, a second grave was opened, which was situated a little to the side of the hollow.

This mound, though not so large, extended in length in the same direction, north and south, as the former. In appearance, (save that it was not flat,) both externally and internally, it was similar to that of the one previously explored. It contained a single inclosure or coffin. No remains except a fragment of a long bone were found.

No. 3. A third of this group, situated about 30 yards down the mountain and on the lower side of an old road, was examined. Its construction and general outlines were the same as those already described. No remains were discovered, and from its position in the deepest part of the hollow it is supposed that all traces had long since been destroyed.

No. 4. The fourth mound was situated about 200 yards from the "Indian Rock," near the base of the mountain. Though much smaller, it resembled the above in all particulars. A large number of fragments of bones belonging to various parts of the body were collected. The exterior shape of the mound had been very much disfigured by hunters.

Mr. French, the owner of the property, needing stone for building purposes, had previously opened several graves and removed from them a quantity of bones and some pieces of pottery.

There were no means by which we could judge the age of these mounds, even approximately. The first graves or stone heaps examined were encircled by a grove of oak and locust trees of an inferior size. Near the fourth there grew several large oaks, but all were at too great a distance to be of any avail in such a determination. The amount of earthy matter on or within could not be relied upon as affording any definite clew, since very little could penetrate the grave, and what was there could easily have been deposited in the lapse of time by nature. The stones were not placed immediately upon the corpse, perhaps; but they rested upon logs and brush, which were supported by the walls of the inclosure. If this supposition be correct, the amount of debris could have been greatly increased.

It is generally supposed that these mounds were quite small at first, and were increased in size by new interments and by the addition of stone from time to time. It is said that whenever a friendly Indian or tribe passed a grave, each individual, out of respect, added a stone or more to the heap. Though this may be plausible, it is just as likely that it was the final interment of the body, and that the size of the mound depended upon the rank and tribal standing of the person. If, on the other hand, these interments were only temporary, it is probable that the large mounds were the final resting places of a large number of bodies by secondary interment.

This hypothesis is in accordance with the customs of many tribes, east and west, and was practiced by the natives of the lower districts of Virginia long after its settlement by the whites.*

The total absence of all stone implements is accounted for by the residents, the supposition being that these were women's graves or of those members of the tribes who were of minor importance. The find of pottery in one or two would strengthen this supposition.

This theory is again to some extent sustained by the opening of sev-

* "Jefferson's Notes" on Virginia.

eral mounds on the top of this mountain yielding bones, pyrites (cubo-octohedral, crystal), arrow-heads, and fragments of pottery. In contradiction, however, to the above, one grave, opened by Mr. Joseph Pancake on his farm in the river bottom, about 2 miles above Romney, in this county, contained a celt, a pipe, and some arrow-heads.

On the front of this pipe, at the upper rim of the bowl, there was carved an eagle in a neat and tasteful manner. Some years ago the party from whom were procured the above specimens opened a large mound in Mineral County, West Virginia, near the town of Ridgeville. In external appearances, according to report, it was similar to those described, but, instead of in a coffin-shaped repository, the body was buried in a sitting posture. The skeleton was nearly whole at the time of exhumation; the feet rested upon the floor; the legs against a wall, above which in the seat were the thigh bones; and against a second wall leaned the bones of the back and chest. The arms seemed to have been placed in a careless position at the side, with the hands open and lying upon the shelf with the thigh bones. The head rested in a recumbent position on a third shelf. A fragment of pyrites was found near by, which is supposed to have been placed in one hand. Among the bones and débris there was discovered a brass button of continental style.

For the authenticity of his description the narrator referred to several gentlemen residing near the locality, who were present and assisted in the work, and in whose possession the bones were when last heard of.

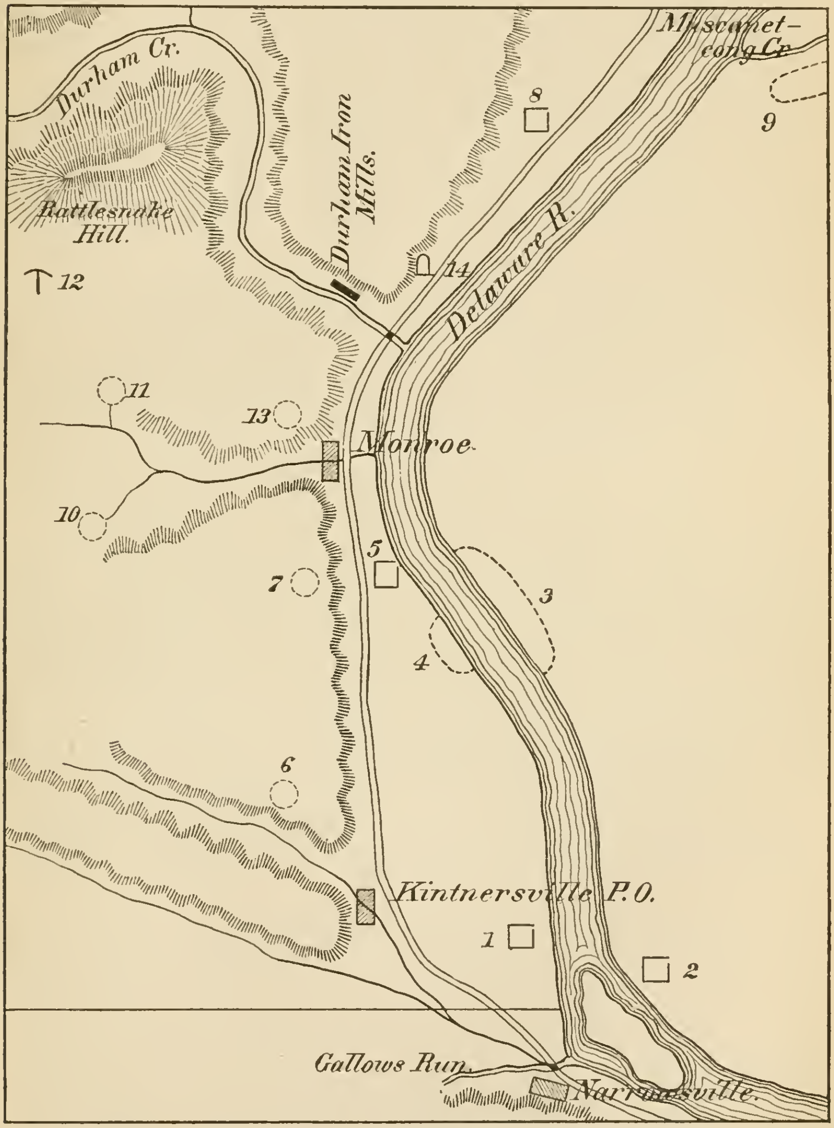
Other mounds and remains were found in abundance as the country was cleared and the land cultivated. The specimens of pyrites and pottery found on the South Branch Mountain have been added to the collection of archæological remains from the district, deposited at Georgetown University.

REMAINS IN BUCKS COUNTY, PENNSYLVANIA.

By John A. Ruth, *Riegelsville, Pa.*

Durham, the most northeastern township of Bucks County, Pennsylvania, is situated on the banks of the Delaware River, 9 miles south of Easton, and by railroad 76 miles north of Philadelphia. The township covers an area of about 9 square miles, and the greater part of it is drained by the Durham Creek and its tributaries. The surface is hilly, the soil fertile and in a high state of cultivation. To its original occupants it presented many natural advantages, and the remains of their workmanship found buried in the soil show that they saw these advantages and made use of them. The southeastern part of the township was their favorite resort. This part of the Delaware Valley is about 1½ miles long, and about one-half mile in width at the widest part. It is bounded on the east by the Delaware River, and on the west and south by a range of bluffs extending from the village of Monroe to the

Narrows, which rise perpendicularly to the height of nearly 400 feet. It is strongly defended by nature, and the scenery is not surpassed by any in the county. There are other localities in the township where relics are found, but nowhere in such abundance as in the locality just mentioned. I shall now describe these and other remains in the order in which they are numbered on the map.



Remains in Durham Township, Bucks County, Pennsylvania.

No. 1 is the site of what once was an extensive village, situated on the banks of the Delaware, near the mouth of Gallows Run, and about one-quarter mile from Kintnerville. It extends along the Delaware several hundred yards, and back from the river about 50 yards. Its extent may easily be traced by the broken cobblestones and chips of flint and jasper which are thickly strewn over the surface. Many of the cobblestones bear marks of fire. Among this refuse a large number of relics have been found. They exhibit all degrees of workmanship from the rudest to the most skillfully wrought. The most abundant relic is the arrow-point, of which have been here collected more than 400 specimens. Many show by their workmanship that they were made by a people who had advanced in the stone art to a high degree of skill. In this locality have also been found many hammers, spear-heads, scrapers, and plummets. The spear-heads found are generally broken. Among the rarer implements are drills, polishing-stones, axes, celts, knives, paint-cups, pestles, ceremonial hatchets, and amulets. The hatchets and amulets are all broken, but are highly polished and well proportioned. They show great skill and patience on the part of those who shaped them. Fragments of pottery are plentiful. Some of it is ornamented. Many of the fragments are well preserved, but others are crumbling and have the appearance of great age. The material used in the manufacture of the stone implements of this and the other village sites in the township is that found in the locality. Probably one-half of the arrow-points are made of trap, the remainder of jasper, quartz, red shale, &c. But few specimens are made of the last-named mineral, which is not a very durable material for stone implements.

No. 2 is also the site of an ancient village, on the farm of Mr. Clark, one mile north of Holland Station, Hunterdon County, New Jersey. The extent of this village was not as great as that at No. 1, but it has added to our collection many fine specimens. Among these is half of the bowl of a stone pipe, the only fragment of a stone pipe yet found. Its shape is similar to Fig. 179 in Dr. Abbott's Stone Age in New Jersey. Two stone axes of very rude workmanship were picked up at this place. The rudest is an ordinary cobblestone notched at the sides, near one end, and slightly grooved half way across one side. The other is an oval cobblestone, 11 inches in length, with a narrow groove around one end. No attempt seems to have been made to sharpen either of these axes.

No. 3 is a locality on the farm of Mr. Snyder, near Holland Church, where have been found a number of spear and arrow points, most of them broken. Tradition tells us that this was an ancient battle-ground. Two tribes lived in the vicinity, and the children, in their wanderings, met each other and quarreled about a large grasshopper which one of them had found. This resulted in a war, and this locality is said to be the place where the decisive battle was fought. The conflict was witnessed by a white man from the opposite side of the river. Such is the tradition as it exists in the neighborhood.

No. 4 is on the farm of Mr. Overpeck, near Monroe. This locality is peculiar in its relics, which consist of triangular arrow-points and fragments of finely ornamented pottery. Besides these, no other relics were discovered, except several pieces of clay pipe-stems, an amulet, several celts, and fragments of pestles. Since the writer has collected at this place, he has found but one arrow-point with a stem, while of triangular arrow-points more than 100 specimens have been gathered, most of them broken. A large number of fragments of pottery were found scattered over the surface. They were in a good state of preservation, and many of them are finely ornamented, especially those pieces which formed the rim of the vessels, some of which are perforated. Chips of jasper occur in the soil, but very few broken cobble-stones. It is difficult to explain why all the arrow-points are triangles, and why the pottery is of better workmanship than that of any other locality in the township.

No. 5 is the site of a small village on the farm of Mr. Tranger, of Monroe. It is situated about 100 yards north of No. 4, but is quite different from it in the character of its relics. Here chips of flint and broken cobble-stones are found again. The relics are principally spear and arrow points, knives, scrapers, plummets, &c.

No. 6 is a locality on the farm of Mr. Overpeck, where we find spear and arrow points, some rude pottery, hammers, and occasionally a few other implements.

No. 7 is on the edge of the bluff, on the farm of Mr. Aaron Tranger. In the character of its relics it is similar to No. 6. Some of the arrow points are made of a material not found in the locality. This place was probably occupied by parties guarding the villages in the valley against invasion. The position commands a good view of the Delaware Valley toward the north.

No. 8 is a locality on the farm of Cooper and Hewitt, one-half mile south of Riegelsville, where have been found arrow-points and a few other relics. The refuse scattered over the surface indicates that it was the site of a small village.

No. 9 is on the farm of Mr. Riegel, near the mouth of the Musconetcong Creek, Hunterdon County, New Jersey. Spear and arrow points are found here.

No. 10 is on the farm of George Shick, between two springs, where have been found spear and arrow points, hammers, knives, scrapers, plummets, a fine drill, &c.

No. 11 is also around a spring, on the farm of Jacob Richards. The relics are the same kind as those found at No. 10.

No. 12 is an ancient jasper mine on the farm of Cooper and Hewitt. The excavation made in mining the jasper is still to be seen. Around it is a ridge of earth and stones, thrown out by the miners. The ground is overgrown with brush and small oak, and is not cultivated for a short distance around the mine. The excavation is partly filled with stone hauled from the adjoining fields. Very few arrow points are found around the mine. Chips of red and yellow jasper are found in large quantities, scattered over more than 20 acres around the mine. With them are found numerous river pebbles and cobblestones with hammer marks on them. Some are worn off around the entire edge; others were originally nearly round, and through use became still more so. Nearly all the hammers found on village sites have finger pits, but these have none, and are found only around this mine. These facts seem to indicate that they were used as hammers for blocking out the jasper into pieces of a suitable size for implements, and that these blocks were then carried to the villages, where they were finished.

No. 13 is on the farm of Henry Adams, situated on the top of the hill. It commands a fine view of the Delaware and Muscanetcong Valleys. Here have been found but two kinds of relics—a few arrow-points and several dozen plummets. Most of the plummets found on village sites are similar to Figs. 204 and 205 in Dr. Abbott's Stone Age in New Jersey, but those found in this locality are nearly all like Fig. 203.

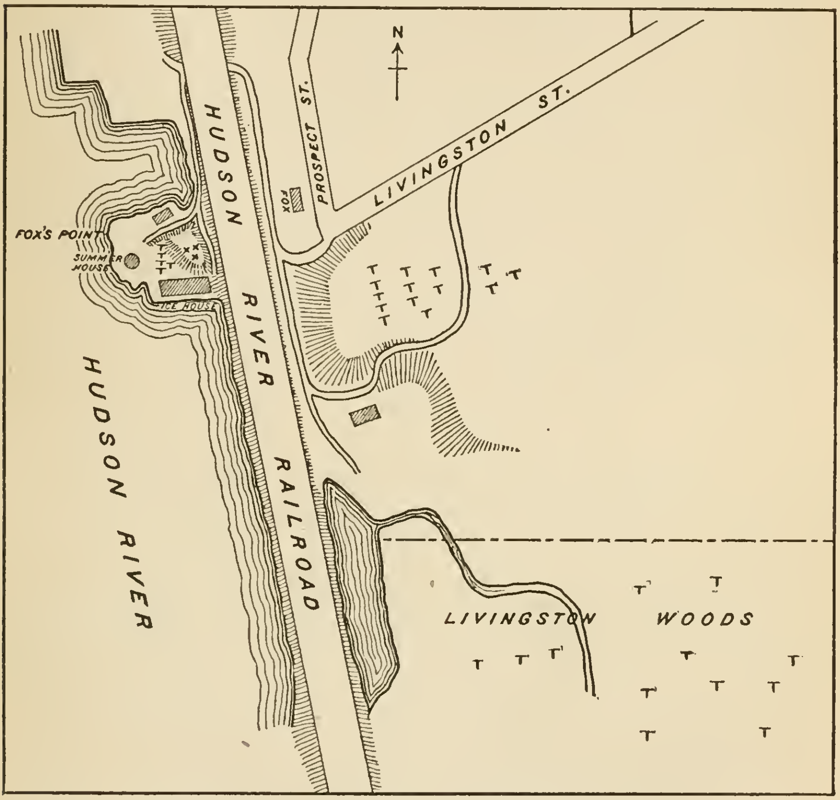
No. 14. Durham Cave is the name given to a cavern in the limestone formation on the north side of the Durham Creek, near its mouth. The cave extends into the hill toward the west, parallel with the creek. A large part of it has been destroyed by quarrying the limestone, which is of excellent quality and was used in the furnace near by. The main passage was about 150 feet long, from 4 to 40 feet wide, and averaged about 12 feet in height. The floor descends as you enter, and at the farther end is a fine spring. A few stalactites formerly hung from the roof. About forty years ago, when the cave was opened, petrified bones were found in one of the rooms. They were removed by several scientists who had come from New York for that purpose, and were sent to some scientific association in that city. A number of interesting relics were also found, among them spear and arrow points, beads, and a skull. The latter is said to have been sent to some museum in Philadelphia. A small room on the right of the main passage was, years ago, named Queen Esther's Drawing-room, after an Indian woman.

RELICS IN POUGHKEEPSIE, NEW YORK.

By Henry Booth, *of Poughkeepsie, N. Y.*

In the southern part of Poughkeepsie, Dutchess County, New York, and extending beyond the city limits, there used to be a large deposit of molding sand. This has been dug out during the last seven or eight years and carted away. The accompanying map shows a part of this sand bed, which has proved to be of great interest. In October, 1882, some fragments of human skeletons were turned up by the laborers on

Fox's Point. This was reported to the writer by Mr. E. W. Frazer, the foreman, who very kindly afforded every assistance in his power to make an examination of this part of the sand bed. The deposit of sand is overlaid by earth, which is generally about 1 foot deep. The stratum of sand varies from a few inches to 4 or 5 feet in depth. On top of this sand, directly below the soil, the larger part of the stone implements were found. At the place on Fox's Point, marked on the map with three



Graves and relic sites in Poughkeepsie, New York.

Greek crosses, the skeletons were dug up. The ground here is a few feet above the level of the Hudson River Railroad. Enough skulls and fragments of skulls were dug up to permit the supposition that six bodies had been buried here. These bones were found at depths varying from 1 foot to 3 feet below the surface. Of four bodies there remained nothing but parts of the skulls, a few teeth, and fragments of ribs. Of another body there were leg bones, fragments of ribs, finger bones, vertebræ, and a nearly complete skull, including the lower jaw. This skeleton lay on its right side, with the knees drawn up to the chin. Of another body there were a few vertebræ and finger bones, and a nearly complete skull, including the lower jaw. This skull rested on its chin, facing westward, or toward Hudson River. Underneath it was found a piece of burnt sandstone, rudely chipped into the form of an arrow-head. With the exception of this stone and a bit of chipped hornstone, nothing was discovered with the bodies. In the hollow on Fox's Point, below and west of this little hillock, the sand, when dug up, showed traces of fire, being red instead of yellow. Intermixed with it were a great number of broken stones, which also seemed to have been burned. Here were found many implements, both fragmentary and entire. They were pounders (oval or round cobble-stones with worked depressions on either side for the fingers), spear-heads, arrow-heads, pestles, &c. On top of the rising ground east of Fox's Point and the railroad many stone implements were found. In 1876 Mr. E. W. Frazer picked up near this place half of a steatite dish, which is now in the American Museum of Natural History in New York City. No iron implements of any kind have been recovered here, and no bodies except those mentioned above. The total number of perfect implements from this locality, now in the writer's possession, is as follows: Pounding-stones, 32; pestles, 5; arrow and spear points, 103; hoes, 6; axes, or hammers, 2; drill, 1; rubbing-stone, 1. The fragments and flakes amount to several hundreds.

NOTES ON THE WAMPANOAG INDIANS.

By Henry E. Chase, A. B., *of Brookline, Mass.*

Every year the signs of Indian settlements along our coast are becoming fewer. The experience of the last two years has taught the writer that great ignorance prevails among those persons whom we might most reasonably expect to direct us to the sites of Indian towns. He has thought it worth while, therefore, to put on record, for the convenience of others, the exact sites of all the Indian shell heaps and other indications of Indian settlement seen during the summers of 1882 and 1883. Besides the mere description of the towns in their present condition, and the implements, weapons, &c., found at or near them, a general history will be given of what has been recorded or is known on the subject from other sources, together with a detailed account of the origin, language, customs, manners, traditions, and religion of these Indians, so far as it was possible to gather them. Further study shows that much of this information is already in such available form in the works of Gookin, Williams, and a few other early writers, who had the best opportunities to study the Indians, that all subsequent scholars will prefer to consult them in the original. References will be made to these and other works which are useful in the study of the Indians referred to in these notes, and only so much of them will be quoted as is absolutely necessary to give one unacquainted with the Indian tribes of

New England a fair knowledge of the Wampanoag tribe, to which the Indians of Cape Cod, Martha's Vineyard, and Nantucket belonged. The practice of the writer has been, after finding alone the site of some Indian town, and obtaining all the information available from the farmers and others living in the vicinity, to turn to the volumes of the Massachusetts Historical Society's works and Barber's Historical Collections, "a general collection of interesting facts, traditions, biographical sketches, anecdotes, &c., relating to the history and antiquities of every town in Massachusetts," and learn what is there said of the Indians once living there. This information was sometimes very satisfactory, but until recently went ahead of the explorations, and there are still a few important additions to be made to the map of Indian settlements on Cape Cod. In the rambles in search of arrow-heads, stone hatchets, &c., little of the history of their former owners could be learned from persons now living near by, the usual information being to the effect that "when the oldest inhabitant was a boy," an old Indian or squaw lived near the spot where the arrows or shell heaps exist. In a few other places, as at Mashpee and Gay Head, the mixed descendants of the Indians may still be seen; but, with the exception of a few names, like Pocknet and Attaquin, their names are English, and their hair inclined to curl, owing to their frequent intermarriage with the negroes. A friend who has given the matter some attention writes that there are now probably none of unmixed blood among the Indians of Mashpee, though many of the people have a strongly marked Indian appearance. Neither these Indians nor some of the same sort at Gay Head could give any exact information in regard to the sites of old Indian towns, and the conclusion is inevitable that they know less about such things than some small white boys living near by, who are in the habit of collecting arrow-heads. At several places on Cape Cod, Martha's Vineyard, and Nantucket people are becoming interested in Indian relics, and it is frequently impossible to buy a stone hatchet (which the owner may have thought worthless), because he heard that another man had sold such a grooved stone for a great price. Several boys have collections of arrow-heads amounting to two or three hundred; and middle-aged men have said that in certain places they could once find all the arrow-heads they wished, and have been surprised when there were found only one or two, perhaps not one. Old men say that it was the habit of the farmers to plow up most regularly all those fields which had been already cleared by the natives, for these always gave the best crops, owing to the rich black soil that was usually found there. On the east side of Bass River, and on Indian Neck, near Wellfleet Harbor, may be seen the wisdom of this practice; for at these places the most thrifty vegetables in the fields were those growing in the dark earth and scattered shell-heaps. But by this practice the most lasting monuments of the Indians have been erased, their graves levelled, their shell heaps scattered, and their weapons and implements of stone plowed under or picked up and removed. On Nantucket and Martha's Vineyard it was easier to get information on our subject, probably partly from the fact that Indian names have been more easily preserved on islands, where may still be found many descendants of the first white settlers, and partly, in the case of Nantucket, through the publication by the Old Colony Line of a historical map of that island, surveyed and drawn a few years ago by the Rev. E. C. Ewer, D. D. To give the reader a general idea of the tribes inhabiting New England, and the relative strength and country possessed by the tribe to which the Cape Cod, Martha's Vineyard, and Nantucket Indians belonged, a few quotations will be made from the writings of Mr. Daniel Gookin, one of the magistrates of Massachusetts colony, and for many years, commencing with 1656, "betrusted and employed for the civil government and conduct of the Indians in Massachusetts colony by order of the general court there."

"OF THE PRINCIPAL INDIANS THAT INHABIT NEW ENGLAND.

"1. The principal nations of the Indians that did or do inhabit within the confines of New England, are five: 1, Pequots; 2, Narragansitts; 3, Pawkunnawkuts; 4, Massachusetts, and 5, Pawtucketts.

"2. The Pequots or Pequods were a people seated in the most southerly bounds of New England, whose country the English of Connecticut jurisdiction doth now, for the most part, possess. This nation were a very warlike and potent people about forty years since; at which time they were in their meridian. Their chief sachem held dominion over divers petty sagamores, as over part of Long Island, over the Mohegans, and over the sagamores of Quinapeake, yea, over all the people that dwelt upon Connecticut River, and over some of the most southerly inhabitants of the Nipmuck country, about Quinabaag. The principal sachem lived at or about Pequot, now called New London. These Pequots, as old Indians relate, could in former times raise four thousand men fit for war, and held hostility with their neighbors that lived bordering upon them to the east and north, called the Narragansitts, or Nechegansitts; but now they are few, not above three hundred men, being made subject unto the English, who conquered and destroyed most of them upon their insolent deportment and just provocation, anno 1638, of which we shall have occasion to speak more particularly in the sequel of our history.

"3. The Narragansitts were a great people heretofore, and the territory of their sachem extended about thirty or forty miles from Sekunk River and Narragansitt Bay, including Rhode Island and other islands in that bay, being their east and north bounds or border, and so running westerly and southerly unto a place called Wekapage, four or five miles to the eastward of Pawcutuk River, which was reckoned for their south and west border, and the easternmost limits of the Pequots. This sachem held dominion over divers petty governors, as part of Long island, Block Island, Cawesitt, Niantick, and others, and had tribute from some of the Nipmuck Indians that lived remote from the sea. The chief seat of this sachem was about Narragansitt Bay and Cannonicut Island. The Narragansitts were reckoned in former times able to arm for war more than five thousand men, as ancient Indians say. All do agree they were a great people, and oftentimes waged war with the Pawkunnakutts and Massachusetts, as well as with the Pequots. The juris diction of Rhode Island and Providence Plantations and part of Con necticut people, possess their country. These Indians are now but few, comparatively; all that people cannot make above one thousand able men.

"4. The Pawkunnawkutts were a great people heretofore. They lived to the east and northeast of the Narragansitts; and their chief sachem held dominion over divers other petty sagamores; as the sagamores upon the island of Nantucket and Nope, or Martha's Vineyard, several others, and some of the Nipmucks. The country, for the most part, falls within the jurisdiction of New Plymouth Colony. This people were a potent nation in former times; and could raise, as the most credible and ancient Indians affirm, about three thousand men. They held war with the Narragansitts, and often joined with the Massachusetts, as friends and confederates against the Narragansitts. This nation, a very great number of them, were swept away by an epidemical and unwonted sickness, *An.* 1612 and 1613, about seven or eight years before the English first arrived in those parts to settle the colony of New Plymouth. Thereby Divine Providence made way for the quiet and peaceful settlement of the English in those nations. What this disease was, that so generally and mortally swept away, not only these but other Indians, their neighbors, I cannot well learn. Doubtless it was some pestilential disease. I have discoursed with some old Indians that were then youths, who say that the bodies all over were exceedingly yellow, describing it by a yellow garment they showed me, both before they died and afterwards.

"5. The Massachusetts, being the next great people northward, inhabited principally about that place in Massachusetts Bay where the body of the English now dwell. These were a numerous and great people. Their chief sachem held dominion over many other petty governors, as those of the Weechagaskas, Neponsitt, Punkapaog, Nonantum, Nashaway, some of the Nipmuck people, as far as Pokomtakuke, as the old men of the Massachusetts affirmed. This people could, in former times, arm for war about three thousand men, as the old Indians declare. They were in hostility very often with the Pawkunnawkutts, who lived on the south border, and with the Pawtucketts, who inhabited on their north and northeast limits. In *An.* 1612 and 1613, these people were also sorely smitten by the hand of God with the same disease, before mentioned in the last section, which destroyed the most of them, and made room for the English people of Massachusetts colony, which people this country, and the rest called Pawtuckett. There are not of this people left at this day above three hundred men, besides women and children.

"6. Pawtuckett is the fifth and last great sachemship of Indians. Their country lieth north and northeast from the Massachusetts, whose dominion reacheth so far as the English jurisdiction, or colony of the Massachusetts, doth now extend, and had under them several other smaller sagamores, as the Pennakooks, Agawomes, Naamkeeks, Pascatawayes, Accomintas, and others. They were also a considerable people heretofore, about three thousand men, and held amity with the people of Massachusetts. But these also were almost totally destroyed by the great sickness before mentioned, so that at this day they are not above two hundred and fifty men, besides women and children. This country is now inhabited by the English under the government of Massachusetts."

Pawkunnawkutt was the Indian name for the country around the present city of Bristol, R. I. King Philip, Pometacom, or Metacomet, lived here, and it was from this place the nation of which he was sachem derived its name. These Indians were, however, sometimes called the Wampanoags, or Wamponoags. Another writer says: "The east side of Narragansett Bay was inhabited by the Wampanoags (who are next in power to the Narragansetts), on the broad regions of country extending to Massachusetts Bay, Cape Cod, and Nantucket. The most powerful sachem of the Wampanoags, at the time of the arrival of the Plymouth settlers, was Massasoit, also called Osemequin. His two sons and successors were Wamsutta, called by the English name of Alexander, and Metacomet, known as King Philip." The five tribes of Indians mentioned used the same language, with, however, some slight difference in the expression, not unlike the differences found in several counties in England. They could readily understand each other, but could not understand some of the inland Indians, particularly the Mawhawks, or Maquas. "Their government is generally monarchical, their chief sachem or sagamore's will being their law; but yet the sachem had some chief men that he consults with as his special counselors. Among some of the Indians their government is mixed, partly monarchical and partly aristocratical, their sagamore doing not any weighty matter without the consent of his great men, or petty sagamores. Their sachems have not their men in such subjection but that very frequently their men will leave them, upon distaste or harsh dealing, and go and live under other sachems that can protect them; so that their principal endeavor is to carry it obligingly and lovingly unto their people, lest they should desert them, and thereby their strength, power, and tribute would be diminished." This description of their government, given in Mr. Gookin's history of the Indians in New England, shows the peculiar, uncertain hold which their rulers had upon them, and throws a good deal of light on the relation which soon came to exist between the rulers of the Wampanoags, Wamsutta and Phillip, and their praying Indians upon Cape Cod, Martha's Vineyard, and Nantucket. Very early Massasoit saw that the English were acquiring a dangerous ascendancy over the minds of his Indians, and begged the English to stop trying to change the religion of his Wampanoags, for they were apt to become poor subjects to him. It is a suggestive fact that in two noted cases in which King Philip sought to administer justice in accordance with Indian law, that of John Gibbs, at Nantucket, for speaking evil of Philip's father, Massasoit, and that of John Sassamon, at Assawamsett Pond, for revealing Phillip's plans to the English, the offenders were preachers of the Gospel to the praying Indians. The English tried to alienate still further the praying Indians from their allegiance to Philip by adding to their list of jurors at the trial of Sessamon's executioners "six of the indifferentest, granest, and sage Indians," that, by their concurrence with the white jurors, the Indians of the praying towns might be committed to the cause of the whites. To make the conviction of the culprits sure, however, they had the full number of twelve white men before adding the six Indians to the jury. The execution of these three Indians by the English was the immediate cause of the Indian war, threatened for some time, but purposely delayed by Philip until he could get the aid of the Narragansetts. The names of Elliot and Williams will ever be associated with the conversion of the Indians under their charge near the Massachusetts and Providence Plantations; but to the less celebrated efforts of the Mayhews, on Martha's Vineyard and Nantucket, and of Mr. Treat, Mr. Bourne, and Mr. Cotton, on Cape Cod, are chiefly due the conversion of the Indians in those places, and the friendly attitude taken by these Indians during the war that devastated the region lying just west of them. The following quotation in reference to the labors of the Mayhews states very well the effect of their labors, and sets forth the tractable nature of the Indians of Martha's Vineyard, which, it may be added, were shared by those on Nantucket and Cape Cod:

"At the time of the settlement (Martha's Vineyard, in 1642) the Indians were very numerous in this town (Edgartown), perhaps more so than in other parts of the island. The Indians of Martha's Vineyard were hospitable, and more tractable than those on the main. Governor Mayhew and his son, as soon as they became settled, attempted to civilize them and introduce the Gospel among them, and their success surprised and delighted the pious of that age. The younger Mayhew labored in this benevolent work with diligence and fervor till his death, in 1657, when it was assumed by his father, and in a few years by his son, and it was carried on by some member of the family till the beginning of the present century. Nearly all the Indians on the island became professed Christians. At first they were called 'catechumens,' but were formed into a church in 1659, and from this another church arose in 1670. The English found most essential advantages from the ascendancy which was gained over their minds; they were disarmed of their rage; they were made friends and fellow-subjects. In King Philip's war all the Indian nations on the main were confederated against the English. Alarm and terror were diffused on every side; but Governor Mayhew was so well satisfied with the fidelity of these Indians that he employed them as a guard, furnished them with the necessary ammunition, and gave them instructions how to conduct themselves for the common safety in this time of imminent danger. So faithful were they that they not only rejected the strong and repeated solicitations of the natives on the main to engage in hostilities, but when any landed from it, in obedience to their orders which had been given them, they carried them, though sometimes their near relations, to the governor, to attend his pleasure. The English, convinced by these proofs of the sincerity of their friendship, took no care of their own defense, but left it entirely to the Indians, and the storm of war which raged on the continent was not suffered to approach, but these islands enjoyed the calm of peace. This was the genuine and happy effects of Mr. Mayhew's wisdom and of the introduction of the Christian religion among the Indians."

The Indians of Cape Cod had been very generally christianized before King Philip's war broke out, and most of them remained faithful to their white neighbors, and aided in protecting the cape against hostile invasion. It is very probable that some of them left the praying towns to join Phillip, as did many from the praying towns near Boston. In the records of drafts of men levied in Massachusetts and Plymouth colonies to fight Philip are found the names of southern or friendly Indians. About twenty of these Indians, under the leadership of an Indian of the Wampanoag tribe, named Captain Amos, living at or near Cape Cod, took part in the disastrous fight near Rehoboth. Rev. Noah Newman, in writing of this encounter, states that Capt. Michael Peirse, with fifty-one of his soldiers and eleven of these friendly Indians, were killed. Because of the friendly attitude of the Cape Cod, Martha's Vineyard, and Nantucket Indians toward the whites, the Indian history of these places is not so eventful as that of the rest of the Wampanoag country lying between Buzzard's Bay and Narragansett Bay. The farmers in the latter region have pointed out to me the past summer the swamp, at the foot of Mount Hope, where Philip was shot, and the place where Benjamin Church encountered Tuspaquin and his warriors on Assawamsett Neck, in Lakeville, Mass., and many other places made memorable during this bloody Indian war. On Cape Cod and adjacent islands there were no hostilities during King Phillip's war, and all encounters between these Indians and the whites took place at a very early date, when white explorers thought it expedient to plunder and kidnap the natives, and they in turn thought best to kill the crew of any shipwrecked vessel, and so secure the plunder. On Nantucket, Gookin writes that some bad Indians committed this offense even later than the year 1649, and were punished for it. In the year 1619, Capt. Thomas Dermer landed at Martha's Vineyard and was attacked by the natives. He and his companions gallantly defended themselves with their swords and escaped. Several Indians were killed in the fray. When Bartholomew Gosnold visited that island, in 1602, it is written that he trafficked amicably with the natives of the vicinity, and it is very probable that Captain Dermer, or Martin Pring, who had spent the summer at Edgartown a few years before (in 1603), did something to provoke the Indians, or Captain Dermer would have been differently treated. Captain Weymouth had kidnapped five Indians in Maine, and one of Captain Smith's commanders, named Hunt, carried off forcibly twenty-seven natives from Massachusetts Bay—Squanto, afterwards the interpreter of the settlers at Plymouth, being one of the number. Such treatment of the Indians would not be likely to win their confidence, and it is no wonder that when the Pilgrims landed the natives should try to take revenge upon them, especially after they had been robbed of corn, themselves pursued, and the graves of their people disturbed by this very company of men. Three days before the landing of the Pilgrims at Patuxet, or Plymouth, while exploring in what afterward became the town of Eastham, they were attacked at night or early in the morning by the Nauset Indians, probably led by Aspinet, a subchief, who owed allegiance to Massasoit. This spot, called Namskeket by the Indians, was named by the English "The First Encounter." Some years before this, the explorer Champlain had an encounter with the Indians of Cape Cod, or Cap Blanc, and immediately started back to Europe. At a time of great want in Plymouth colony, through the assistance of Squanto and Massasoit, the colonists obtained supplies of corn from the Indians of Barnstable County. Very soon the land itself, which was so easily cultivated, attracted emigration from Plymouth, and from this time forward there was little to be recorded but the deeding of land to whites, the poverty, drunkenness, and plagues of the natives, and the labors of good men like Mr. Treat to instruct them and improve their condition. We have few particulars in regard to Indian wars of the Wampanoags, either among themselves or with other tribes, those given by Gookin and in the history of Nantucket being almost the only ones. On Nantucket, according to their traditions, there were two tribes of Indians, one that crossed from the Vineyard and landed on the west end of the island, the other that came across from Monomoy, or Chatham, and landed upon the east end. These two tribes, or portions of the Wampanoag tribe, engaged in a war about the year 1630, the last Indian war on the island, and the only one of which we have any knowledge. In studying the history of Indian tribes in almost any part of the country one cannot fail to be struck by the terrible ravages that disease makes when once it enters their midst. Longfellow, in his tale of Hiawatha, did not overlook this sad feature in Indian life, and the description of the pestilence is hardly too strong to represent the mortality and distress produced among the Indians by many diseases not usually fatal to whites. On the sixteenth page of Barber's Historical Collections is given a very interesting account, first published in "Good News from New England," of a visit made by Edward Winslow to Massasoit, whom the Plymouth colonists had heard was lying very ill at Mattapuyst. The sachem's condition is graphically described, and the primitive means employed by the Indians to cure him. One passage of the description is as follows: "When we came thither (Puckanokick) we found the house so full of men, as we could scarcely get in, though they used their best diligence to make way for us. There were they in the midst of their charms for him making such a hellish noise as it distempered us that were well, and therefore unlike to ease him that was sick, etc." The simple but sensible methods used by Mr. Winslow for his recovery, and their success, show what might often have been accomplished for others in a similar condition. According to early writers, the most general and fatal diseases among these Indians before the whites came were yellow fever, and a hectic fever ending in quick consumption. The traditional method for "laying" the yellow fever upon Martha's Vineyard would be most likely to spread the disease. Small-pox and even measles were very fatal in the Indian towns after the coming of the whites, if not before. Intemperance soon increased the natural improvidence of the Indians, undermined their constitutions, and provoked quarrels among them which often ended in a fatal drunken fray. The following description of a portion of the Wampanoag tribe living at Middleborough, preserved in one of the earlier volumes of the Massachusetts Historical Society's collections, gives a fair description of their methods of living, and of the prevalence of hectic complaints among all this tribe of Indians:

"Before the town (Middleborough) was incorporated this place went by the name of Namaskett, which was an ancient Indian name, and was formerly plentifully inhabited by the Indian natives, who were governed by the noted sachem Tispacan. But when the town was incorporated and began to be settled by the English, the natives began to scatter and decrease; but there is now a settlement of them which descended from the ancients of Namaskett, which inhabit a part of said town known by the name of Betty's Neck (which place took its name from an ancient Indian woman by the name of Betty Sesemore, who owned that neck), where there are now eight Indian houses and eight families. (About the year 1794.) The general number of Indians, old and young, that live there is between thirty and forty. Their houses are poor; they own some land; they live imprudent; are very fond of liquor. They till their land, which produces good crops of corn and rye, which they trade off for spirituous liquors with any retailer that is so destitute of principles as to trade with them, so that by the middle of the winter their corn and grain is generally gone. Then, by their baskets and brooms (which they make) they purchase it to supply immediate necessity. They are very subject to hectic complaints, for more than half that are born are carried off young with consumptions."

Within the past summer I found living on Betty's Neck only three Indians, all women, descendants of Massasoit, and relatives of Philip's faithful follower, Tuspaquin, the Black Sachem, chief of all the Nemaskett and Assawamsett Indians. Full particulars of this interesting family, whose home is in North Abington, Mass., may be learned in a book published by the mother, Mrs. Zerviah Gould Mitchell, now aged 76 years. She claims to be a lineal descendant, in the seventh generation, from the "great and good Massasoit." Both she and her daughters have received good education, and the mother became eloquent in describing the treatment of Tuspaquin, Annawon, and some other Indians engaged in King Philip's war. The mother and the daughter Melinda, or Teweeleema, have aquiline noses and long black hair, and are as good types of this tribe of Indians as I have ever seen. It is only while their house in North Abington is let that they expect to remain on this spot, for which they appear to have a strong attachment. We were informed by the mother that the "men folks" of their family were dead or gone, and it is very probable that after this generation passes away no more Indians will ever live on Betty's Neck, unless this family is quickly re enforced by Indians of Mashpee or Gay Head. The native population on Cape Cod at the time the whites landed cannot be exactly known, but, through the labors of those men interested in the conversion of the Indians upon Cape Cod, not many years after its settlement, we know that there was once a large native population which dwindled rapidly away, and of which time has now left us hardly a trace. A letter dated Sandwich, July 1, 1674, from Richard Bourne to Daniel Gookin, on the "Progress of the Gospel among the Indians in the colony of New Plymouth," gives a list of the praying Indians in the towns of Cape Cod at that date. He states explicitly that he has been "conversant with and employed amongst them these many years," and it is very probable that the list includes all the places of any consequence at the time of his writing, for special mention is made of all places which still need religious aid. In the year 1792, when the first volume of the Massachusetts Historical Society was published, containing this letter from Mr. Bourne, the sites of some of the Indian towns mentioned by him were already forgotten, and so explanatory notes, written largely by the Hon. Nat. Freeman, of Sandwich, were inserted, now seen inclosed in brackets. The proportion of these converted Indians to the unconverted ones may have have been small at this early date, but in regard to the former Mr. Bourne appears to have gained exact information, even mentioning the number of those converted who could read and write. The number that could read and write will be omitted in the quotation, as it is for the names and sites of towns that the letter is valuable to us rather than their degree of culture.

"First there is at Meeshawn, or near the head of the cape [Cape Cod. Part of these Indians probably lived in Provincetown, but the greatest number in Truro] and at Punonakanit, or Billingsgate [New Wellfleet], that are praying Indians, that do frequently meet together upon the Lord's Day to worship God; and likewise the rest as followeth, 72. "Potonumaquut [the southeast part of Eastham], or Nawsett [the north part of Eastham], or Eastham, there are praying Indians 44. Manomoyik [Chatham] there are praying Indians 71. Sawkattukett [the west part of Harwich], Nobsquassit [the northeast part of Yarmouth], Matakees [the land between Barnstable and Yarmouth Harbors, lying principally in the northwest part of Yarmouth and] Weequakut [pronounced at present Cheekwacket, the southwest part of the east precinct in Barnstable], praying Indians 122. Satuit, Pawpoesit, Coatuit [Coatuit is in the southwest part of Barnstable], Mashpee, Wakoquet [Satuit, or Sanctuit, Hawpoesit, and Wakoquet or Waquoit, are all within or near the limits of Mashpee] there is praying Indians 95. Codtannut [probably Canaumut Neck in Mashpee], Ashimut [or Shimnit. On the west line of Mashpee], Weesquobs [between Pokesset meeting-house and Wenaumut Neck in Sandwich], there is praying Indians 22. Pispogutt [concerning this see Mr. Freeman's letter], Wawayontat [Waywayantic or Wewewantett, Wareham], Sokones [commonly pronounced Succonussett. Part of Falmouth], there is praying Indians 36. Cotuhtikut [or Titticut, part of Middleborough], Assoowamsoo [or Assoowamsett, part of Middleborough], there are praying Indians, one with another, 35." Besides these places; Mr. Bourne mentions Mannamit [in Sandwich, near the bottom of Buzzard's Bay], also Mananiet, which is supposed to be the same place.

"As for lands set out to the Indians, distinct from the English lands, there are divers places already bounded, viz: Where I am most conversant there is a tract of land preserved for them and theirs forever, under hand and seal, the which is near ten miles in length and five miles in breadth. There is the like done at Comassakumkanit [probably Herring Pond, in Plymouth], near Sandwich, and at Cotuhtikut."

Mr. John Cotton, pastor of the English church at Plymouth in 1674, writes to Mr. Gookin that he sometimes preached to a company of 40 praying Indians at a place called Kitteaumut [or Katamet, now spelled Cataumut; part of Sandwich, on Buzzard's Bay]. Mr. Cotton spells Mashpee, Marshpang. The following letter of the Hon. Nat. Freeman, dated September 23, 1792, published in the same volume of the Massachusetts Historical Society's Collections, in reference to the sites of Indian towns on the cape, gives a fuller account of some of the places and Indians mentioned in the letter of Mr. Bourne: "From the best of my own recollection, and the little additional information I have obtained, I believe there are not more than two or three Indians, and those females, remaining in Sandwich. In Barnstable I know of not one, except it be in a part of Mashpee included in Barnstable limits for taxing. These, as they are not within the boundaries of the township, are included in the number for Mashpee. In Falmouth proper there may be, at a place called Cataumet [the same which is noted in Holland's map], seven or eight, some of whom are mixed. An Indian territory, called Herring Pond, in the neighborhood of Sandwich, about 5 miles northwest from this village, and so extending thence along shore to Monument Ponds, all included within the township of Plymouth, I am told by Joseph Nye, esq., one of their guardians, contains about a hundred and twenty souls, one-half of whom are mixed. The Indian name of this territory I never could learn. They appear to have been considered as a distinct tribe, now known by the name of the Herring Pond Indians. Might not this place be Comassakumkanit?" (See Gookin's *Hist. Collection*, p. 108.)

The same Mr. Nye, who is guardian also to the Mashpee tribe, says that there are about two hundred and eighty souls in that place, of whom at least two thirds are mixed. I suppose the Indians have diminished since 1785, but the mixed race may be increased, as many negroes and mulattoes from abroad have, since that period, settled there. I know of none below Barnstable upon the Cape, except at Potanumaquut, a part of Harwich, and there, I believe, there may be six or seven souls only. The Rev. Mr. Damon thinks there is one in Truro. Wakoquet, Weequakut, or Coquit (see Gookin's *Hist. Collect.*, pp. 197–200), probably may be Wawquoit. The latter seems as like the sound as either, but as the first is associated with Satuit, Pawpossit, Coatuit, and Mashpee, it is most likely to be that. Then the second may be what is now called Chequocket, or by some Shequocket, which is in the southwest part of the east parish in Barnstable, where there is an inlet called Lewis's Harbor, not the same as Lewis's Bay, which is more easterly. Or if it comport better with the history, it may be a place and pond near Howland's Ferry, Tiverton, R. I., called Quaket, or Quaket Pond. There is a place in Mashpee called Popponessit. This may be Pawpoesit. Weesquobs cannot be located. Great neck in Mashpee is a place famous for eels. The Indians, when they go in a canoe, with a torch, to catch eels in the night, call it Weequash, or, anglicized, weequashing. There was a great number of Indians formerly on this neck, and it seems now the metropolis of Mashpee. Whether any supposed affinity between Weesquobs and Weequash will justify a conjecture is hard to say. Codtaumut may be Canaumut Neck, in Mashpee. Kitteaumut is probably Cataumut in Holland's chart. Shumuit, which I suppose to be Ashimuit, is about equidistant from Cataumut, on Buzzard's Bay, and Canaumut Neck; rather nearest the latter. It might be associated with either in Gookin's Historical Collections. But if we suppose Weesquobs to be Whakapee, a pond in Mashpee, then, most likely, Codtaumut and Canaumut must be the same. If we associate Cataumut, Shumuit, and Great Neck (for Weesquobs) together, there would then be other places not contiguous. Wawayontat is said to be Wareham. There are two rivers which pass through Wareham into the bay. That through the town is called Agawam, and the Indians generally call Wareham by that name. The other, which is near the west end of the township, toward Rochester, is called Weantick. This may be Wawayontat. Falmouth still goes by the name of Sokonesset, and is undoubtedly the Sokones mentioned by Gookin. There is a place on Buzzard's Bay, on Sandwich side, called Pokesset; but I have been told Indians used to call it Poughkeeste. It is the second parish in Sandwich, about 8 miles southwest from my house [near the meeting-house of the first parish], but not more than two leagues across the bay to the mouth of Weantick River, and lies on a line between Wareham and Falmouth, adjoining northerly on Cataumut, which is rather in the edge of Falmouth than Sandwich, as you supposed. Can Pokesset be the same as Pispogutt? There is a neck of land within Pokesset, called Pachawesit. This seems as dissimilar as the other. The place where Doctor Bourne's house stands, viz, about two miles up Manumit River, and near the Herring Pond, is called Pumpisset; and a neck of land in Wareham, next to Monument, or Manumit, and parted from it by a small gut, is called Cowesit. The syllable *pis* is in one of them; but Pokesset was the most noted Indian place. Besides these places, the writer has heard of the following places, which are spelled phonetically: Scusset, the next village westerly from this; Unset, or Onset, and Quansit, two little bays, or shores at the bottom of Buzzard's Bay, within Wareham; Cohasset, the gut between Manumit and Cowesit; Wenaumut, a neck within Pokesset; Mashne, an island in Buzzard's Bay; Quisset, an inlet in Falmouth, north shore Buzzard's Bay; Nobska, near Wood's Holl, a bluff shore or head; Naashawn, Nashawinna, Cuttahunka, Pesk, Elizabeth's Islands; Menemsha, a bight on the Vineyard shore; Quashne, or Quashnet, a river in Mashpee; Shanton, or Scorton, the lower end of Sandwich; Muset, a creek in Sandwich off Spring Hill; Skunkamug, south side of the parish of Great Marshes; Hockanum, between Yarmouth and Nobscusset; the east parish of Yarmouth; Suet, or Sesuet, a neck in Yarmouth; Naamskeket, the south side of Harwich; Skeket, or Skaket, the lower part of Harwich next to Eastham. The following summary of the Indian population at different times on Cape Cod is found as a foot note to a part of Gookin's Historical Collections, page 201, printed in 1792: "Christianity met with much better success in Plymouth than in Massachusetts. In the year 1685, the praying Indians in this colony amounted to fourteen hundred and thirty-nine, besides boys and girls under twelve years of age, who were supposed to be more than three times that number." (Hutch., vol. i, p. 349.)

In the year 1693 there were within the limits of Eastham (which then included Wellfleet and Orleans) 505 adult Indians, to whom Mr. Treat preached; 214 adults, besides stragglers, at Mashpee and places adjacent, under the care of Mr. Rowland Cotton, minister of Sandwich; 180 Indians, to whom Mr. Thomas Tupper preached; and 500 more, under the care of Mr. John Cotton, minister of Plymouth. (Matthew Mayhew's Narrative, pp. 46–53. See also Mather's *Magnalia*, book vi, p. 60, and Neal's *Hist.*, chap. vi, p. 256.) In the year 1764 there still remained in the colony 905 Indians of every age, 223 of whom were in the county of Plymouth, 515 in the county of Barnstable, and 167 in the county of Bristol. Since that period their numbers are much lessened. There is at present [1792] no Indian church in the counties of Plymouth or Bristol, and Mashpee only, in the county of Barnstable. Of 134 Indians in Dartmouth and Freetown in 1764 there are now [1792] about 33 left. (Information of Rev. Mr. Backus.)

In the other towns of Bristol they are probably extinct. There are four or five families of Indians in Middleborough, two or three in Pembroke, five or six persons in Bridgewater, and probably a few scattered about in other parts of the county of Plymouth. (Inf. of Rev. Mr. B.) In the county of Barnstable a few Indians remain at Potanumaquut, a few in the town of Barnstable, and a few at Herring Pond, between Sandwich and Plymouth. But the great body of them reside at Mashpee, where there are about 80 families, consisting principally of a mixed race, not more than 40 or 50 persons being pure Indians. (MS. Let. of Rev. Mr. Mellen.)

In September 14, 1674, Mr. Cotton writes as follows of the Indian towns upon Martha's Vineyard: "When I lived at the Vineyard the praying towns were Chappaquidgick [an island east of Martha's Vineyard, separated from it by a strait about a quarter of a mile wide. It is within the limits of Edgartown], Nashamoiess [the south part of Edgartown], Sengekontakit [also spelled Sanchecantacket, the north part of Edgartown], Toikiming [Taacame or Takame,Tisbury], Nashuakemmink [Nashonohkamack, Chilmark], Talhamo [probably part of Chilmark], one church there gathered long before, but no officers. Since I lived here [Sandwich] I went over with Mr. Eliot thither [in the year 1670], and Hiacoomes was ordained pastor; John Tokinosh, teacher; John Nonoso and Joshua Mummeecheeg, ruling elders."

In the year 1692 the number of Indians on Martha's Vineyard was much lessened. The church, however, at that time consisted of more than 100 persons. (Mat. Mayhew's *Nar.*, p. 28.)

In the year 1720 there were on the Vineyard six small villages, containing about 155 families and about 800 souls. Each of these villages was supplied with an Indian preacher. There was also a small assembly at Winthrop's Island; another, consisting of twelve or fourteen families, at Tucker's Island and Nashaun, which lie near together. There were a few Indians left at No Man's Land. Beside these Indian assemblies there was a small congregation of Baptists at Gay Head. [Exp. Mayhew's *Nar. of Ind. on Mar. Vin.*, p. 2.] For the state of the Indian Baptists on Martha's Vineyard in the year 1774, see Backus's *Hist.*, vol I, p. 439. In the year 1764 there were remaining in Duke's County 313 Indians, 86 of whom were in Edgartown, 39 in Tisbury, and 188 in Chilmark. About that period they began to intermarry with negroes, in consequence of which the mixed race has increased in numbers and improved in temperance and industry. At present [about 1792] there are of pure Indians and of the mixed race about 440 persons, 75 of whom live on Chappaquiddick [not more than one-third pure]; about 25 at Sanchecantacket [not more than one-fifth pure]; about 40 at Christiantown, in the north part of Tisbury, toward the Sound [about one-half pure]; about 24 at Nashonohkamuck [about three-quarters pure]; and about 276 at Gay Head [of which about one-quarter are pure]. In this account unmixed negroes are not reckoned. [Information of Captain Jerningham and Benjamin Bassett, esq.]

Barber states in his Historical Collections that at the time of the settlement by the English of Nantucket, in 1660, there were nearly 3,000 Indians on the Island. Upon what authority he makes this statement I cannot discover; but another authority, probably much better than that on which he made the statement, places the number of Indians on the island, in the year 1659, at about 700. In the year 1694 the Indians on Nantucket were about 500 adults. There were five assemblies of praying Indians, and three churches; two Congregational, and one of Baptist. [Gardner's Let. in Mather's *Magn.*, book vi, p. 56.]

Three hundred and fifty-eight Indians were remaining the 16th of the eighth month, 1763, when a fever began among them, and lasted till the 16th of the second month, 1764. Of this distemper 222 died. [See Hutch. *Hist.*, vol. I, p. 35.] The Indians on the island are now [1792] reduced to 4 males and 16 females. [MS. of Friend Zaccheus Macy.]

On Cape Cod, at present [1883], there is not a pure-blooded Indian, so far as I can learn. The notes accompanying the Rev. E. C. Ewer's Historical Map of Nantucket state that the last Indian on that island died in 1822, and the last man with Indian blood in him, Abram Quary, died in 1855. While near Shimmo, on Nantucket, last summer, this man, Abram Quary, was described to me by a white man who once knew him and evidently regarded him as a curiosity. While walking with my brother through the graveyard at Vineyard Haven, on Martha's Vineyard, in the summer of 1882, studying the inscriptions on the stones, we came suddenly on an old grave-digger, busily at work preparing a grave. We asked him a few questions about the most common Vineyard names, and also about the Indians on the island. He told us, beside a few other interesting facts, that he knew that the last pure-blooded Indian, a woman, had been buried on the island only a very few years before. In about 260 years, then, from the landing of the Pilgrims at Plymouth, a race of men, then occupying eastern Massachusetts, has practically become extinct.

Alas, for them, their day is o'er,
Their fires are not from shore to shore;
No more for them the wild deer bounds,
The plough is on their hunting-grounds;
The pale man's axe rings through their woods,
The pale man's sail skims o'er their floods,
  Their pleasant springs are dry.

(*Charles Sprague's Centennial Ode*, 1830.)

Unlike the aids to the study of Egyptology, the monuments of the Indians are of the simplest kind, very apt to be wholly overlooked by the modern observer, or regarded by him as an interesting curiosity for his children to play with. In truth, this tribe of Indians appear to be almost wholly lacking in the spirit which prompted the Egyptians to raise lasting memorials of their lives and deeds. These Indians were poor, and not very far advanced in the arts, and could not, therefore, be expected to erect such monuments; but nevertheless, one would hardly expect, after having carefully passed over so large a region as that of Cape Cod, Martha's Vineyard, and Nantucket, where we know that many Indians once lived, and where abundant evidence may still be seen of their skill and perseverance in fashioning articles of ornament, weapons, or utensils, to find not a trace of any attempt on the part of the natives, before their contact with the whites, to convey to later generations an idea, either historical or otherwise, in a form likely to last. It is possible that records of wars or other remarkable events in the history of this tribe may have been kept by them, as in the case of other tribes, preserved as pictographs embroidered on wampum; but these, of course, cannot now be found if they ever were in the possession of this part of the Wampanoag tribe. Inscribed tablets of stone, or bowlders with picture writings upon them, have, I believe, never been found in this region, if we except, of course, such instances as the gravestones at Gay Head, inscribed after the Indian language, had been reduced to writing by the whites. In an Indian burying-ground on Assawamset-neck, in Lakeville, near Middleboro', on the land of Mr. Charles Jewett, containing twenty-five or more graves, was one bearing a peculiar inscription of two letters or characters.

This graveyard is the resting place of the relatives, and some of the ancestors of the three Indians before mentioned residing on Betty's-Neck, descendants of Massasoit and Tuspaquin. The latter name, contracted into Squinn or Squeen, appears on one of the stones, lately broken into fragments by some vandal Two or three of the graves have well engraved slate head-stones, much like those in any old grave-yard of New England. Most of them have no stones whatever, and a few have a short, thick, plain slab of stone or bowlder at one or both ends. It is very probable that all these graves were made after the Indians had ceased to bury interesting relics with their dead. I mention this fact because I heard that the three surviving Indian women living near by were greatly distressed a short time ago to find that some relic hunters had tried to dig up some of their ancestors. Considering the circumstances of these burials, and the prominent part taken by the ancestors of these persons in the early Indian history of this vicinity, it seems a pity that the graves cannot remain undisturbed as a reminder to future generations of the Indians of New England, now that so few monuments of them remain. Not to overlook entirely a very interesting rock about which there has been endless speculation, it may be well to mention here the "Dighton Rock," or "Writing Rock," which was found by the first white colonists beside the Taunton River, on the Berkley side, opposite the landing-place for sloops at Dighton. This spot does not lie within the country of the Cape Cod Indians, but it is a part of the territory of the Wampanoag tribe, to which they belong.

Prof. F. W. Putnam, of Harvard College, assures me that it is now the belief of the best scholars that the inscription on this rock is nothing but an Indian pictograph, and that the attempt, by the aid of subjective drawings of it, to make it serve as testimony of a visit to this country by the Northmen, or Phœnicians, is pure folly in the light of later discoveries of pictographs, closely resembling it, in other parts of the United States. A picture of this rock, with a very good description of it, copied from the second volume of Kendall's Travels, may be found on pages 117, 118, and 119 of Barber's Historical Collections. Mr. Kendall traveled through the northern parts of the United States in 1807 and 1808. He made a careful examination of the Dighton Rock, visiting it several times for the purpose. Mr. Kendall writes of another inscribed rock as follows: "The only sculptures on any rock not on the Writing Rock consist in two or three figures or characters having some similitude to the letters XOO, and which are seen on the corner of a slab of stone lying within a few yards of the Writing Rock." Mr. Kendall presents a series of wild conjectures and Indian traditions in regard to the origin of the Writing Rock, prevalent among the learned and unlearned of his time, to which list may be added that of Mr. R. B. Anderson in his work entitled "America not discovered by Columbus." The latter writer attempts to prove the truth of the old Scandinavian or Icelandic tales relating to the discovery of America by the Norsemen, 500 years before Columbus set sail, by appealing to the circumstantial evidence of the skeleton in armor discovered at Fall River, the tower at Newport, and the Dighton Writing Rock. In the interpretation of the writing on the Dighton Rock, Mr. Anderson discovers some marks which he considers are Roman characters, copied by him as follows: CXXXI. This, he says, represents 151, for the Icelanders reckon 12 decades to the 100. Then he finds a small row-boat between the letters N and M. He makes N stand for Norse, the boat for seafaring, and the M for men, and proceeding in this way confirms, to his own satisfaction, the truth of the old legends. He closes his fourteenth chapter as follows: "Upon the whole, the Dighton Writing Rock removes all doubt concerning the presence of Thorfinn Karlsefne and the Norsemen at Taunton River, in the beginning of the eleventh century." The "skeleton in armor" discovered at Fall River will be described at length in speaking of certain relics once found upon Cape Cod which appear to throw some light upon the probable history of these far-famed remains. So far as I have been able to discover in my researches upon Cape Cod, Martha's Vineyard, and Nantucket, for evidence of a former Indian population there, all the testimony or evidence to be found is of an unintentional sort on the part of the natives. The Indians appear to have expended unstinted labor, with considerable skill, in fashioning their implements, weapons, and ornaments of stone, but none whatever in preserving their history. Therefore the methods employed in tracing out the settlements of Indians in these places must be, or were for me, like those of a person discovering the camps of a very early prehistoric race. It is really surprising how little beside the remains usually found at prehistoric settlements can now be found on the sites of several of the largest Indian towns on Cape Cod, such as those at Wellfleet, probably the seat of Mr. Treat's labors among the praying Indians.

After a careful examination of the site of one of these settlements near Drummer Pond, in South Wellfleet, which was evidently once of considerable importance, I was able to find only a few bricks, which had formed fire-places; a few bits of iron nearly rusted away; fragments of coal, and glass bottles, and a goodly number of broken clay pipes and pipe-stems of the ordinary Irishman's style. Besides these, and to my eyes much more conspicuous, were the common indications of an Indian town, the shell heaps, bones of animals and fishes, with numberless chippings of quartz, porphyry, jasper, &c., made by the Indians in fashioning their arrow-heads. Perfect arrow-heads were not common, but the desert expanse of coarse sand and gravel surrounding the town was one of the best of places to find arrow-heads unless they had already been picked up. Along the coast, shell heaps are the most striking evidence that we have of prehistoric tribes. Shell heaps are found in almost all parts of the world upon the sea-coast, and their size and contents indicate a more or less prolonged halt or settlement there of a family or tribe. Some only mark stopping places on a journey; others were the sites of villages long inhabited by the natives, but most of them, in the opinion of Professor Putnam, were places to which the Indians were in the habit of resorting from the interior to get supplies of mollusks, which they opened, smoked or dried, and laid up for winter use. Shell heaps are refuse heaps, the name given those on the Danish islands being Kjoekkenmoeddings, and the most common things found in them are of course like the most common indestructible refuse thrown from modern kitchens. Shells, and bones broken to extract the marrow, make up the great mass of the heaps, but there can usually be found with them, or near by, a few implements, weapons, ornaments, broken pottery, and even human bones, which may have fallen here by chance. Implements of stone and bone, for crushing open the edges of the shells and extracting the meat, are the relics properly belonging here, and it is very unusual in examining a large shell heap not to find at least several of these stones. Near or upon these shell heaps may usually be found black spots frequently surrounded by blackened stones, where the natives were in the habit of making their fires and cooking their food. Pieces of charcoal, even, may sometimes be found in the midst of these black heaps of ashes, and I have several times had good success in hunting for fragments of broken pottery near these old fire-places.

The shells composing the shell heaps of Cape Cod, Martha's Vineyard, and Nantucket are mostly quahoags, oysters, clams, both the small kind and the large sea clam, fragments of razor shells, conches, periwinkles, a few scallops, and the large salt-water snail shell so commonly found clinging on rocks. At Edgartown, Martha's Vineyard, near the "Swimming Place," and at one other place on Cape Cod, are found large numbers of land snail shells in little piles in the midst of the shell heap, which leaves little doubt that the Indians did not hesitate to eat even these when they could collect them in large enough numbers. It is possible that they were collected with a view to pierce and string them, for they would make better ornaments when strung than ordinary periwinkles. On Indian Neck, in South Wellfleet, Mr. Theophilus Rich, a few years since, while digging, found the skeleton of an Indian which was apparently, when first uncovered, well preserved, but soon crumbled all away excepting the jaw-bone and teeth and a double row of common periwinkles which had hung about the neck and rested on the chest. The teeth were worn down close to the base, or were, as the discoverer affirmed, "double all the way around." Among the quahoag and periwinkle shells near the oldest shell heaps lying to the north of Wellfleet Harbor were found some which had been perforated from within outward, ostensibly for the purpose of stringing. It was possible to tell roughly which shell heaps were the older, because some of them had the quahoag shells in them dented on the edges or broken in pieces by hammer stones, while in other piles which in other respects appeared equally old it could be seen that the quahoag shells had been opened by a knife, which could be inserted to cut the strong adductor muscle and thus avoid breaking the shell. One shell heap, a very short distance from the most western large wharf, on the north side of Wellfleet Bay, was especially interesting from the fact that here occurred the shells of the long narrow native oysters, now extinct on the New England coast, but whose shells make up by far the larger part of the great shell heaps of Maine. It is a rare thing to find these oyster shells so far toward the south, and a few of them discovered some years ago in the mud about Back Bay, Boston, are said to have created considerable comment at the Boston Natural History Rooms. The shells in the heap were very old, and the larger ones crumbled so easily that only one was preserved. Soon after the examination of this shell heap, Mr. Graham, living near by, showed a very fine large specimen of this oyster's shell which he said he dredged up in the bay. Both valves were perfect, and looked as if the occupant had just removed. The owner of it saw that it was very rare, and he refused an offer for it of $5. If it is true that this variety of oysters was once common along the coast of Cape Cod, and yet a thorough search should prove that the shell heaps of Cape Cod contain very few of them, will it not help to establish the fact that the Indians have not plenti fully inhabited Cape Cod till a comparatively recent time? On Cape Cod scattered shells and a thin layer of rich black earth, often containing a few stone chips, are found in the vicinity of nearly all Indian towns where the ground may have been fertilized by the natives for their crops, or where the soil was already best for their cultivation. This layer is usually from 6 inches to 1 foot below the surface, but in one or two places it occurred fully 2 feet down. This depth does not necessarily make the time of accumulation great, for the sand of Cape Cod is noted for its habit of shifting about under the action of the wind, and in some places, where arrow-heads occur most plentifully, the wind has removed all the sand which may once have covered them, and has left them on a smooth gravelly surface, where they may be easily seen. The writer was drawn to an examination of the "drift gravel" of the cape by the success which Dr. C. C. Abbott had in finding stone implements, &c., in the gravel near Trenton, N. J., but none have been found except where a bank had washed away, and the implements which belonged in the layer of soil above had sunk down into the gravel, and been covered up there by later slides. The laws which govern the distribution of Indian camps on Cape Cod, Martha's Vineyard, and Nantucket are much easier to apply than those which govern the distribution of our villages in the same regions. It is possible to predict with considerable certainty where will be found remains of Indian settlements. Indians did not dig wells, and they were largely dependent for food upon the fish and shell-fish which they caught at the mouths of streams and sheltered bays. Therefore they almost invariably chose a sheltered spot, near the shore of some indentation of the coast, or on some stream leading from such indentation. This they did for convenience in bringing their fish and shell-fish to their camps, which were placed as near as possible to a fresh-water stream or pond to obtain a ready supply of drinking water. It was an easier thing for them to adjust the position of their homes conveniently to these supplies than to bring them any distance to their homes; and so these matters were considerations of prime importance to them in selecting a camping-ground. Accordingly the ponds or brooks in the vicinity of bays that supply shell-fish and quiet fishing-grounds, help us to find vestiges of Indian settelment, provided they have not since been destroyed by cultivation of the ground. This method has proved very successful on the parts of Cape Cod visited, and if followed up further in the vicinity of Chatham Harbor, Barnstable Harbor, and the numerous inlets on the Falmouth shore, would probably bring to light many more shell heaps.

The largest shell heaps found were about Wellfleet Bay, Bass River, Centreville River, and Buttermilk Bay, the exact spots being marked upon the map. In the vicinity of Wellfleet Bay, especially where the wind has taken all the soil from the rounded tops of the hills, the visitor cannot fail to notice the scattered shells and numberless chips of quartz and porphyry marking the spots where the "ancient arrow maker" sat. Mr. Graham speaks of one man who went carefully over these hills, a few years ago, and collected in three days arrow-heads and other Indian relics which he sold for $15. There are still many imperfect arrow-heads, broken or unfinished, with numberless cores, chips, and hammer stones; but the best specimens have evidently been picked up in most of the places visited in the vicinity. It is fortunate for the collector of to-day in these regions that the soil of Cape Cod, Martha's Vineyard, and Nantucket is very sterile in many places, and there is no accumulation of rich vegetable mold to attract cultivation or cover Indian relics such as exist at Mount Hope, R. I., and a few other celebrated Indian regions. The following list gives a summary of objects found during the days of the past two summers collecting on Cape Cod, Martha's Vineyard, and Nantucket.

It must be first understood that with the exception of a visit of three days to Chilmark, Martha's Vineyard, all were obtained in a few hours' search, while on an excursion of a day each to these islands. At Wellfleet the writer camped three days with his brother, who assisted him in the search. The list cannot be specially interesting except to give an idea of what may still be accomplished in a very short time in collecting Indian relics in a State where such things are now generally supposed to be very rare.

In the vicinity of Bass River, between Yarmouth and Dennis, were found a stone ax-head, with a deep groove for receiving the withe or thong by which it was fastened to the handle; two stone drills for boring; a piece of stone 6 inches by 4 inches, chipped roughly to an edge all around, and probably used as an ax or hoe; a large fragment of a soap-stone pot, with handle or ear attached; thirty arrow-heads.

Harwich.—Forty arrow-heads and 4 spear-heads; a polished celt of jasper; an unpolished hatchet, or tomahawk, of gneiss; pieces of soapstone pottery, also pottery of clay baked with pounded shells or coarse sand; bones broken in lengths, and charcoal in fire-places; a piece of graphite worn by use in marking.

Buttermilk Bay (at the head of Buzzard's).—Twenty-five arrow-heads of quartz and porphyry, and 1 of brass; 1 broken stone knife.

Chatham (near Taylor's Pond, in South Chatham).—A water-worn pebble, of good quality graphite, 2 inches long and 1¼ inches wide, given by a friend, who found it beside a shell heap.

Brewster.—Among some chips of stone made by the Indians in arrow-making, and collected by a friend, was one of siliceous chert, evidently from a limestone region. In the center of the siliceous portion was a minute spiral-shaped fossil shell.

Centreville.—Twelve stone arrow-heads, 2 spear-heads, and 1 arrow head of brass.

North Truro.—Two arrow-heads, 3 spear-heads.

West Yarmouth.—Three arrow-heads.

Cotuit.—Two arrow-heads. On Oyster Island, in the harbor, 2 arrow-heads and part of the skeleton of an Indian.

Cataumet.—One arrow-head.

Wellfleet and South Wellfleet.—Five hammer stones, a number of cores, over 200 arrow-heads, 3 spear-heads, good pieces of clay pottery, a pipe-stem, and a club-head of syenite with a deep groove all around to fasten it to a handle, as seen in the club of the Massachusetts Historical Society's collection.

At Assawamsett Pond, Middleborough.—One arrow-head and two fine pestles.

Nantucket.—Thirty-three arrow-heads, 10 cores, 3 spear-heads, 1 celt of sandstone, and one gun-flint.

Martha's Vineyard, Chilmark.—Ten spear-heads, 48 arrow-heads, and 3 hammer-stones.

Edgartown.—Fifteen arrow-heads, 2 hammer-stones, and 1 flake of stone with edges trimmed up as a minute celt, or scraper.

Some of the spear-heads were of the type called leaf-shaped implements, but a few of them were much larger, and would have made formidable weapons in a fight. Many of the arrow-heads and some of the spear-heads would not be preserved by some collectors; but they are saved, because they illustrate different stages of completion, from the core, out of which only one or two chips have been broken, down to the finished specimen off which not another chip could be taken without injuring the symmetry. Other specimens have been cast aside when nearly finished, owing to some imperfection in the stone itself, and, in one case, occurred several arrow-heads roughly blocked out and left in a pile, evidently with an intention, on the part of the maker, to finish them up at his leisure. The vessels found on Cape Cod are of three sorts: First, those made of soap-stone; second, and most abundant, pottery made of clay mixed with pounded shells and baked after the proper shape had been given by molding the clay in a basket. The basket was burned away, leaving the outer surface much better baked and, in consequence, far redder than the dark clay within. The outer surface bore the imprint of the wickerwork of the basket, and the inner surface the marks of some tool used in applying and shaping the clay with which the basket was lined. The clay must have been applied in three layers, for the broken shells in the center never appeared on the surface to weaken the pottery or mar the beauty.

The third kind of pottery was made of clay and coarse sand uniformly mixed, and did not appear as tough and well baked as the preceding variety. Among the articles of Indian manufacture found on Cape Cod care was exercised to discover any indications of an ancient aboriginal trade by which the Indians may have been supplied with articles which they could not obtain in their vicinity. With the exception of the single flake of stone from Brewster containing a fossil shell, all the material from which arrow-heads were made upon Cape Cod, Martha's Vineyard, and Nantucket, might have been collected on the spot; although one variety of jasper of which are made a good number of arrow-heads seems to be very rare in this region.

Several pestles found on Cape Cod, and one from Middleborough, were made of a slate, belonging in the Carboniferous group, occurring abundantly in Rhode Island, and from which several pestles in the collection of Brown University are made.

Besides these pestles the most interesting objects, which point to some sort of trade or an exchange by force between these Indians and the Narragansetts or some other tribe, are the broken pots of steatite, or soap-stone, found at Bass River, Winslow's Narrows, and Harwich Port, and the pieces of graphite found at Taylor's Pond and Harwich Port.

The Narragansetts are mentioned first, because they were noted for their industry in manufacturing and exchanging articles with other tribes, and a comparison of the specimens from Cape Cod with some obtained this summer in Rhode Island lead to the belief that both the graphite and the soap-stone came from that region also.

This summer the famous ledge of soap-stone at Johnston, R. I., just outside of Providence, was visited. To this the Indians must have resorted for years to obtain material for their stone pots and pipes.

Rev. Fred. Denison, of the Rhode Island Historical Society, and one of the committee chosen to preserve this interesting relic, has published a circular which describes the condition of the quarry when first discovered. Extracts from this circular, prepared by Mr. Denison, will be given to show the importance of this quarry to the aborigines.

"This largest excavation measures about 10 feet in length, 6 feet in width, and now 5 feet in depth. From the top to the ledge, as left by the glaciers, the excavation must have been carried down about 15 feet or more, inasmuch as, when it was opened, there lay across its top a fallen slab of slate-stone that once stood full 10 feet high above it, forming its eastern wall.

"The excavation was found partly filled up with dirt, *débris* of Indian art, some whole stone pots, some partly finished pots, some only blocked out, numerous stone hammers, and a few shells. Many of these valuable relics have passed into private hands and are highly prized. The sides and bottom of this excavation contain about sixty distinct pits and knobs of places where pots and dishes were cut from the rock, while all parts bear marks and scars made by the stone implements of the swarthy quarrymen. From the excavations and their surroundings have been removed about three hundred horse-cart loads of the stone chips left by the Indian workmen, yet some have been preserved by Prof. J. W. P. Jenks, in the museum of Brown University." In the possession of a friend on Cape Cod, is a broken soap-stone pipe which he found at Harwich Port. In Rhode Island a perfect stone pipe of this same pattern was seen. The handles or ears on some of the pots found at the quarry above described, were exactly like the handle on a piece of a stone pot found at Bass River. With the additional evidence that the stone itself is similar in the two places there can be little doubt that the Johnston, R. I., quarry supplied the Cape Cod Indians with their stone pots and pipes.

The only other interesting implements or weapons which were once in the possession of the Cape Cod Indians and found along with their other weapons of stone were two arrow-heads of brass, one of which the writer's brother found at Buttermilk Bay, and the other was discovered by the writer at Centreville, while hunting for Indian relics. They are of very thin evenly wrought brass sheathing, and a notch in the edge of the one from Buttermilk Bay suggests that they were cut out by a metallic knife or shears with a good cutting edge. The one from Centreville and another which Professor Putnam found at Revere, Mass., were both made on the same pattern as the arrow-heads found with the celebrated "skeleton in armor" discovered at Fall River, with the exception that the latter were pierced with holes for better securing them to the shaft.

It was the custom of the Indians of Cape Cod, Martha's Vineyard, and Nantucket, to bury their dead in a sitting posture, wrapped in bark and, if a warrior, supplied with his usual weapons. On the east side of Bass River, just above the lower bridge, while digging for a well, a man found two Indians buried in this way. One of them had buried with him a stone knife, spear, and arrows. The arrows were in a quiver which, with the wooden shafts, soon crumbled on exposure to the air. Other Indians have been found buried in this way on other parts of Cape Cod, at Martha's Vineyard and at Nantucket. At Cedar Pond, near Betty's Neck, in Lakeville, another one, "curled up" and carefully wrapped in bark, was exhumed. Soon after their contact with the whites the Indians gave up this method of burial. The writer has the skull of an Indian buried at Chilmark, Martha's Vineyard, soon after the whites settled on the island, the skeleton of which was lying horizontally amidst faint vestiges of a coffin. On the west shore of Oyster Island, in Cotuit Harbor, was found part of the skeleton of a large Indian buried in a sitting posture, but much disarranged by the sliding away of the bank which had uncovered it.

During the period in which the Indians were gradually changing from their old method of interment to that of civilized nations, it was their habit to bury with their dead, ornaments and weapons obtained from the whites, while, in other respects, the burial may have been exactly similar to that of their ancestors. There is an account of such a grave in Florida, where was found an ornament of gold, made from metal of about the standard weight of the coin taken to that coast by the first settlers. In another southern grave was found an old sword of the early settlers. Coats of mail were sent to the colonists in Virginia and Plymouth colonies, to defend them from their enemies, the Indians. Armor was used as late as the time of King Philip's war in 1675. The disasters connected with Indian warfare among the colonies, and the chance of lost or cast away armor falling into the hands of the Indians is enough, in my opinion, to explain the presence of some few pieces of armor in their graves without going back to the early times of the Northmen's explorations. The "skeleton in armor," discovered at Fall River, is minutely described in an article written by Mr. John Stark, and published in the third volume of the American Magazine, at Boston, in the year 1837. This account may also be found on page 124 of Barber's Historical Collections, with a drawing of the skeleton and armor in the position in which it was discovered. "The body was in a sitting posture and enveloped in a covering of coarse bark of a dark color. Within this envelope were found the remains of another of coarse cloth, made of fine bark and about the texture of a manila coffee bag. On the breast was a plate of brass 13 inches long, 6 broad at the upper end, and 5 at the lower. It was oval in form, the edges made irregular, apparently by corrosion. Below the breast plate and entirely encircling the body, was a belt composed of brass tubes, each four and a half inches in length, and three-sixteenths of an inch in diameter, arranged longitudinally and close together; the length of a tube being the width of the belt. The tubes are of thin brass, cast upon hollow reeds, and were fastened together by pieces of sinew. This belt was so placed as to protect the lower parts of the body below the breast-plate. The arrows are of brass, thin, flat, and triangular in shape, with a round hole cut through near the base. The shaft was fastened to the head by inserting the latter in an opening at the end of the wood, and then tying it with a sinew through the round hole—a mode of constructing the weapon never practiced by the Indians, not even with their arrows of thin shell. Parts of the shaft still remain on some of them. When first discovered the arrows were in a quiver of bark, which fell to pieces when exposed to the air."

The skull and a few other bones of the skeleton were much decayed, but the upper viscera were entire, and the flesh and skin on the hands, arms, one knee, and a part of the back were in a good state of preservation, though the skin looked black as if it had been tanned. In connection with the discovery of this skeleton in armor, this writer mentions the fact that the famous Dighton Rock, bearing an inscription "of which no sufficient explanation has yet been given," lies on the edge of a river but a short distance away, and that near this rock brazen vessels have been found. All these signs seem to him to indicate that some mariners—the unwilling and unfortunate discoverers of a new world—lived some time after they landed, and, having written their names, perhaps their epitaphs, upon the rock at Dighton, died and were buried by the natives.

In the summer of 1882 the writer learned that some few years before, the skeleton of an Indian had been discovered in Centreville by some workmen while making the cellar of Captain Crawford's house. Buried with this skeleton was found a breast-plate of brass. Last summer it was learned from Mrs. Crawford that such a breast-plate had been found, but that it had disappeared, she knew not where. She remembered few particulars in regard to the position of the skeleton and any coverings that might have been on it, but remembered well holes near the edges of the breast-plate that had probably once been occupied by rivets or strap buckles to fasten it to the body. She felt sure it was an Indian, because all around the house on the sides of the little hill upon which the house was built there was an abundance of stone chippings and arrow-heads, and once a queer Indian pipe-bowl had been found. On the rear side of the little hill a good number of quartz and porphyry chips were then picked up, and at the house next door a fine leaf-shaped implement, which had been picked up on this hill, was exchanged for an old jack-knife. The first white explorers that visited New England found considerable copper in the possession of the natives which was used chiefly in the form of ornaments, but sometimes to head their arrows. Very soon, even before Gosnold or the Pilgrims arrived, the Indians had in some way obtained brass of the traders and fishermen who visited their shores.

In "Mourt's Relation or Journal of a Plantation settled at Plymouth in New England" we hear of arrows curiously "headed with brasse, some with Hart's horne and others with Eagle's claws." Another writer, sending home to England an account of the settlement at New Plymouth, says of the Indians: "For their weapons they have bowes and arrowes, some of them headed with bone, and some with brasse: I have sent you some of them for an example."

The following account of some copper articles in the possession of the Indians is taken from John Brereton's "Brief and True Relation of the Discovery of the North Part of Virginia, being a most pleasant fruitful and commodius soil." Brereton was with Gosnold when he discovered Martha's Vineyard in 1602. Even then they found an European rigged boat, the work of some Frenchmen, in the possession of the Indians of New England. From these Frenchmen, or other traders and explorers, the articles of "paler colored metal" described by Brereton as in the possession of the Indians that visited them while staying at Cuttyhunk may have come. The Indian probably told Brereton the truth in regard to the copper, which might have been dug up in some places in Connecticut or New Jersey, for afterward in these places the first white settlers sometimes found pieces of native copper, and even mined it, at the junction of the trap and red sandstone. Brereton's account of the metal found in the possession of the Indians is as follows:

"They have also great store of copper, some very red and some of a paler color, none of them but have chains, ear-rings, or collars of this metal. They head some of their arrows herewith much like our broad arrow-heads, very workmanly made. Their chains are many hollow pieces cemented together, each piece of the bigness of one of our reeds, a finger in length, ten or twelve together on a string, which they wear about their necks. Their collars they wear about their bodies like bandoleers, a handful broad, all hollow pieces like the other, but somewhat shorter, four hundred pieces in a collar, very fine and evenly set together. Besides these they have large drinking-cups made like skulls, and other thin plates of copper much like our boar spear blades, all which they so little esteem, as they offered their fairest collars or chains for a knife or such like trifle, but we seemed little to regard it. Yet I was desirous to understand where they had such store of this metal, and made signs to one of them with whom I was very familiar, who, taking a piece of copper in his hand, made a hole with his finger in the ground and withal pointed to the main from whence they came."

With a knowledge of this custom of the Indians, that is, of stringing tubes of copper or brass in the form of wide belts and wearing them about the waist, the discovery of such a belt on the skeleton at Fall River buried in other respects like any Indian (with the exception of the breast plate) need not seem so strange, especially when we find that brass and copper were quite abundant among them at an early date, and one other Indian at least had come into possession of a brass breast-plate.

Before the Pilgrims landed on Cape Cod it is certain that the Indians there had killed three Englishmen, and killed or retained as slaves the whole ship's crew of a French vessel which landed there in distress. This they did for the sake of plunder, and very probably some copper or brass came into their possession at these times. Granting, then, that the Indian whose skeleton was found at Centreville did not engage in successful war with the colonists, or get the brass breast-plate from them by trade, it is still possible for him to have obtained it, or the material for it, at a still earlier date from these unlucky explorers.

An account of the burial customs of the Indians on Cape Cod would be imperfect without reference at least being made to the description of an Indian burying ground discovered by the Pilgrims while exploring on Cape Cod before the settlement at Plymouth. This account may be found under the history of Gov. John Carver, in a book compiled by J. B. Moore, entitled "Governors of New Plymouth and Massachusetts Bay."

The place where Governor Carver and "nine of his principal men, well armed," landed after leaving the Mayflower and rounding the point off Wellfleet Harbor, was probably on Indian Neck, where, it will be seen by consulting the map, many Indian shell heaps may now be found. On the shore Carver and his men saw ten or twelve Indians engaged in cutting up a large fish, but found it difficult to go directly to the shore where the fish lay, on account of the shoal water. The Indians ran off, taking with them all the fish they could carry. The shores of the shallow bay or cove in which they landed were almost lined with the remains of large fishes like that which the Indians had cut up. The fish proved to be a grampus, and so the explorers called the bay Grampus Bay. This bay is now called Blackfish Bay or Creek, and it is only a few yards to the north of this shallow bay that the shell heaps and other signs of Indian settlement, before described, around Drummer Pond may be found. With this explanation and a reference to the map,

Sketch-map of Cape Cod, Massachusetts.

the history of the discoveries made by the Pilgrims at this time may be more interesting, and should be read among the very first books by those who wish to become better acquainted with the history of the Indians in this vicinity.

The traditions of the Indians of Cape Cod, Martha's Vineyard, and Nantucket have been wholly omitted in these notes, but may be found in full, together with many interesting facts in regard to the Indians' dress, wigwams, canoes, &c., in a few books the titles of which will soon be given.

The fable in regard to the lignite and fossil bones of cetaceans or whales found abundantly in the Tertiary clay of Gay Head, Martha's Vineyard, is very interesting. These Indians supposed that the blackened wood or lignite marked the spot where the giant Manshope broiled the whale on a fire made of the largest trees, which he pulled up by the roots. The rest of the tradition is very interesting, but if repeated would necessitate entering on the almost equally interesting traditions of the Indians of Nantucket and Cape Cod.

Mr. Treat wrote that there were in 1693 under his care in Eastham, which then included Wellfleet and Orleans, four Indian villages where he was in the habit of visiting the natives in their wigwams. At this time there were five hundred adult persons in the villages; but notwithstanding every exertion made for the benefit of the Indians, they wasted away by fatal diseases and other causes, so that in 1764 they were reduced to four individuals only.

One reason why so few traces of settlement can now be found on the sites of these old Indian villages is undoubtedly owing to the fact that the civilized Indians persistently kept up the custom of living in wigwams until they had become wholly extinct or had mixed with other races. As late as the year 1779 there was a cluster of wigwams about a mile from the mouth of Bass River, probably at the spot where the shell heaps and arrow-heads are so abundant. About this time the small-pox was prevalent and most of them died.

In 1745 thirteen Indians from this company on Bass River and the immediate vicinity accompanied the Cape Breton expedition. The condition of their embarking was that Mr. Thacher, of Yarmouth, should be their captain. Of these thirteen only three lived to return, two being killed by the enemy, and eight dying of disease. One of Thacher's Indians, hired by Colonel Vaughan for a bottle of brandy, was the first of the provincials who entered the grand battery at Louisburg. He crawled in at an embrasure and opened the gate, which Vaughan immediately entered, the enemy having withdrawn from this battery, though at the time this circumstance was not known. This information is from an extract made from "Alden's Collection," on page 60 of Barber's *Historical Collections*, and it adds several other interesting stories of the Indians of this vicinity.

Very little interesting information exists about the Indians of Centreville and Buttermilk Bay, where the shell heaps would indicate a population nearly as great as that at Bass River and Wellfleet Bay.

Until the breast-plate of the Skeleton in Armor is found, and a thorough investigation can be made, the history of this warrior must remain a mystery, and we may regard him as a very ordinary and vain Indian, buried in his finery, or we may think of him as a successful warrior safely returned from a secret participation in King Philip's war, and afterwards buried in the spoils which he had stripped from a fallen foe.

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ANTIQUITIES FROM OMETEPE, NICARAGUA.

By CHARLES C. NUTTING.

Although the name of this island has been spelled "Ometepec" by previous explorers, I have decided to adopt the spelling of the inhabitants of the country, which is also that used in official papers.

This latter fact I discovered through reading official reports of the eruption of the volcano published in "El Centro Americano," a Nicaraguan newspaper. This island is situated about 9 miles from the town of San Jorge on the west shore of Lake Nicaragua. It is about 20 miles long by 10 wide, and the greater part of its surface is covered by two volcanoes, which are prominent features of the scenery from all parts of the lake.

The Volcano Madera is of greater bulk than its companion and much more irregular in form. So far as I could learn it has never been known to give signs of activity within historic times.

The Volcano Ometepe, situated on the northern end of the island, is said to be one of the most regular in form in the world, being a perfect cone from all points of view. It is about 5,000 feet high.

This has also been considered an extinct volcano, but, during my visit, it began showing signs of activity. On March 6, 1883, a thin column of smoke was seen to issue from the exact summit, and about six weeks afterward there was a slight flow of lava on the southeastern side.

Ometepe has the reputation of having been an object of worship by the peoples of past ages, and the large number of stone images found on the island would seem to indicate that it was sacred ground. It was evidently a chosen spot for burial, as the immense number of graves and burial urns still testify.

The present inhabitants of the island are mostly Indians of a rather purer type than is found on the adjacent mainland, although many of them show a mixture of Spanish blood and a few are partly negro.

For a description of the appearance of the pure-blooded native, I can not improve upon that given by Dr. J. F. Bransford, in his "Archæological Researches in Nicaragua," page 6:

"In physique the Indians are usually rather short, low-browed, with dark copper skin and coarse hair. On and near Madera are a few of commanding stature, many of the men being over 6 feet high and the women proportionately large. The head is short, the features strongly marked, with heavy lower jaw and large teeth."

I was unable to discover any remnant of reverence among the natives for the old idols found on the island, nor did they offer the slightest objection to the removal of one of them, although they were convinced that said removal was simply a freak of insanity on my part.

One prominent characteristic of these Indians is the deference and obedience which they pay to the opinion and will of their wives, whom they consult on all matters of importance.

This fact is well illustrated by an instance which is, perhaps, worth recounting.

While digging for antiquities the writer found a spot peculiarly rich in the objects of his search, but it was on land owned, or at least worked, by an Indian who proved unusually avaricious and demanded payment for every yard of earth disturbed.

He also put in a bill for damages done to his crop of young plantains by my men passing over them on their way to and from work. I considered the bill a just one and offered to pay it while settling up my other accounts, when, to my great surprise, he refused to accept the money. Upon being pressed for a reason he said that his "mujer," or "woman," had forbidden his taking the money.

In order to test the extent of his obedience I urged him to take the money, telling him that his "mujer" need know nothing of the matter. He steadily refused, however, and gravely stated that "women knew everything."

The Catholic Church is here, as elsewhere in Central America, the controlling power among the Indians. But they still retain some curious remnants of their own ancient superstitions, among which may be mentioned an almost universal belief in the *personality* of the great forces and features of nature.

They attribute life and passion to Lake Nicaragua, for instance, not only in a figurative but also in a literal sense.

This power of ancient superstition was well illustrated by an instance which occurred during my ascent of the Volcano Ometepe.

This ascent was made at the request of the "alcalde" of the town of Moyogalpa, who furnished me with six men to carry water and provisions.

After entering the dense forest which clothes the summit of the peak, I became convinced that the men knew nothing about the trail, and accordingly determined to make a way for myself and, selecting the most intelligent of the men for my companion, I pushed on ahead leaving the others to shift for themselves.

After toiling upward for an hour or so, wishing to ascertain the whereabouts of the rest of the party, I asked my companion to shout, and see if they were within hearing. He seemed extremely reluctant to do so, and I gave the call myself, much to his evident alarm.

After shouting several times without any response, I was informed by the Indian that my efforts were useless as the others wouldn't answer even if they heard me.

Upon inquiring the cause of this, I was told that they were "afraid to make a noise so near old "Ometepe" as it might make him "muy bravio" (very angry)!

I found, upon rejoining the others shortly afterward, that it was even so, and that my calls were plainly heard, but not answered for the reason given.

The Indians are good-natured and indolent, as a rule, and rarely quarrelsome or dangerous, except when under the influence of liquor. I found it much easier to lead than to drive them. Their good-will is readily gained, and more can be accomplished through that than through either fear or money.

The antiquities secured by me may be divided into two general classes: (1) Sculptures in stone; (2) Vessels of clay and their contents, including all objects found in the burial places.

Among the stone sculptures I saw a number of human figures about life size, besides smaller articles comprising images of men and animals, and also utensils such as grinding stones and vessels for various purposes. I saw and examined seven human figures carved in stone and of nearly life size.

No. 1. A large human figure, sitting, about 5 feet high. The head, upper arm, and knee are wanting. Found lying, half embedded in the gravel on the lake shore, about 3 miles north of Moyogalpa. This is probably the figure referred to by Dr. Bransford as "an image without a head lying in the edge of the lake."

No. 2. Companion to the last, about the same length, but of slighter build, from which I judge that it was intended for a female. This figure also differs from No. 1 in having the arms bent at the elbows with the hands resting on the knees, while in No. 1 the hands hung down straight at the sides. Both Nos. 1 and 2 are headless, and the latter is probably the one referred to by Dr. Bransford as follows: "Another was said to be uncovered at low water during the dry season." At the time of my visit the figure was lying in the water, by which it was nearly covered.

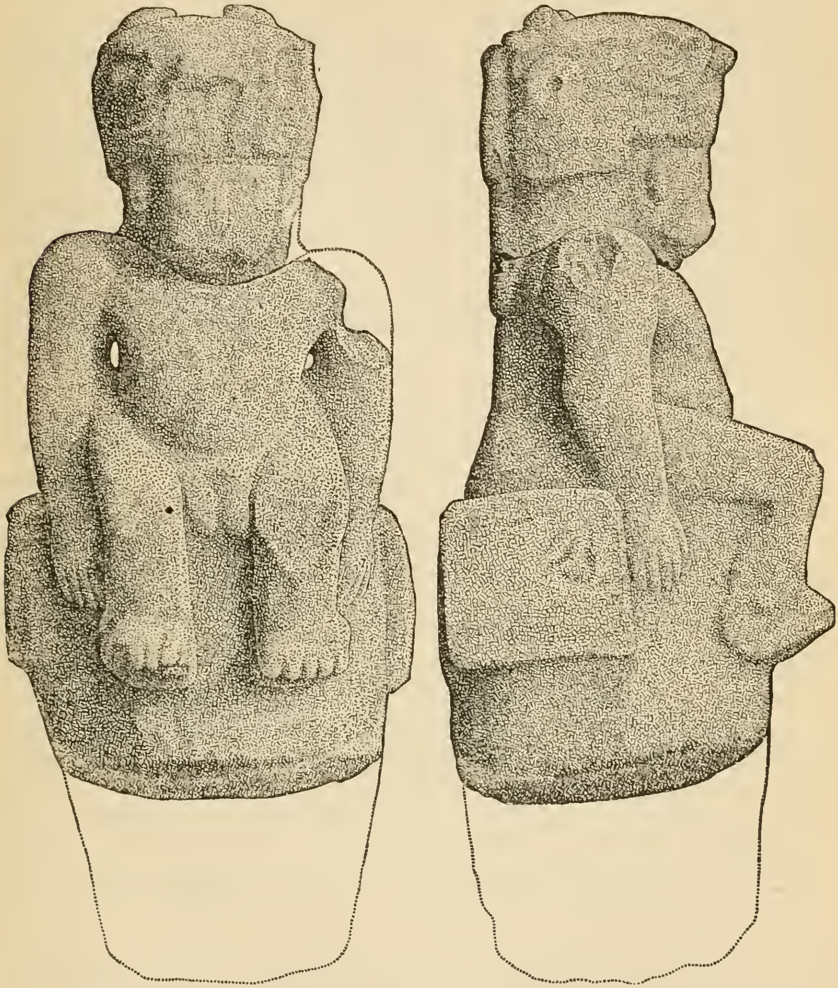
Nos. 3 and 4 are Dr. Bransford's Nos. 1 and 2. They have been taken from their original position in the forest and set up as gate posts at the Catholic church at Los Angeles. They are now the property of Dr. Earl Flint, of Rivas, who bought them from the church and intends shipping them to this country.

No. 5 is a very much worn figure of "a man in a standing position." The basalt rock is worn almost smooth, but it bears evidence of workmanship. I must confess that I could not make out the figure of the man, and give it as such on the authority of the native who guided me to it.

No. 6 was a seated female figure found in the dense forest south of Los Angeles. This figure also was headless, and I failed to find the missing part.

No. 7 was the companion to the last, and in better condition than any of the others I examined. The head was off, but I found it lying near, and found that it fitted well, having been broken off at a comparatively recent date. This figure I determined to secure for the National Museum, and succeeded in transporting it down to the lake shore, across the lake and over the mountains to the Pacific coast, where I placed it in charge of the Pacific Mail Steamship Company.

The idol is now in the National Museum at Washington, and forms the subject of the following illustration:



Front and side view of stone figure from Ometepe. (Size=$\frac{1}{12}$.)

The figure is that of a man seated. It is about life size, but the legs are small in proportion to the body. The head is large and is surmounted by the head of some animal. The arms are separated from the body at the elbows and hang straight down.

The following are some of the measurements: Height of figure without base, 4 feet 3 inches; height of figure and base, 5 feet 9 inches;

width of seat, 2 feet 1 inch; height of seat, 1 foot 7 inches; sole of foot to knee, 1 foot 2 inches; arm and hand, 2 feet 1 inch; greatest girth of body, 3 feet 11 inches; greatest girth of base, 5 feet 11 inches; girth of neck under chin, 3 feet 6 inches; girth of arm, 1 foot 4¾ inches; height of head from shoulder, 1 foot 2½ inches; across knees, 1 foot 2½ inches; knee to back of figure, 1 foot 10½ inches.

I also shipped to the museum a figure, supposed to be that of a monkey. The head only is distinct. It was found in a cacao plantation, about one-half mile northwest of Moyogalpa. This figure is said by the natives to have been worshipped by their ancestors.

The burial urns and their contents and accompanying objects of clay, bone, shells, and human remains were all found in two localities, which are called, for convenience in reference, graves Nos. 1 and 2, although it must be understood that each was a burial ground of some extent, and not a simple grave.

GRAVE NO. 1 was located some 400 or 500 yards from the spot where the idol last mentioned was found, being more to the southwest and nearer the shore of the lake. It was situated in a plantain patch owned by an Indian.

The fact that the spot was exposed to the direct rays of the tropical sun rendered it a trying place to work, and I have nothing but praise for the three men (Indians) who toiled faithfully day after day in the excavations at this place.

The surface ground here is of rich loamy soil about 8 inches in depth, under which is a bed of sand nearly 2 feet in depth. Underlying this sand is a hard bed of ashes and grit, through which the excavations did not penetrate.

The burial urns were of two general classes, round and shoe-shaped. The natives call the former "*Ollas*," and the latter "*Burrugas*."

Although carefully packed in soft grass, all the large vessels that I secured were badly broken, and at the time of writing only two of them have been mended so that measurements can be taken.

No. 61,713 was the first vessel encountered, and was found covering the mouth of a large shoe-shaped urn, being inverted over the same. It is a large basin-shaped dish, round at the bottom, being 7 inches deep and 18¼ broad.

No. 61,712 was also used as a cover to an urn of similar shape. It has a flaring rim at the top, and foot at the bottom, and is 14½ inches high by 18 broad at the top.

No. 61,714 was a rather small round urn.

No. 61,708. A shoe shaped urn which is being restored.

No. 61,710 is a round deep urn.

No. 61,711 is a round medium-sized urn.

No. 61,709 is a shoe-shaped vessel.

No. 61,750 is a shoe-shaped vessel.

No. 61,707 is a small urn, made of the same material as the preceding. It resembles No. 61,712 in shape and measures as follows: Depth, 8½ inches; greatest breadth, 10½ inches.

These large urns were generally found at a depth of about 2 feet. The round ones generally had covers of material similar to the urns themselves, while the shoe-shaped vessels were more often covered with more delicate, painted bowls. Fragments of human bones were found in nearly every urn, but they crumbled at a touch upon being exposed to the air.

Many articles of more delicate construction and finer workmanship were found. They were often used as covers to the shoe-shaped urns, or buried near the latter, or placed within the urns, where bowls were sometimes found inverted over the scull of the occupant, apparently serving as a cap or protection to the head.

I was much surprised to find, in several instances, that bowls had been broken, and afterwards placed within the urns. This is proved by the fact that many of the bowls which were found in pieces inside of the urns were too large to pass through the mouth of the urn when entire.

No. 61,691. Bowl, painted on outside. Found inside of round urn; Depth, 3⅞ inches; width, 8¾ inches.

No. 61,692. Bowl, painted on outside. Found as cover for shoe-urn. Depth, 4⅛ inches; width, 9½ inches.

No. 61,693. Bowl, painted on outside. Found at a depth of 5 feet, inside of round urn containing skull. Depth, 4⅞ inches; width, 9 inches.

No. 61,694. Bowl, painted on outside. Found outside of urn. Depth, 4 inches; width, 8½ inches.

No. 61,695. Small bowl painted on outside. Two red lines around inside close to the top. Found inside of round urn. Depth, 3 inches; width, 5½ inches.

No. 61,696. Small bowl painted on outside. One indistinct red line around inside of urn. Found inside of round urn. Depth, 2¼ inches; width, 5 inches.

No. 61,697. Bowl with raised figure of human face on each side. Painted on the outside. A brown line around inside of rim with a red line immediately under it. Found covering a shoe-shaped urn. Paint very fresh. Depth, 4⅛ inches; width, 9½ inches.

No. 61,698. Bowl with raised figure similar to preceding. Painted on outside with a delicate pattern in fine lines and dots. Painted on inside with rather coarser pattern covering entire inner surface. Found covering a burial urn. Paint very fresh and distinct. Depth, 3¾ inches; width, 10 inches.

No. 61,699. Bowl with raised figure somewhat distorted. Painted inside and out with rather a ruder pattern than the last, and not so carefully executed. Colors remarkably fresh and distinct. Found outside of burial urn. Depth, 3½ inches; width, 8½ inches.

No 61,700. Shallow bowl painted inside and out with similar patterns. On the outside there is a series of twelve hieroglyph like figures of two kinds in alternation. On the inside are ten similar figures also alternating. This bowl is thicker and more solid in construction than any of the others. I have been unable to find another like it in the collection of the National Museum. It was found inside of a round urn where it served as a cover for a human skull. Depth, 2¼ inches; width, 7 in ches.

No. 61,701. Shallow dish with flat bottom and flaring sides. Painted on outside simply in black and red lines broken by short vertical lines extending around its circumference. On the inside the design is much more elaborate, being more like that found on some of the larger bowls. This also was found inside of a round urn and had been used as a skull cover. Depth, 2¼ inches; width, 7½ inches.

No. 61,702. Shallow dish with bottom more rounded and sides more flaring than the last. Painted inside and out with very elaborate designs. Paint scaled off in many places. Found near a shoe-shaped urn. Depth, 1⅝ inch; width, 6¼ inches.

No. 61,703. Deep dish with rounded bottom and flaring sides. This dish is ornamented both inside and out with designs more intricate and elaborate than any other that I have seen from Ometepe. The colors are quite fresh and distinct. Found inside of round burial urn. Depth, 2 inches; width, 5⅝ inches.

No. 61,704. Deep, narrow-mouthed, bowl-shaped vessel ornamented on the outside with a series of red and black lines, and oblong longitudinal panels inclosing circular and square figures. Lower half of outside and entire inside not ornamented. Found inside of a shoe-shaped burial urn. Depth, 4 inches; width, 5⅜ inches.

No. 61,705. Deep, flat-bottomed, straight-sided vessel, painted red, and ornamented with incised lines on the outside near the rim. Found outside of burial urn. Contained human bones. Depth, 3¾ inches; width, 6¼ inches.

No. 61,706. Two miniature shoe-shaped vessels joined together, facing in opposite directions with a handle on top (broken off). The two vessels are joined together inside by a round hole. This specimen is unique in the collections of the National Museum. Depth, 2½ inches; width, 4⅝ inches.

No. 61,744. Under this number come the numerous legs or feet of tripod vessels of clay encountered in all parts of the excavations. They almost always are made to represent the head of man or some animal, are hollow inside, and often have a little ball of hard clay within which makes a rattling noise when shaken. They are always painted in designs corresponding to those found on the vessels to which they belong. Although dozens of these legs were found I did not encounter a single entire tripod.

No. 61,745. Two vase ornaments representing heads of animals well executed and much more elaborate in form than the preceding. Unpainted.

No. 61,743. Clay "Sinkers." An intelligent native told me that he considered that these objects commonly called "sinkers" were, in reality, tools used for molding the various clay vessels with which they are associated.

No. 61,746. A small round fragment of painted ware, perforated so as to form a ring. Probably an ornament of some sort.

No. 61,747. Shell implement found in burial urn.

No. 61,748. Fish vertebra found in burial urn.

No. 61,749. Flint flakes found in burial urns. Said by the natives to have been used in fashioning the incised ornaments on pottery.

No. 61,715. Clay disc; I can think of no probable use whatever for this article. It is simply a round hard burnt disk 4½ inches wide by about ⅝ inches thick with rounded edges.

No. 61,716. Arrow-head found beside a skeleton which had been buried outside of burial urns, and stretched at full length with face up.

No. 61,717. Small portion of a semi-fossilized human bone, probably the ulna. Found inside of burial urn, at a depth of 5 feet below surface of ground. No. 61,693, was found in the same urn.

A great number of skulls and other portions of human skeletons were encountered both inside and without the urns. Those inside the urns were extremely fragmentary and crumbled at the slightest touch. I brought the fragments of a skull found at a depth of five feet along with Nos. 61,717 and 61,693.

I also collected a large number of bones from skeletons found outside of urns.

These seemed to be in a much better state of preservation, but were all jolted to pieces on the homeward voyage.

Some of these skulls are remarkably thick with a good facial angle.

It seems hard to account for these two modes of burial in the same spot.

Skeletons were often found stretched out right by the side of the urns.

The fact that those found outside of urns were in a much better state of preservation than those inside would seem to preclude the idea of the two modes being contemporaneous; the urns being an excellent protection for the latter. The indications are that a considerable lapse of time must have intervened between the two modes of burial, and that the urn burial is the older method, and that the full-length interment was practiced by a subsequent race. This subsequent race must have exposed the urns in digging their graves, and the question arises. Why were the urns left undisturbed?

Dr. Bransford has suggested to me the most plausible answer to this question which is substantially as follows: "All mankind, both savage and civilized, have a peculiar reverence for the graves of the dead, and, among many uncivilized races, this reverence has taken the form of a deep-rooted superstition which forbids the molestation of any grave. This was probably the feeling which induced the 'subsequent race, spoken of above, to leave unmolested the urns containing the remains of human beings."

GRAVE No. 2.—This place of burial was found at a spot only 200 or 300 yards northwest of Grave No. 1.

The character of the ground is much the same here as at No. 1, but the urns were found much nearer the surface, the tops of the vessels generally coming within a foot of the surface of the ground.

Most of the large urns were broken by roots of trees which had penetrated them in all directions, but they seem to be of the same style as those found in No. 1, with perhaps a little more attempt at ornamentation.

No. 61,737. A large, ornamented, shoe-shaped urn, much like No. 22,343 of Dr. Bransford's collection in size, shape, and ornamentation.

No. 61,738. A very large round urn which I succeeded in getting out of the ground intact, but it was badly smashed on the voyage.

No. 61,739. Medium-sized shoe urn, also badly broken. There was one vessel, badly broken by roots of trees, that had an ornamentation which I have not seen elsewhere among specimens brought from Ometepe. The vessel was about size and shape of Dr. Bransford's No. 22,320, but was rather more regularly formed. The ornamentation consisted in a regular, five-pointed star formed of raised lines. One of the points was missing.

The smaller articles of pottery from Grave No. 2 differ from those found at No. 1 in several important particulars. They have, in general, an appearance of greater age, and are more often ornamented with raised figures or designs. The painting is less elaborate and the paint much less fresh and distinct.

No. 61,718. Deep bowl, painted on the outside in a rather elaborate pattern. The design in color differs from that of similarly shaped vessels from Grave No. 1 in having the color laid on in bolder and more massive bands and patches. Shows slight traces of having been over the fire. Perhaps it was a vessel used in cooking. Depth, $3\frac{1}{4}$ inches; width, $6\frac{1}{2}$ inches.

No. 61,719. Shallow bowl painted outside in a crude pattern, and inside in an elaborate one. Found in burial urn. Depth, $1\frac{1}{2}$ inches; width, 4 inches.

No. 61,720. Large bowl with raised figures of human face on each side, the nose and mouth being much more prominent than in similar vessels from Grave No. 1. This bowl shows decided evidence of being subjected to action of heat, being scorched and blackened, and having a large proportion of the paint worn or scaled off. Painted in elaborate designs both inside and out. Found outside of burial urn. Depth, 4 inches; width, $9\frac{1}{4}$ inches.

No. 61,721. Narrow-mouthed pot or vessel, of peculiar shape. This peculiarity consists in a deep, broad groove extending from rim to bottom on one side. This may be a suggestion of the double shoe-shaped vessel, No. 61,706. Depth, 3½ inches; width, 4½ inches.

No. 61,722. Wide-mouthed bowl with an ornament consisting of a projecting turtle's head, well executed, on each side. It is ornamented also by broad raised bands, a flaring rim, a ring or pedestal for a stand, and three rings of incised dots, two of which rings extend entirely around the vessel, while the third is interrupted only by the turtle's heads. Colors red and perhaps originally black. Found outside of burial urns. Depth, 2½ inches; width, 5¼ inches.

No. 61,723. Bowl with flat bottom and slightly concave sides, and incised pattern running entirely around on the outside near the rim. Colored like preceding. Found outside of urns. Depth, 2⅛ inches; width, 5¼ inches.

No. 61,724. Hemispherical bowl with circular standard. Unornamented. Found outside of urns. Depth, 4¼ inches; width, 8 inches.

No. 61,725. Small, shoe-shaped vessel with raised ornament representing the face of some animal (tiger?). Black, polished. Found in urn. Depth, 4½ inches; width, 4½ inches; length, 5 inches; width of mouth, 2⅛ inches.

No. 61,726. Small, wide-mouthed shoe-shaped vessel. Unornamented and unglazed. Found outside of urn. Depth, 5 inches; width, 4¾ inches; length, 7¼ inches; width of mouth, 4 inches.

No. 61,727. Small, shoe-shaped urn, similar to last with the exception of a raised handle at small end. Front part missing. Found outside of urn. Depth, 5 inches; width, 4¾ inches; length, (?) inches; width of mouth, 3¼ inches.

No. 61,728. In form this vessel seems to be intermediate between the shoe-shaped and round styles. There is a slight vertical depression on the smaller end, and also two crescent-shaped ridges in imitation of the rope or chain ornaments found on the large, shoe-shaped urns. The material is either very old or poorly burnt, it being very "rotten." Depth, 5 inches; width, 6 inches; length, 7 inches; width of mouth, (?) inches.

No. 61,733. Diminutive, shoe-shaped urn, with raised ornaments at each end. Found in urn. Depth, 2¼ inches; width, 1⅝ inch; length, 2¼ inches; width of mouth, ⅞ inch.

No. 61,730. Similar to last. Unornamented. Found in urn. Depth, 2½ inches; width, 2 inches; length 2⅝ inches; width of mouth, 1¼ inch.

No. 61,729. Narrow-mouthed round vessel, with a series of vertical depressions and corresponding elevations running around the upper part. There is also a raised ornament, probably a head, on each side near the top. These ornaments are connected by a "rope ornament" extending entirely around the vessel. The combination of form and ornamentation is different from that seen in any other specimen from Nicaragua. Depth, 6¾ inches; width, 8 inches.

No. 61,731. Miniature of round urn, unornamented and unpainted. Found inside of round urn. Depth, 1½ inches; width, 1¾ inches.

No. 61,732. Same as last.

No. 61,734, 61,735. Ornaments from a large, curiously shaped dish which served as a cover for No. 61,738, but had been broken to pieces by roots. These ornaments were intended to represent the head of some animal, and show considerable care in design and execution.

No. 61,736. Beak of parrot in clay.

Many legs of tripod dishes were found, bearing a general resemblance to those of Grave No. 1. Very few bones were found, and those were even more fragmentary than in Grave No. 1.

No. 61,740 is a rude carving of a face in stone, found inside of burial urn.

ON THE COMPARATIVE PHONOLOGY OF FOUR SIOUAN LANGUAGES.*

By Rev. J. Owen Dorsey,
of the Bureau of Ethnology.

The term "Siouan" has been applied to that family of Indians which has been known heretofore as the "Dakotan Family."

It is unfortunate that we are obliged to use this adjective, which is derived from "Sioux," as the latter is not a genuine Indian word. According to Dr. J. H. Trumbull, "Sioux is the termination of the French plural of the Ottawa *Nadowessi*, by which a Dakota was designated. The Ottawa plural is *Nadowessiwag* (or *-ak*); the French made it *Nadowessioux*, and the *couriers de bois* reduced it to *Sioux*." "Dakotan" should have been the appellative, as the Sioux call themselves "Dakota" and "Lakota." But, in honor of Albert Gallatin, who was the first to classify the Indians of this family as the "Sioux," the Bureau of Ethnology of the Smithsonian Institution has adopted the new term, "Siouan," as the name of this family.

The writer is responsible for "¢é-gi-ha" as the name of the second group appearing in the following list, and for "ꞁɔi-wé-re," the name of the third group. ¢egiha means, "Belonging to the people of this land," or, "Those dwelling here," *i. e.*, the aborigines or home people. When an Omaha was challenged in the dark, if on his own territory, he usually replied, "I am a ¢egiha." So might a Ponka reply, under similar circumstances, when at home. A Kansas would say, "I am a Ye-gá-ha," of which the Osage equivalent is, "I am a ¢e-ɥá-ha." These answer to the Oto "ꞁɔi-wé-re" and the Iowa "ꞁɔé-ɥi-wé-re." "To speak the home dialect" is called "¢egiha ie" by the Ponkas and Omahas, "Yegaha ie" by the Kansas, "ꞁɔiwere itc'e" by the Otos, and "ꞁɔeɥiwere itc'e" by the Iowas. When an Indian was challenged in the dark, if away from home, he must give his tribal name, saying, "I am an Omaha," "I am a Ponka," etc.

LANGUAGES OF THE SIOUAN FAMILY.

1. Dakota, in four dialects: Santee, Yankton, Teton, and Assiniboin.
2. ¢egiha, in four dialects: Ponka (spoken by Ponkas and Omahas), Kansas, Osage, and Kwapa.

* Read before Am. Assoc. A. S., Section "H," at Montreal, August, 1882.

3. ʇɔiwere, in two (?) dialects: spoken by the Iowas, Otos, and Missouris.
4. Hotcañgara or Winnebago.
5. Mandan, in two dialects.
6. Hidatsa, in two dialects: Hidatsa and Absaroka.
7. Ye-sa^n, or Tutelo.

The three surviving Tutelos are with the Six Nations, in Canada, and the Hon. Horatio Hale has been making special investigations concerning their history and language.

The writer has obtained about 20,000 words of the Ponka dialect, 4,900 Kansas words, 3,500 Osage words, about 9,000 of the ʇɔiwere, and over 1,100 of the Hotcañgara. He gained over 1,000 Kwapa words, but he is unwilling to publish any of this material at present.

TABLE I.—THE SIOUAN ALPHABET.

This alphabet includes all the sounds which the writer has found among the tribes speaking the four languages, Dakota, ¢egiha, ʇɔiwere, and Hotcañgara. It is substantially that adopted by the Bureau of Ethnology in 1880, and used by the writer in his monograph, "The ¢egiha Language," to be published as "Contributions to North American Ethnology, Vol. VI."

a	as in *father*.
ă	nearly as in *what*, or as *o* in *not*.
a^n	a nasalized a.
ă^n	a nasalized ă.
‘a	an initially exploded a.
‘ă	its short sound.
‘a^n	a nasalized ‘a.
ä	as in *hat*.
e	as in *they*.
ĕ	as in *get*.
‘e	an initially exploded e.
‘ĕ	its short sound.
i	as in *machine*.
ĭ	as in *it*.
i^n	a nasalized i.
ĭ^n	a nasalized ĭ.
‘i	an initially exploded i.
‘i^n	a nasalized ‘i.
o	as in *no*.
o^n	a nasalized o.
‘o	an initially exploded o.
‘o^n	a nasalized ‘o.
u	as in *rule*.
ŭ	as *oo* in *foot*.
u^n	a nasalized u.
ŭ^n	a nasalized ŭ.
‘u	an initially exploded u.
‘u^n	a nasalized ‘u.

u̱	a sound between u and o.
‘u̱	an initially exploded u̱.
ü	as the Germ. umlaut, in *küssen*. N. B.—It has a short sound in some Osage words.
ü^n	a nasalized ü.
ai	as in *aisle*.
ei	as i in *ice*, *nice*.*
au	as *ow* in *cow;* Germ. *Haus*.
yu	as u in *tune;* *ew* in *new*.
ui	as in Germ., *pfui!**

Prolonged vowels: a+, a^n+, e+, i+, i^n+, o+, o^n+, u+, u^n+.

b	as in *be*.
c	as *sh* in *she*.
ɔ	a medial *sh*, between *sh* and *zh*.
ç	as *th* in *thin*.
ɗ	a medial *th*, between *th* and *dh*.
d	as in *do*.
¢	as *th* in *the*.
g	as in *go*.
h	as in *he*.
j	as z in *azure*.
k	as in *kick*.
ʞ	a medial k, between k and g.
k'	an explosive k.

*Rarely used.

m as in *me*.
ɯ a medial m (m, w, b), sometimes synthetic(?).
n as in *no*.
hn a pure nasal, the h being expelled through the nostrils.
ñ as *ng* in *sing*, *singer*.
p as in *pipe*.
d a medial p, between p and b.
p' an explosive p.
q a *kh*, as in Germ. *ach*.
r as in *row*.
s as in *see*.
ƨ a medial s, between s and z.
t as in *two*.
ʇ a medial t, between t and d.
t' an explosive t.
w as in *we*.
ʍ a sound between b and w.
x as *gh*, the sonant of q (kh).
y as in *you*.
z as z and s in *zones*.
dj as j in *judge*.
tc as *ch* in *church*.
ʇɔ a medial tc, between tc and dj.
tc' an explosive tc.
ts as in *its*.
ʇƨ a medial ts, between ts and dz.*
ny as ñ in *cañon*.
hw as *wh* in *when*, *what*.

Almost any consonant can be prolonged by adding the plus sign (+).

The consonants may be arranged as in the following table:

TABLE II.—CLASSIFICATION OF CONSONANTS.

A.—MUTES.

	Sonants.	Sonant-surds.	Surds.	Explosives.	Nasals.			
Labials	b	d	p	p'	m	ɯ	w	ʍ
Dentals	d	ʇ	t	t'	n		l, r	
Palatals	g	ᵷ	k	k'	ñ	ny	y	

B.—SPIRANTS.

			h					
					hn			
Dentals	ȼ	ð	ç					
Palatals	x		q					

C.—SIBILANTS.

Mutes	z	ƨ	s					
Spirants	j	ɔ	c					
Compounds	dj	ʇɔ	tc	tc'				
Do		ʇƨ	ts	ts'				

In the Dakota books which have been published up to date, no distinctions have been made between long and short vowels. The writer cannot say that such distinctions do exist in Dakota, but he knows that they are essential in Ȼegiha, Ʇɔiwere, and Hotcañgara.

In Ponka "o" and its compounds are always wanting, but that dialect has the diphthongs, which have not been found in Dakota. The Dakota never use the following: ȼ, r, ç, and the sonant-surds (according to Mr. Riggs). The Ʇɔiwere does not use b, g, j, l, s, and z. In the Osage, the only sonants are ȼ and x, the sonant-surds taking the places of their corresponding sonants. The vowels, u̱, ü, and üⁿ, are peculiar to the Kansas, Osage, and Kwapa. Inverted m and w are used by the Kansas.

* No "dz" has been found, so far, by the writer in any of these languages.

The initially modified or exploded (?) vowels are indispensable. Important distinctions are made by means of them. Thus, in Ponka, we find e, *that (aforesaid)*; but ‘e, *to dig;* i, *to be coming hither for the first time;* but ‘i, *to give;* iⁿ, *to wear*, as a robe; but ‘iⁿ, *to carry on the back;* gaaxe, *to uncover an object by blowing off a robe*, etc. (said of the wind); but ga‘axe, *to strike and glance off*, *to make the sound heard when metal* or *a bone is hit.* Rev. A. L. Riggs admits that these explosive vowels are found in Dakota; but his father, the late Dr. S. R. Riggs, gave them as simple vowels in his dictionary and grammar, describing the initial modification of the vowel as "a hiatus." A few of the words containing these modified vowels may be seen by turning to Table III, Nos. 170 to 180.

Sonant-surds.—These sounds have been found by the writer in ¢egiha, Ʇoiwere, and Hotcañgara, as well as in some of the languages of the Indians now on the Siletz reservation, Oregon. Dr. S. R. Riggs was inclined to the view that such sounds are possible, but his son, Rev. A. L. Riggs, holds the contrary opinion. The writer uses the term, "sonant-surd" tentatively. He is ready to accept any other term which may be suggested by scholars, if it be sufficiently descriptive of the nature of this class of sounds. By "sonant-surd" is meant a sound between a sonant and its corresponding surd. A few Ponka examples are given, showing the difference between three sonant-surds and the corresponding sonants, surds, and explosives.

P-mutes.—ba (sonant), a verbal modal prefix; da (sonant-surd), *head, nose;* p‘ă (surd), *bitter;* bi, verbal prefix; di, *liver;* pi, *good;* p’iⁿxe, *puckered, corrugated.* *K-mutes.*—ga, verbal modal prefix; ʞaxa, *a crow;* kage, *third son, male friend;* k’axe, verbal root. *T-mutes.*—de, *while, during;* ʇe, *buffalo;* te, a future sign; t’e, *dead;* di, adverbial terminal particle; ʇi, *lodge;* ti, *to have come hither for the first time;* t’iⁿxe, verbal root, *drawn up*, as the mouth of a bag.

The Dakota "hn" is heard in such words as hnaka and hi-hnaku. It differs from the ¢egiha "hn." The "h" in the former is expelled from the mouth, but in the latter it comes through the nostrils, with a very slight effort, often escaping the notice of a white man. It is generally used in the 2d. sing. of verbs in ¢a (ya) and ¢i (yü).

EXAMPLES.

English.	Ponka.	Kansas.
You go	hne *or* ɔne (*of* ¢e)	hne (*of* ye)
You count	hnawa, ɔnawa (*of* ¢awa)	hnawa (*of* yawa)
You finish, stop	hnictaⁿ, ɔnictaⁿ (*of* ¢ictaⁿ)	hnüctaⁿ (*of* yüctaⁿ)

Except in contractions, all syllables end in a vowel, pure or nasalized. In Dakota there are a few words that seem exceptions to this rule, of which Dr. Riggs said, "These may possibly be forms of contraction, but we have not now the means of showing the fact."

Almost any sound can be prolonged in ȼegiha and ⅃oiwere, if it be alone, or stand at the end of a syllable. Prolongation occurs in many interjections, and is often used for emphasis. *E. g.* haⁿegaⁿtce, *the morning;* haⁿegaⁿtcĕqtci, *very early in the morning;* haⁿ+egaⁿtceqtci, *ve—ry early in the morning!* Weahide, *far;* we+ahide, *fa—r!*

Sound-shifting.—As far back as 1872, the writer began to notice many examples of sound-shifting, while comparing the Dakota with the Ponka. After a study of the ⅃oiwere and Hotcañgara, begun at the Omaha and Winnebago reservations, Nebraska, in 1878, he began the formulation of the principles discovered. One of the most important ones is that of triliteral syllables. A triliteral monosyllable in ⅃oiwere (and often the corresponding ones in Dakota and ȼegiha) is changed into a quadriliteral dissyllable in Hotcañgara, when the first letter of the monosyllable is a mute, a palatal spirant, or a spirant sibilant; and the second consonant is a labial or dental mute, or a dental spirant. The first consonant of the Hotcañgara dissyllable is always a surd, the second is, as in the corresponding ⅃oiwere word, a labial or dental mute, or else a dental spirant; and each consonant (in Hotcañgara) must be followed by the same vowel sound. In no case, as far as examples have been gained, can any mute stand next to one of the same order; *e. g.*, a labial cannot precede a labial.

It is probable that the Dakota biliteral monosyllables "da" and "du" were originally triliteral syllables, an initial "c" having been dropped. That is, Nos. 32, 33, 34, 36, and 37 of the Dakota column in Table III were originally cda, cda-tkaⁿ, cda, cdu, and cduxo, respectively. This seems very probable when we find clo (Teton for cdo), in No. 35, equivalent to the ȼegiha ɔnu, and cda (No. 31) equivalent to the ȼegiha ɔna. In No. 58 there seems to have been a transposition of syllables, final -ha being equivalent to ȼegiha initial a, and initial du to ȼegiha final ɔniⁿ. So, Dakota mdu, equivalent to ȼegiha bȼi, and mdu-ha to ȼegiha a-bȼiⁿ; Dakota yu to ȼegiha ȼi, and yu-ha to ȼegiha a-ȼiⁿ.

In comparing the Ponka with itself, or with the Dakota, we find instances of permutations of sound, as follows: c and q, x and z, ȼ and n. The words in which these occur are not always synonyms, but when we find a word in which "c," for example, is used, we may infer that the language contains another word, differing from it only in the substitution of "q" for "c." Or, one language uses "c" where the other employs "q."

The meanings of the words and syllables in the following table will be found at the end of this article.

TABLE III.—SOUND SHIFTING.

No.	Dakota.	¢egiha.			⅂ɔiwere.	Hotcañgara.
		Ponka.	Kansas.	Osage.		
1	mda, bla	b¢a	bla	d¢a	pra	pá-ra
2	mda-, bla-	b¢a-	bla-	d¢a-	ha-ta-	ʇa-
3	...	b¢acka	blacka	d¢acka	pracke	páracke
4	mdaya, blaya	b¢a¢a	blaya	d¢a¢a	prara	párara
5	mdaska, blaska	b¢aska	blaska, blak'a	p¢aska, d¢ak'a	praçke	páras
6	mdaza	b¢azĕ	blazĕ	d¢ase	praƽe	...
7	mdaja	b¢aje	...	...	...	...
8	...	b¢axe	blaxe	d¢axe	...	...
9	mda, bla	b¢e	ble	d¢e	ha-tce	ʇó-na
10	...	b¢e	ble	d¢e	pre	pére
11	...	b¢eda^n, bebeda^n	bleda^n	...	...	pére-
12	...	b¢eʞa	blek'a	d¢ek'a	preke	péro-niñke
13	pe-mni	be-b¢i^n, b¢e-b¢i^n	bye-bli^n	d¢e-p¢i^n	pre-pri^n	...
14	mdexa	b¢exe	...		...	...
15	...	...	...	...	preçe	pérese
16	...	b¢u	blu	d¢u	pro	poro
17	o-mdo-tə^n	b¢u-ga	blu-ga	d¢u-ʞa	pro-ʞe	...
18	...	b¢ub¢uga	...	...	proproʞe	póropóro
19	mdu	b¢i	blü	d¢ü	pru	púru
20	mdu-	b¢i-	blü-	d¢ü-, d¢u-, d¢i-	ha-tci-, ha-tu-	ʇu-
21	...	b¢ije	blüje	...	...	...
22	kpukpa	b¢ip'ĕ	...	...	prup'ĕ	...
23	mna	b¢a^n	bla^n, blŭ^n	d¢a^n	pra^n	pá-na
24	...	b¢a^n-xe	blŭ^n-xe	...	...	...
25	...	b¢a^n-ze	blŭ^n-ze	...	...	...
26	wiktce-mna	g¢e-ba	le-bla^n	ʞ¢e-d¢a^n	ʞre-pra^n	'kérepána
27	mni	-b¢i^n	-bli^n	-d¢ı^n	-pri^n	-píni
28	pe-mni (see No.	13).				
29	yą-mni	¢a-b¢i^n	y̌a-bli^n	¢a-d¢i^n	tá-nyi	tá-ni
30	yu-mni	¢i-b¢i^n	yü-bli^n	¢ü-d¢i^n	ru-pri^n	...
31	cda	ɔna	cta	cta	ɔra	...
32	da-	ɔna-, hna-	hna-	cta-	ɔra-	cára-
33	da-tka^n	ɔna-ta^n	hna-ta^n	cta-ta^n	ɔra-ta^n	cára-tcka^n'na
34	da	ɔne, hne	hne	ctse	ɔre	cére
35	icloya	iɔnnga	ictŭñga	ictŭñʞa	o-ɔro	o-códo-da
36	du-	ɔni-, hni-	hnü-	ctu-, cçi, ctü-, ctyu, ctsü-, *etc.*	ɔru-, ɔri-, ɔro-	cúru-
37	duxo	ɔnixu	hnüxu	ctüxu	ɔrixo	(See No. 191.)
38	hda-	g¢a-	la-	ʞ¢a-	ʞra-	ká-ra-
39	hdatka^n	g¢ata^n	lata^n	ʞ¢ata^n	ʞrata^n	káratcka^n'-na
40	hda	g¢e	le	ʞ¢e	ʞre	ke-re
41	hde	g¢e	le	ʞ¢e	ʞre	kere
42	hdepa	g¢ebe	lebe	ʞ¢ede	ʞrewe	weresere, warasere, (Alexander).
43	ahde	ag¢ĕ	alĕ	aʞ¢e	aʞre	etcá-keré-na
44	hdecka	g¢eje	leje	ʞ¢eɔe	ʞreɔe	kírikíricke
45	hdu-	g¢i-	lü-	ʞ¢u-, ʞ¢i-, ʞ¢ü-, *etc.*	ʞru-, ʞri-, ʞro-	kú-ru-
46	wamdu-ckada^n	wag¢icka	walücka	waʞ¢ücka	waʞri	wakídi
47	wamdu-da^n	wag¢i	walĕ	waʞ¢i	...	...
48	ihdi	weg¢i	ɯyeli	weʞ¢i	wiʞri	bikíni
49	hdi	g¢i	li	ʞ¢i	ʞri	kí-ri
50	hna	g¢ă^n	lañge	ʞ¢añʞe	ʞrañe	...
51	ahnaka	ag¢a^n	ala^n	aʞ¢a^n	aʞrañe	etca-kánañk-
52	octehda	g¢a^n	lŭ^n, la^n	ʞ¢ŭ^n	ʞrŭ^n	...
53	...	g¢a^n¢ĕ	la^{n}ye	ʞ¢a^n¢e	...	...
54	kpa-	gi-đa-	gi-pa-	...	ʞwa-	ká-wa-
55	ca-kpe	ca-đe	ca-pĕ	ca-pĕ	ca-ʞwe	a-ké-we
56	yapa-	cpa-	cpa-	cpa-	ɔwa-	cá-wa-
57	-na, -nana	ɔna^n, hna^n	...	hna^n, hnŭ^n	-ɔna	-cá-na
58	du-ha	a-ɔni^n	a-hni^n	a-hni^n	a-ɔní	a-cí-ni
59	...	q¢a^n	qla^n	q¢a^n	qra^n	-qá-na
60	qpa	qpa	qpa	qpa	qwa	...
61	hoqpa	huqpe	huqpe	huqpe	hoqwe	ho-qí-wi
62	qdo-ka	q¢u	qlu-ge	q¢u-ʞe	qro-ʞe	...
63	qte, cte	qta	...	...	qta	qá-ta, qé-te
64	qtca	qti, qtci	qtci	qtsi	qtci	...
65	sde-tca	-sne	stye-ge	-stse-ʞe	-ƽre-ʞe	...
66	ha^{n}ska	snede	stye-dje	stse-ʇse	ƽre-ʇɔe	sé-re-tce
67	...	...	...	...	u-twá-ke	i-tcá-wa-ga-ra
68	nakpa	niʇa	na^{n}ta	na^{n}ta	na-twa	na-tcá-wa

The following are some of the vowel changes which have been observed. The references are to the examples which precede or follow.

No.	Dakota.	¢egiha.			⊥oiwere.	Hotcañgara.
		Ponka.	Kansas.	Osage.		
69	a (See Nos. 1–8.)	a	a	a	a	a
70	a (See No. 64.)	i	i	i	i	....
71	a (See Nos. 9, 61.)	e	e	e	e	e, i
72	e (See Nos. 13, 26, 41.)	e	e	e	e	e
73	i (See Nos. 49, 120—a variation.)	i	i	i	i	i
74	i (See No. 48.)	e	e	e	i	i
75	o (See Nos. 16, 17.)	u	ṵ, u	‘ṵ, ṵ, u	o	o
76	u (See No. 58.)	i	i	i	i	i
77	u (See Nos. 19, 20, 22.)	i	ü	ü	u	u

Other consonant changes follow, but the list is not exhaustive. The references are to the examples which precede and follow.

No.	Dakota.	¢egiha.			⊥oiwere.	Hotcañgara.
		Ponka.	Kansas.	Osage.		
78	ba-	ma-	bá-	dá-	dá-	ma^n-
79	bo- (1)	mu-	bṵ-	dṵ-	do-	do-
80	bo- (2)	bi-	bü-	dü-	wi-	....
81	wa	ma	ba	da	da	wa-ra
82	wa^n-hi^{n}qpe	ma^n	ma^n	ma^n	ma^n	ma^n-na
83	wa^n-ju	ma^n-ji	ma^n-jü	ma^n-ɔü	ma^n-yu	ma^n-woju-ra
84	wa^n ji	wi^n *or* wi^{n}aqtci	mi^n *or* mi^{n}qtci	mi^n *or* mi^{n}qtsi	iya^n *or* iyañke	hi-ja^n *or* hijañ-kida
85	tuwe	ĕ-be	bye	de	wayere	....
86	wi-tca	mi-ʞa	mi-k‘a	mi-k‘ă *or* mi^n-ka	mi^n-ke *or* mi-ke	wa-ke
87	wi	mi^n	mi^n, mi^{n}ŭ^{n}ba	mi^n, mi^n-ŭ^n-da	di	-wi-da
88	wi-, i-,	we-	mye-	we-	wi-	hi- (see No. 48)
89	maka, mañka	mañga	mañga	mañʞa	....	ku^n-cke-da
90	maku	mañge	măñge	mañʞe	mañe	mañge-ra
91	mani	ma^n¢i^n	ma^{n}yi^n	ma^n¢i^n, ma^{n}yi^n	ma-nyi	mani-na
92	ma-qpi-ya	ma-qpi	ma-qpü	ma-qpü	ma-xu (I.), maxue (Ot.)	maxi-da
93	mi-ye	wi	mi	wí-e	mí-re, mi^n′-re	ne
94	pa-	ba-	ba-	da-	wa-	wa-
95	pa (see nasu, etc.)	da (see nacki)	myeqli^n, bye-qli^n	we¢üq¢i	na^{n}çu	nasu-ra
96	bo-pa^n	he (see No. 145)	pye	pce	....	....
97	....	ahe	apye	apce	....	....
98	epa	ehe	epye, epce	epce	ihe	ihe-na
99	tcopa	juhe	jupye	ɔupce	ni yuwe	....
100	tcap'a	jahe	japye	ɔapce	yawe	....
101	ao^{n}pa	a‘a^{n}he	ak'uhe	ak'u^{n}be	at'a^{n}we	eʇɔa-t'ŭ^{n}p-
102	oo^{n}pa	u‘a^{n}he	uk'uhe	uk'u^{n}he	ot'a^{n}we	....
103	sdipa	snibe	styü-be	....	ðri-we	....
104	hde-pa (see No. 42).					
105	capa	cabe, *dark*; ɔnabe, *soiled*	cabe, *dark*	cade, *dark*	cewe, *dark*; içewara, *soiled*	cĕp, etc., *dark*
106	depa	‘abe	k'abe	k'ade, ʞede	q‘awe	....
107	sapa	sabĕ	sabĕ	sadĕ	çewe	sĕp, etc.
108	tcapa	jabe	jabe	ɔade	rawe	daba-ra
109	pe- (see No. 13.)	be-, b¢e-	bye-	d¢e-	pre-	....
110	-pi	-i	-be	-de	-wi, of 2d and 1st pl.	-wi, of 2d and 1st pl.
111	poxa^n	bixa^n	bixa^n	....	wixa^n	....
112	poxe	da	pa	pa	pa	pá-ra

TABLE III.—SOUND SHIFTING—Continued.

No.	Dakota.	¢egiha.			Ɉoiwere.	Hotcañgara.
		Ponka.	Kansas.	Osage.		
113	it'e	de	pye	pe, pĕ	pe	pé-ra
114	da	na	da	....	....	wa-ta-
115	ka-dopa	ga-nade	ga-dadje	ɥaʇaɟse, *mire*	....	....
116	kata	nakade	dakadje	ɟakaɟse	ɟaqra^n	ɟakatc-
117	ska^n	naska^n	daska^n	ɟaska^n	ɟaçka^n	....
118	cnija	nat'cga	dats'ega	ɟats'eɥa	ɟatc'eɥe	....
119	do, *etc.*	nuɥa	duk'a	ɟuk'a	ɟoke	ɟoɥe (*sic*)
120	doksi	nusi	dusü	ɟusü	I., roqçi; Ot., roçi	ahuka-da
121	dote	nude	dudje	ɟuɟse	ɟoɟɔe	winahi-da "swallower"
122	de	¢e	ye	¢e	ɟɔe	ɟi
123	den	¢e¢u	yega	¢eɥa	....	....
124	....	¢égiha	Yegáha	¢eɥáha	Ɉoiwére (I.), Ɉoéɥiwére (Ot.)	....
125	deja	neje	djeje	ɟseɔe	....	....
126	ide	ine	idje	....	....	....
127	ideya	ine¢ĕ	idjeyĕ	....	....	....
128	tceti	ne¢ĕ	djeyĕ	ɟse¢ĕ	peɟɔe u^n	....
129	dekcitku	inegi	idjegi (m.) *or* idjeye (f.)	ih-ɟseɥi	iɟɔeɥa	hi-tek-
130	mde, bde	ne	dje	....	tceta	ɟé-ra
131	mdo	nu	du	ɟu	ɟo	dó-ra
132	mdoka	nuga	duga	ɟuɥa	ɟoɥa	toga (doga?)
133	mdokaska	nuski	duski	ɟuski	ho-çka	....
134	mdoketu	nuge	duge	ɟuɥe	ɟoɥe	doke
135	mdoza	nuzĕ	dui^{n}ze	ɟuse	ɟoçi	ɟose-ra
136	na-	na-	da-	ɟa-	ɟa-	ɟa-
137	naxi *and* wa-naxi	wa-naxĕ	wanaxe	wanaxe	....	wanaxi-da
138	nape	na^{n}be	nü^{n}be *or* nä^{n}be	na^{n}de	nawe	naba-ra
139	wanap'i^n	wana^{n}p'i^n	wana^{n}p'i^n	wanü^{n}p'i^n	wana^{n}p'i^n	wana^{n}p'i^n
140	nacka *and* hna-cka	ɟebi'a	tcebük'a (generic.)	tsedük'a, tsedyuk'a (generic).	waɥracke, H.	wakanacke-da
141	ni	¢i	yi	¢i	ri	ni
142	ya-	¢a (See No. 33.)	ya-	¢a-	ra-	ra-
143	ya-	¢a- (See No. 29.)	ya-	¢a-	ta-	ɟa-
144	yu-	¢i- (See No. 30.)	yü-	¢ü-, ¢u-, *or* ¢i-	ru-, ri-, *or* ro-	ru-
145	tca-poñ-ka (see Nos. 96–100.)	¢a-hañ-ge *or* na-hañ-ge	ya-păñ-ge puzeze styedje	ɥ¢a-pañ-ɥe	ra-wañ-e *or* ¢a-wañ-e	na-wañ-ga-ra
146	tcexa	¢exe, nexe	djexe	ɟsexe	rexe	rexe (*or* reqe)
147	tce-hu-pa	¢e-ba	ye-ba	¢e-da	....	....
148	tceji	¢ezĕ	yezĕ	¢ese	reɔe	dezi-de
149	tcap'a (see No. 100.)					
150	tcapa	jabe (see No. 108.)				
151	tce-tca	je-ga	je-ga	ɔe-ɥa	re-ɥe	....
152	ce-tca	qe-ga	qe-ga	qe-ɥa	qe-ɥe	ce-ga-ra
153	he-tca	he-ga	he-ga	he-ɥa	he-ɥe	he-ga-da
154	to	ɟu, ɟu-qude	tu, tuhu, tuhu-qudje	t'uhu, t'uhu-quɟse	to	tco-ra, tcoqo-tce-da
155	t'a	t'e	ts'e	ts'e	tc'o	tc'e-na
156	ca	jide	jüdje	ɔüɟse	cuɟɔe	cuɟɔe-ra
157	cota	cude	cudje	cuɟse	coɟɔe	qi-da
158	ka^{n}ta	ɥande	kandje	kanɟse	....	kandje-ra
159	kute	kide	küdje	küɟse	ɥuɟɔe	....
160	ka-	ga-	ga-	ɥa-	ɥi-	ɥi-
161	ki-	gí-	gí-, gü'-	ɥí-, ɥyú-	ɥí-	ɥí-
162	kitcaxa	giaxe	kixe	kcixe	ɥiu^n	ɥi'u^n-na
163	ki-	gi-	gi-, gü-	ɥi-, ɥyu-	ɥra-	ka-ra-
164	ku	gi	gü	ɥyü	ɥu	ɥu-na
165	qo-ka	qu-ga	qüñga	quɥa	qoɥe	qoga-ra
166	coka	cuga	cuga	cuɥa	coɥe	coga-ra
167	cako	cage	caɥeyaha	caɥeha	caɥe	cago-ra
168	cuñka-waka^n, etc.	cañge	cüñge, kawa	káwa, kawá	cüñ-e	cüñk qata-ra, cüñk qote-ra
169	süñkaku	i-sañga	isuñga, isu^{n}ya^n	isüñɥa	içüñ-e	hi-süñka-ra
170	k'a, k'e	'e	we	we	k'e	(See No. 177.)
171	k'exa	k'axe, k'exe, 'axe	k'axe	k'axe	q'axe, q'exe, 'exe	....
172	depa (see No. 106.)					
173	cuta	¢i-'a, ¢ic'a	yüts'age	¢üts'aɥe	ruy'aɥe (I.), ruc'aɥe (Ot.)	....
174	....	bi'a, bie'a	büts'age	düts'aɥe	wiy'aɥe (I.), wic'aɥe (Ot.)	....

TABLE III.—SOUND SHIFTING—Continued.

No.	Dakota.	Çegiha.			Ʇoiwere.	Hotcañgara.
		Ponka.	Kansas.	Osage.		
175	duzaha^n	'a^{n}sage	k'a^{n}sage	k'a^{n}saɥe	q'a^{n}çaɥe, ka^n-çaɥe	....
176	ao^{n}pa	a'a^{n}he	ak'uhe	(See No. 101.)		
177	o^{n}cida	¢a-'e-¢ĕ	ʎa-k'e-yĕ	¢a-k'e¢ĕ	na^{n}tuta^n	(See No. 170.)
178	k'i^n	'i^n	k'i^n	k'i^n	k'i^n	k'i^n-na
179	k'u	'i	k'ü	k'ü	ok'u^n	ho-k'u^n-na
180	....	-'u	-k'u	-k'u	....	....
181	ha^{n}hepi, ha^{n}ye-tu	ha^n	ha^{n}i^n	ha^{n}i^n	ha^{n}he	ha^{n}he-na
182	toha^n *and* tohan	ata^n	haka^n	hatqa^n, hakqa^n	tata^n	tca-tca^n
183	eta^{n}ha^n	e-ʇa-ta^n, ĕ-di-ta^n	ĕ-dji-ka^n	e-ʇsi-tqa^n	-ʇa-wă	....
184	peha^n	deta^n	peka^n, pye-ka^n	pe-tqa^n	peta^n	petca^n-na
185	opeha^n	ubeta^n	ubeka^n, ubye-ka^n	udetqa^n, ude-kqa^n	oweta^n	....
186	toka, *foe*	ukit'ĕ	ukütce	....	okitce	okiktce
187	o-ki-he, *joint*	ukit'ĕ	ukütce	ukütse	o-cŭ^n-cŭ^n	wai-dakikede-da
188	hi	ti	tci	tsi	tci	tci-na
189	xapa	xabe	xaʍe	....	xawe	....
190	kaxa	gaxe	gaxe	ɥaxe	u^n	'u^n-na
191	yuxo	¢ixu	yüxu	¢üxu	rixo	(See Nos. 37 and 204.)
192	aze	maze	baze	dase	daðe	waza-ra
193	puza	bize	büze	düse	duðe	ʇakasi-de
194	mdaza (see No. 6.)					
195	mdoza (see No. 135.)					
196	sapa (see No. 107.)					
197	sa^n	sa^n	sa^{n}ha^n	sa^{n}ha^n	ça^{n}ta^n	....
198	siha	si	si	si, sühü	çi	si-ra
199	si^{n}te	sĭnde	sĭndje	sĭnʇse	çĭnʇɔe	sĭnʇɔĕ-ra
200	ska	skă	skă, waskă	skă, waskă	çka	ska
201	skuya	ski¢ĕ	sküʍe	....	çku	sku
202	c	c	c	c	c	c
	(See Nos. 55, 105, 157, 166, 167, 168.)					
203	c	q	q	q	q	c (see No. 152.)
204	quxa	qixe	qüxe	qüxe	qoxe, qoɥe	qoxa

NOTES ON TABLE III.

In the Ʇoiwere column, "I." stands for "Iowa dialect," "Ot." for "Oto dialect," and "H." for Rev. Wm. Hamilton, formerly missionary to the Iowas. In the Hotcañgara column, "Alexander" stands for Jas. Alexander, a full-blood Winnebago, the writer's principal authority.

No. 1. The Santee "md" is now written "bd" by some of the missionaries. Its Teton equivalent is "bl." Mda (bda, bla), verbal root, *separated*, as layers or slices.—2. mda, bla, fragment-pronoun, first singular of verbs in ya.—3. b¢acka, applied to a dish, &c., that is low and spreads out, with a rim not on a level with the bottom.—4. mdaya, *level, spread out*.—5. mdaska, *flat, as boards;* in Kansas and Osage, a distinction is made between blaska (d¢aska), *flat, as the edge of a board*, and blak'a (d¢ak'a), *flat, as the wide surface* or *side of a board*.—6. mdaza, *ripped* or *torn open*.—7. mdaja, *straddling*.—8. b¢axe, *wider at one end than at the other*.—9. mda, *I go*.—10. The first syllable in Nos. 11–15.—11. b¢eda^n, *thin*.—12. Ditto.—13. pemni, *twisted*.—14. *A pelican*.—15. *Intelligent*.—16. The first syllable in Nos. 17 and 18.—17. omdoto^n, *cornered, having corners;* but b¢uga, *circular, all around, the whole*.—18. *Having the corners rounded off*.—19. *Pulverized*.—20. Fragment-pronoun, first singular of verbs in yu (¢i, yü, ¢ü, ru, ru).—21. *Spinning around; pushed aside*.—22. *Mixed together*, as water and grease, or manure and earth; *fine*, as flour.—23. *To smell, emit an odor*.—24. *A crunching sound, as on ice* or *snow*.—25. *Fine*, as *thread*, etc.—26. *Ten*.—27. *Turned around, as a gimlet*.—29. *Three*.—30. *To turn around, as an auger*.—31. *Bare, smooth*.—32. Fragment-pronoun, second singular of verbs in ya (¢a, ya, ¢a, ra, ra).—33. *You drink*.—34. *You go*.—35. *The right* (hand, foot, etc.).—36. Fragment-pronoun, second singular of verbs in yu (see 20 above).—37. *You draw a mark* (such as is on an arrow).—

38. Fragment-pronoun, third singular of the possessive of verbs in ya and ka.—39. *To drink his own* milk, etc.—40. *To go back* or *homeward.*—41. The first syllable in Nos. 42–44.—42. *To vomit.*—43. *To set up an upright inanimate object.*—44. *Spotted.*—45. Fragment-pronoun, third singular, possessive of verbs in yu.—46. *Insects.*—47. *Maggots.*—48. *Grease.*—49. *To have come back* or *home.*—50. See Dakota, hi-hna-ku, *her husband;* g¢ăⁿ, *to take a wife* (Ponka, eg¢añge, *her husband*).—51. *To place a curvilinear object, a plaster,* etc., *on* something else.—52. *To revile, curse.*—53. *Broad.*—54. Fragment-pronoun, third singular possessive of verbs in pa (ba, ba, da, wa, wa).—55. *Six.*—56. Fragment-pronoun, second singular of verbs in pa.—57. *Alone, only.*—58. *You have.*—59. Second syllable of gaq¢aⁿ (gaqlaⁿ, etc.), *to go hunting with a large party* or *the whole tribe.*—60. A syllable in Dakota waqpanitca, *poor;* iqpaya, hiⁿqpaya, etc., *to fall from a height,* etc.—61. *To cough.*—62. Verbal root, *make a hole through.*—63. *Good* (or *bad*), in Hotcañgara it also means *large.* Used in forming the verb *to love, honor,* etc., in some of the languages.—64. *Very.*—65. *Split.*—66. *Long, tall.*—67. *Muskrat.*—68. *Ear.*—78. Fragment-pronoun, third singular, denoting action by cutting with a knife or saw.—79. Fragment-pronoun, third singular, action by shooting, etc.—80. Fragment-pronoun, third singular, action by weight or pressure, blowing with the mouth, etc. (N. B. These are not exactly synonymous in all the dialects).—81. *Snow.*—82. *Arrow.*—83. *Quiver.*—84. *One.*—85. *Who.*—86. *Raccoon.*—87. *Sun, moon.* Miⁿ sometimes means both, in Kansas and Osage, but miⁿŭⁿba (miⁿŭⁿda) always means *the moon.* In Hotcañgara, haⁿp-wida, *the sun,* and haⁿhe-wida, *the moon.*—88. Prefix showing the means or instrument, ordinal numerals, etc.—89. *Skunk.*—90. *Chest.*—91. *To walk.*—92. *Cloud.*—93. *I, me.*—94. Fragment-pronoun, third singular, action by pushing with the hands, etc.—95. *Head.*—96. *To pound,* as corn, *in a mortar.*—97. *To go along over* (land, etc.).—98. *I say.*—99. *To wade* or *ford.*—100. *To stab.*—101. *To lay a horizontal inanimate object on* something else.—102. *To lay* such an object *in* something else.—103. *To lick.*—105. *Blackened, defiled.* ¢egiha, cabe, *black, in the distance* (as distinct from sabe), *dark,* as a color.—106. *Notched* (*once*); but demdepa, ‘a‘abe, k’ak’abe, etc., *notched many times.*—107. *Black, near at hand.* See Nos. 197 and 200.—108. *Beaver.*—110. Plural ending of verbs.—111. *To blow with the mouth.*—112. *Nose.*—113. *Forehead.*—114. *To beg.*—115. *To get mired,* as cattle.—116. *Hot.*—117. *Melted, thawed, to melt* or *thaw.*—118. *Withered, dead,* as vegetation.—119. *Moist, wet.*—120. *Arm-pits.*—121. *Throat.*—122. *This.*—123. *Here.*—124. *Belonging here, the home people,* etc.—125. *To urinate.*—126. *A blaze.*—127. *To cause to blaze, to kindle a fire.*—128. *To make a fire.* The ʇɔiwere is, literally, "*Fire to-make.*"—129. *His* or *her mother's brother.* The Kansas distinguishes between idjegi, *his mother's brother,* and idjeyĕ, *her mother's brother.* In ihʇseqi, and other Osage kinship terms, the "h" is slightly audible, and approximates "q" (kh).—130. *Lake.*—131. *Potato, potatoes.*—132. *A male animal.*—133. *To belch* or *hiccough.*—134. *Summer.*—135. *A loon.*—136. Verbal modal prefix, showing *action of heat, cold,* etc.—137. *Ghost, spirit.*—138. *Hand, paw,* etc.—139. *Necklace.*—140. *The common frog.* Note the resemblance between the Dakota, ʇɔiwere, and Hotcañgara, on the one hand, and the three ¢egiha words on the other. *Bull-frog* is toⁿtoⁿtañka in Dakota, ʇebi‘a ʇañga in Ponka, tcebŭk’a-tăñga in Kansas, tsedŭk’ataⁿ in Osage, and tcŭⁿtcŭⁿ-na in Hotcañgara.—141. *Thee, you.*—142. Verbal modal prefix, third singular, of *action with the mouth, lips, teeth,* or *tongue,* also fragment-pronoun, second singular, of first conjugation in Dakota, Ponka, ʇɔiwere, and Hotcañgara.—144. Verbal modal prefix, third singular, of *action by pulling with the hands,* etc.—145. *Mosquito.*—146. *Kettle.*—147. *Jaw.*—148. *Tongue.*—151. *Thigh.*—152. *Dry,* as grass.—153. *A buzzard.*—154. *Blue, green;* ʇuqude, etc., *blue-gray* (?).—155. *To die, dead.*—156. *Red.*—157. *Smoke.*—158. *Plums.*—159. *To shoot at.*—160. Verbal modal prefix, third singular, *action by hitting, falling, blowing* of the wind.—161. Verbal prefix, third singular, first dative, of most conjugations.—162. *To make for* or *to* (dative of action without request, etc.).—163. Verbal prefix, third singular, possessive, of certain verbs beginning with consonants.—164. *To be returning, coming back.*—165. *Badger.*—166. *Thick.*—167. *Nails, claws.* In Kansas and Osage, cage (caqe) means *fingers.*—168. *Horse.* Dakota, cuñka wakaⁿ,

mysterious dog; or cuñk-tañka, *big dog.*—169. *His younger brother.*—170. *To dig.*—171 Verbal root, *scraping sound.*—173. cuta, *to fail.* The writer has been unable to find synonyms of this in Dakota. But in the other languages they abound: thus, ¢i'a, ¢ic'a, *to fail in pulling* with the hands, or *in working, for want of time;* ¢ig¢a^{n}¢a, *to make a mistake in pulling*, etc., *to miss in trying to grasp an object, which is too large;* ¢iona^{n}, *to fail to hold an object;* ¢iona^{n}¢a, ditto; ¢ii^{n}äjĭ, *to fail to produce the desired effect in pulling, working, rowing, writing,* etc.—174. *To fail in bearing* or *pressing on* (also, in Ponka, *in blowing with the mouth;* in Kansas, *in pushing with the hands*). So there are big¢a^{n}¢a, biona^{n}, bii^{n}äjĭ, ¢ag¢a^{n}¢a, ¢a'a, ¢ac'a, ¢aona^{n}, ¢ai^{n}äjĭ, ba'a, bac'a, bag¢a^{n}¢a, etc., in Ponka, with their equivalents in Kansas, Osage, and Ɉoiwere.—175. *Swift*, as a horse.—177. *To be merciful, to pity.*—178. *To carry on the back.*—179. *To give.*—180. Verbal root, *to scrape*, as with the finger-nails.—181. *Night.* The Santees say, ha^{n}yetu; the Yanktons and Tetons, ha^{n}hepi.—182. *When? how long? how far?* In Dakota the *time word* is tohan, and the *space-word*, toha^{n}.—183. *From.*—184. *A crane.*—185. *To fold* or *wrap up in, to make a bundle of.*—183. *To have come hither for the first time.*—189. Verbal root, *to flay* (animals, not persons).—190. *To make, do.*—191. *To draw a mark*, such as is on an arrow.—192. *The female breasts.*—193. *Dry*, not wet.—197. *White, in the distance.* See Nos. 105 and 107.—198. *Foot, feet.* Sühü, in Osage, *a bird's legs.*—199. *A tail.*—200. *White, near by.* See No. 107.—201. *Sweet, sour.*—204. Verbal root, *staved in, broken in, as a hollow object.*

INDEX.

A.

C.

Page.

D.

E.

G.

Page.

H.

N.

O.

P.