

NO.

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ANNUAL REPORT

OF THE

BOARD OF REGENTS

OF THE

SMITHSONIAN INSTITUTION,

SHOWING

THE OPERATIONS, EXPENDITURES, AND CONDITION
OF THE INSTITUTION

FOR

THE YEAR 1882.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.

1884.

~~8~~15.

[FORTY-SEVENTH CONGRESS, SECOND SESSION.]

CONGRESS OF THE UNITED STATES.

IN THE HOUSE OF REPRESENTATIVES,

February 20, 1883.

Resolved by the House of Representatives (the Senate concurring), That fifteen thousand five hundred and sixty copies of the Report of the Smithsonian Institution for the year 1882 be printed; two thousand five hundred copies of which shall be for the use of the Senate, six thousand and sixty copies for the use of the House of Representatives, and seven thousand copies for the use of the Smithsonian Institution.

Attest:

EDW. MCPHERSON,

Clerk.

IN THE SENATE OF THE UNITED STATES,

March 2, 1883.

Resolved, That the Senate agree to the foregoing resolution of the House of Representatives.

Attest:

F. E. SHOBER,

Acting Secretary.

LETTER

FROM THE

SECRETARY OF THE SMITHSONIAN INSTITUTION,

ACCOMPANYING

*The annual report of the Board of Regents of that Institution for the year
1882.*

JANUARY 22, 1883.—Ordered to be printed.

SMITHSONIAN INSTITUTION,
Washington, D. C., January 19, 1883.

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 1882.

I have the honor to be, very respectfully, your obedient servant,
SPENCER F. BAIRD,
Secretary Smithsonian Institution.

Hon. J. W. KEIFER,
Speaker of the House of Representatives.

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION FOR
THE YEAR 1882.

SUBJECTS.

1. Proceedings of the Board of Regents for the session of January, 1883.

2. Report of the Executive Committee, exhibiting the financial affairs of the Institution, including a statement of the Smithsonian fund, the receipts and expenditures for the year 1882, and the estimates for 1883.

3. Annual report of the Secretary, giving an account of the operations and condition of the Institution for the year 1882, 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.

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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 1882.

	Term expires.
The Vice-President :	
DAVID DAVIS (<i>pro tem.</i>).....	Mar. 4, 1883
The Chief Justice, MORRISON R. WAITE.	
United States Senators :	
GEORGE F. HOAR (from Feb. 21, 1881)	Mar. 4, 1883
NATHANIEL P. HILL (from May 19, 1881)	Mar. 4, 1885
SAMUEL B. MAXEY (from May 19, 1881)	Mar. 4, 1887
Members of the House of Representatives :	
NATHANIEL C. DEERING	Dec. 26, 1883
EZRA B. TAYLOR	Dec. 26, 1883
SAMUEL S. COX.....	Dec. 26, 1883
Citizens of Washington :	
PETER PARKER (appointed in 1868).....	Dec. 19, 1885
WILLIAM T. SHERMAN (appointed in 1871).....	Mar. 25, 1885
Citizens of a State:	
JOHN MACLEAN, of New Jersey (appointed in 1868)	Dec. 19, 1885
ASA GRAY, of Massachusetts (appointed in 1874).....	Dec. 19, 1885
HENRY COPPÉE, of Pennsylvania (appointed in 1874)	Dec. 19, 1885
NOAH PORTER, of Connecticut (appointed in 1878).....	Jan. 26, 1884
MORRISON R. WAITE, Chancellor of the Institution and <i>President of the Board of Regents.</i>	

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

WASHINGTON, *January 17, 1883.*

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 M. R. WAITE; the acting Vice-President, Hon. DAVID DAVIS; Hon. S. B. MAXEY; Hon. N. P. HILL; Hon. G. F. HOAR; Hon. N. C. DEERING; Hon. S. S. COX; Hon. E. B. TAYLOR; Rev. Dr. JOHN MACLEAN; Dr. ASA GRAY; General W. T. SHERMAN; Dr. H. COPPÉE; and the Secretary, Professor BAIRD.

Excuses for absence on account of sickness were received from Hon. Peter Parker and Rev. Dr. Noah Porter.

The minutes of the last meeting were read and approved.

The Secretary presented a statement of the finances of the Institution.

General Sherman, from the Executive Committee, presented the annual report in relation to the funds of the Institution, the receipts and expenditures for the year 1882, and the estimates for the year 1883.

On motion of Dr Coppée it was

Resolved, That the report of the Executive Committee for 1882 be accepted.

Resolved, That the income for the year 1883 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.

The Secretary stated that the bronze statue of Professor Henry, ordered by Congress from Mr. W. W. Story, had just been received, but that owing to the condition of the weather, it was impossible to place it in position at the present time. He suggested the propriety of deferring the public unveiling of the statue until the next annual meeting of the National Academy of Sciences in April. He also stated that Mr. Story was now in the city, had examined the Smithsonian grounds, and fully approved of the site for the statue suggested by the Executive Committee.

On motion of General Sherman it was

Resolved, That the 19th of April, 1883, be selected as the day for the ceremony of unveiling the statue of Professor Henry, and that the Congress of the United States, the Diplomatic Corps, the Executive Departments, and the public generally be invited to be present.

Dr. Maclean having called the attention of the Board to the fact that the sundry papers of Professor Henry on scientific subjects had not been published in the series issued by the Smithsonian Institution, it was

Resolved, That the Secretary be requested to have the scientific writings of Prof. Joseph Henry collected and published.

The Secretary presented his annual report of the operations, expenditures, and condition of the Institution for the year 1882.

On motion of Mr. Cox it was

Resolved, That the report of the Secretary be referred to the Executive Committee, with authority to transmit it to Congress.

The Secretary called attention to the importance of fire-proofing the eastern portion of the Smithsonian building, especially as the supply of water was now so scanty that none could be had above the basement floor. The Committee on Appropriations of Congress had given assurance that the necessary amount should be granted at the present session.

The Secretary also called attention to the growth of the Government collections and the necessity for speedy action in relation to an additional building for the use of the Museum and the Geological Survey. He presented the following bill, which had been introduced in the House of Representatives, on the 10th of April, 1881, by Hon. Mr. Shallenberger, and was now before the Committee on Public Buildings and Grounds.

FORTY-SEVENTH CONGRESS, FIRST SESSION.—H. R. 5781.

A BILL for the erection of a fire-proof building on the south portion of the Smithsonian Reservation, for the accommodation of the United States Geological Survey, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the sum of two hundred thousand dollars be, and hereby is, appropriated, out of any money in the Treasury not otherwise appropriated, for the erection of a fire-proof building on the south portion of the Smithsonian Reservation, for the accommodation of the United States Geological Survey, and for other purposes: *Provided*, That the consent of the Regents of the Smithsonian Institution be first obtained thereto, and that the building be under their direction when completed: *And provided further*, That the building be erected by the Architect of the Capitol, in accordance with plans approved by the Director of the United States Geological Survey, the Secretary of the Smithsonian Institution, and the Architect of the Capitol, acting as a board therefor."

After a very full expression by the Regents in favor of immediate action, on motion of General Sherman it was

Resolved, That the Board of Regents of the Smithsonian Institution recommend to Congress to enlarge the National Museum, so as properly to exhibit the mineral, geological, and other collections already on hand

and increasing each year, by the erection of a fire-proof building on the southwest corner of the Smithsonian Reservation, similar in style to the present National Museum; and they request an appropriation of \$300,000 therefor, to be expended under the direction of the Regents of the Institution.

On motion of Dr. Gray it was

Resolved, That the Chancellor, General Sherman, and the Secretary be, and they are hereby, authorized and empowered to act for and in the name of the Board of Regents in carrying into effect the provisions of any act of Congress which may be passed providing for the erection of an additional building for the National Museum.

The Secretary informed the Board of the death of Miss Margaret Connor, a lady who had been employed for fifteen years in the Institution, and recommended an allowance of one hundred dollars to defray the expense of medical attendance and other expenses of her last illness, which, on motion of Mr. Maxey, was agreed to.

The Board then adjourned to meet on the 19th of April, 1883, to attend the ceremonies of unveiling the statue of Professor Henry.

REPORT OF THE EXECUTIVE COMMITTEE OF THE BOARD OF REGENTS OF THE SMITHSONIAN INSTITUTION FOR THE YEAR 1882.

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 both the Institution and the Museum for 1882, and the estimates for the year 1883 :

Condition of the fund January 1, 1883.

The amount of the bequest of James Smithson deposited in the Treasury of the United States (act of Congress August 10, 1846).....	\$515,169 00
Residuary legacy of Smithson, added to the fund, deposited in the Treasury of the United States (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
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Total permanent Smithson fund in the Treasury of the United States, bearing interest at 6 per cent. per annum	\$703,000 00
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Statement of the receipts and expenditures for the year 1882.

RECEIPTS.

Interest for the year 1882 from the United States.....	\$42,180 00
Balance, cash on hand January 1, 1882	25,255 52
<hr/>	
Total receipts.....	\$67,435 52
<hr/> <hr/>	

EXPENDITURES.

For operations of the Institution during the year, viz :

Building:

Repairs and improvements.....	\$649 30
Furniture and fixtures.....	1,346 53

General expenses:

Meetings of the Board.....	411 25
Lighting the building.....	53 10
Postage and telegraph.....	166 11
Stationery.....	954 49
Incidentals, freight ice, &c.....	492 81
Books and periodicals.....	1,793 76
Salaries and labor.....	16,415 18

Publications and researches:

Smithsonian contributions.....	732 50
Miscellaneous collections.....	4,939 37
Annual report.....	1,728 03
Explorations.....	3,036 35
Apparatus.....	98 10
Literary and scientific exchanges.....	4,981 19

Total expenditures.....	\$37,798 07
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Balance January 1, 1883.....	\$29,637 45
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ESTIMATES FOR 1883.

The following are the estimates of receipts by the Institution proper for the year 1883, and of the appropriations required for carrying on its operations during the same period:

Receipts.

Interest on the permanent fund, receivable July 1, 1883, and January 1, 1884.....	\$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
	<hr/>
	\$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, 1882.....	\$32, 882 19
Appropriated for fiscal year, 1882-'83.....	91, 000 00
	<hr/>
Total available	\$123, 882 19
Expended as per vouchers audited, in 1882	79, 058 88
	<hr/>
Balance available January 1, 1883, for six months ending with fiscal year June 30, 1883	\$44, 823 30

PRESERVATION OF COLLECTIONS, ARMORY BUILDING.

Balance available January 1, 1882.....	\$1, 058 13
Appropriated for fiscal year, 1882-'83.....	2, 500 00
	<hr/>
Total available.....	\$3, 558 13
Expended as per vouchers audited, in 1882.....	2, 002 34
	<hr/>
Balance available, January 1, 1883, for six months ending with fiscal year June 30, 1883	\$1, 495 79

FURNITURE AND FIXTURES, NATIONAL MUSEUM.

Balance available January 1, 1882	\$25, 619 06
Appropriated for fiscal year, 1882-'83	90, 000 00
	<hr/>
Total available.....	\$115, 619 06
Expended as per vouchers audited, in 1882.....	84, 436 94
	<hr/>
Balance available January 1, 1883, for six months ending with fiscal year June 30, 1883.....	\$31, 182 12
	<hr/> <hr/>

NORTH AMERICAN ETHNOLOGY—SMITHSONIAN INSTITUTION.

Balance available, January 1, 1882.....	\$8, 540 90
Appropriated for fiscal year, 1882-'83.....	35, 000 00
	<hr/>
Total available	\$43, 540 90
Expended as per vouchers audited, in 1882.....	23, 100 46
	<hr/>
Balance available January 1, 1883, for six months ending with fiscal year June 30, 1883.....	20, 440 44
	<hr/> <hr/>

* These acts are given in full in the Appendix.

INTERNATIONAL EXCHANGES—SMITHSONIAN INSTITUTION.

Balance available January 1, 1882.....	\$1,500 00	
Appropriated for fiscal year, 1882-'83.....	5,000 00	
	<hr/>	
Total available.....		\$6,500 00
Expended as per vouchers audited, in 1882.....		4,000 00
	<hr/>	
Balance available January 1, 1883, for six months ending with fiscal year June 30, 1883.....		2,500 00
	<hr/> <hr/>	

FIRE-PROOF BUILDING, NATIONAL MUSEUM.

Balance available January 1, 1882.....	\$5,317 65	
Expended as per vouchers audited, in 1882..	5,304 38	
	<hr/>	
Balance returned to the United States Treasury.....		\$13 27
	<hr/> <hr/>	

POLARIS REPORT.

Balance available January 1, 1882.....	\$3,597 75	
Expended in 1882.....	1,678 85	
	<hr/>	
Balance available January 1, 1883.....		\$1,918 90

CONCLUSION.

The Executive Committee has examined 765 vouchers for payments made from the Smithsonian income during the year 1882, and 2,169 vouchers for payments made from appropriations by Congress for the National Museum, making a total of 2,934 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 the Museum.

The committee has examined the account-books of the National Museum, and find the balances unexpended as before stated, viz:

Preservation of collections.....	\$44,823 30
Armory building.....	1,495 79
Furniture and fixtures.....	31,182 12

to correspond with the certificates of the disbursing clerks of the Departments of the Interior and of the Treasury.

The balance unexpended of the appropriation of \$8,000 made by the Forty-sixth Congress in 1880 for completing the preparation of the report of Dr. Emil Bessels of the scientific results of the Arctic expedition under the late Capt. C. F. Hall, according to the certificate of the disbursing agent of the Treasury Department, is \$1,918.90.

The quarterly accounts-current, the bank-book, check-book, and journals have been examined, and found to be correct.

The balance to the credit of the Institution proper, on the 1st of January, 1883, in the hands of the Treasurer of the United States, available for the current operations of the Institution, is \$29,637.45.

Respectfully submitted.

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

[Dr. Maclean's examination of the expenditures and vouchers was limited to those of the Smithsonian Institution proper, January 15, 1883.]

WASHINGTON, *January 17, 1883.*

THE SMITHSONIAN INSTITUTION.

MEMBERS EX OFFICIO OF THE "ESTABLISHMENT."

(January 1, 1883.)

CHESTER A. ARTHUR, President of the United States.
DAVID DAVIS, President 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.
TIMOTHY O. HOWE, Postmaster-General.
HENRY M. TELLER, Secretary of the Interior.
BENJAMIN H. BREWSTER, Attorney-General.
EDGAR M. MARBLE, Commissioner of Patents.

REGENTS OF THE INSTITUTION.

(January 1, 1883.)

MORRISON R. WAITE, Chief Justice of the United States,
President of the Board.
DAVID DAVIS, President of the United States Senate.
GEORGE F. HOAR, member of the Senate of the United States.
NATHANIEL P. HILL, member of the Senate of the United States.
SAMUEL B. MAXEY, member of the Senate of the United States.
NATHANIEL C. DEERING, member of the House of Representatives.
EZRA B. TAYLOR, member of the House of Representatives.
SAMUEL S. COX, 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 AND ASSISTANTS OF THE SMITHSONIAN INSTITUTION AND NATIONAL MUSEUM, JANUARY, 1883.

SMITHSONIAN INSTITUTION.

SPENCER F. BAIRD,

Secretary, Director of the Institution.

WILLIAM J. RHEES, *Chief Clerk.*

DANIEL LEECH, *Corresponding Clerk.*

NATIONAL MUSEUM.

SPENCER F. BAIRD, *Director.*

G. BROWN GOODE, *Assistant Director; Curator, Department of Art and Industry.*

TARLETON H. BEAN, *Curator, Department of Ichthyology.*

WM. H. DALL, *Honorary Curator, Department of Mollusks.*

FREDERICK P. DEWEY, *Assistant Curator, Department of Metallurgy.*

JAMES M. FLINT, *Honorary Curator, Section of Materia Medica.*

EDW. FOREMAN, *Assistant, Department of Ethnography.*

GEO. P. MERRILL, *Assistant, Section of Building Stones.*

RICHARD RATHBUN, *Assistant Curator, Department Marine Invertebrates.*

CHARLES RAU, *Curator, Department of Archaeology.*

ROBERT RIDGWAY, *Curator, Department of Ornithology.*

CHARLES V. RILEY, *Honorary Curator, Department of Entomology.*

FREDERICK W. TAYLOR, *Chemist.*

FREDERICK W. TRUE, *Curator, Department of Mammals, and Librarian.*

CHARLES D. WALCOTT, *Honorary Assistant Curator, Department of Invertebrate Fossils*

LESTER F. WARD, *Honorary Curator, Department of Fossil Plants.*

CHARLES A. WHITE, *Curator, Department of Invertebrate Paleontology.*

HENRY C. YARROW, *Honorary Curator, Department of Herpetology.*

WM. S. YEATES, *Acting Curator, Department of Mineralogy.*

REPORT OF PROFESSOR BAIRD,

SECRETARY OF THE SMITHSONIAN INSTITUTION, FOR 1882.

To the Board of Regents:

GENTLEMEN: I have the honor to present herewith a report of the operations and condition of the Smithsonian Institution for the year 1882.

As in previous years, I propose to include in the present report, in addition to matters pertaining strictly to the Institution, a brief account of the operations of the National Museum and the Bureau of Ethnology, which may be considered as part of the Smithsonian Institution, as well as of the work of the United States Fish Commission, which is under my charge.

THE SMITHSONIAN INSTITUTION.

INTRODUCTORY.

There are no specially distinctive or prominent facts to be mentioned in connection with the work of the Institution and its collateral departments during the year 1882; although it may be said that, at no time, has the establishment been in better condition, whether we take into account the character of the work accomplished, the economy of expenditure, or the satisfactory condition of its funds at the end of the year.

The publications of the Smithsonian Institution, or those made under its direction, have been of average amount; the international exchanges have been more than ever extensive and important; the scientific researches of the Institution have been extremely productive, while the Museum has been enriched by a greater quantity of valuable material than ever before.

THE HENRY STATUE.

I am happy to announce that the memorial statue of Professor Henry, the construction of which, by Mr. W. W. Story, was authorized by Congress on the 1st June, 1880, is finished, and in Washington. It was hoped that it might be delivered in time to be in position by the end of the year 1881. Owing, however, to certain imperfections found in the statue after being cast in bronze, it became necessary to reproduce it; and it was not until the month of November, [1882,] that it was actually completed and shipped.

The pedestal of the statue, which was made in the United States, was delivered in the early part of the year, but the statue itself did not arrive from Rome until the end of December. It is hoped that the next report to the Board will contain a notice of the successful erection of this memorial.

THE BOARD OF REGENTS.

The original law organizing the Smithsonian Institution provides for vacancies of three members of the House and one member of the Senate at the end of each Congress, the successors to be appointed by the Speaker of the House and the President of the Senate, respectively, in the ensuing December. Although no special provision is made for resignations, it would of course naturally be inferred that an appointment to a vacancy of this kind should be for the period of the remainder of the term of service of the former incumbent, as is the case in the United States Senate. In fact, however, with some previous vacancies occurring by death, or resignation of Senatorial position, the service was continued for six years, and with a result that all the Senate regencies became vacant at the same time. By the appointment, however, of Senator Hoar, on the 21st February, 1881, and of Senators Hill (of Colorado) and Maxey (of Texas) on the 19th May, of the same year, the normal term of service was re-established, with vacancies occurring at intervals of two years—the term of Senator Hoar expiring with his Senatorial term, in March, 1883; of Senator Hill, in March, 1885; and of Senator Maxey, in March, 1887.

The existing vacancies of the House members were filled by the appointment of Hon. N. C. Deering, of Iowa; Hon. E. B. Taylor, of Ohio; and Hon. S. S. Cox, of New York.

The annual meeting of the Board was held on the 18th of January, 1882, and was attended by all the new regents. The Chief Justice, Mr. Waite, referred to the loss the Institution and the whole country had sustained in the untimely death of President Garfield, who had been connected with the Board of Regents with but little interruption since 1863.

The committee having in charge the erection of the new building authorized by Congress for the reception and exhibition of the collections of the Government, made a report that the work had been completed in a satisfactory manner and within the amount of the appropriation. The thanks of the Board were voted to the committee for the able and satisfactory manner in which it had discharged its duties.

The thanks of the Board were also tendered to General Montgomery C. Meigs for his highly valued services as consulting engineer of the National Museum Building Commission, in connection with the construction of the fire-proof building for the Museum.

Authority was given to the Secretary and the executive committee to apply to Congress for an appropriation to render the east range and

wing of the Smithsonian Institution fire-proof, in continuation of previous appropriations for the same purpose made and applied to the main portion of the building.

FINANCES.

The report of the executive committee, which has just been presented to you, presents the details of the financial condition of the Institution proper, and a report upon the expenditure of items placed by Congress under its direction. The sale of the Virginia bonds mentioned in the last report is still believed to have been wise, and has removed all source of anxiety as to the stability or amount of the funds permanently invested from which a regular income could be depended on. With an aggregate fund of \$703,000 in the United States Treasury, the income of the Smithsonian Institution amounts to \$42,180. This, with a balance on hand at the beginning of the year, has furnished the fund from which the expenses proper are paid. These are classified under the several heads of building, general expenses, publications and researches, and literary and scientific exchanges.

What has heretofore been a very great item of expense—from \$9,000 to \$11,000—connected with the international exchanges, has been greatly reduced by the appropriation of Congress made specifically for that purpose. This expenditure is either directly in the interest of the country at large, or that of the Government bureaus and of the Library of Congress, and it is, therefore, eminently proper that the whole amount should be refunded. The Secretary of State has accordingly asked for an appropriation of \$10,000 for the coming fiscal year, instead of the \$5,000, which is at present available. This saving will enable the Institution to extend its labors liberally in the direction of researches and publications, as well as be available for the unusually heavy repairs required in connection with the Smithsonian building.

After successive additions to the appropriation for a fire-proof building of the National Museum the account has been finally closed by returning \$13.27 to the Treasury.

The available balance of the Smithsonian Institution for the expenditures of the first half of the year 1882, according to the report of the executive committee, amounts to \$29,637.45.

BUILDINGS OF THE INSTITUTION.

Smithsonian Building.—No unusual expenditure has been required to keep this edifice in good order, although a certain amount of wear and tear has of course been necessarily provided for. Some important changes have, however, been made, adding greatly to the facilities for work. The entire basement has been put in thorough order; the floors, walls, and ceilings covered with a thick coat of whitewash, answering the double purpose of a sanitary protection and of increasing the amount of light; the improvement in the latter respect being very

marked. The west basement, which has heretofore been occupied indiscriminately for the preservation and elaboration of the collection of birds and fishes, has been subdivided, and each subject confined strictly to its own section, much to the improvement of the service. An opening has been made from the northwestern tower of the main building into the second story of the adjacent corridor; and a stairway placed in the tower, ascending from the basement to the level of the gallery of the main hall, permits ready access between the three floors. The special object of this was to give to the curators of fishes and marine invertebrates an opportunity of using the galleries of the main hall in their work of arrangement and cataloguing. The hall or corridor between the main central room and the western or "pottery" room has been occupied by the collection of fishes, for which it was specially arranged.

At the last meeting of the Board the Secretary called attention to the combustible and insecure condition of the eastern portion of the Smithsonian building, and presented plans, prepared at his request by the architects, Messrs. Cluss & Schulze, which, without materially changing the architecture of the building, would provide largely increased accommodations for offices and work-rooms, the storage of publications, the exchange system, &c.

The Board unanimously adopted a resolution instructing the Secretary and executive committee to present the subject to Congress and request an appropriation for the purpose. The Secretary, in accordance with this instruction, sent the following letter on the 13th of March to the Speaker of the House of Representatives :

"By instruction of the Board of Regents of the Smithsonian Institution, I have the honor to transmit to Congress the following resolution adopted at the last meeting of the Board, January 11, 1882; and, in doing so, beg that it be referred to the appropriate committee of the House of Representatives and receive that attention which the urgency of the case requires :

"*Resolved*, That the Secretary and executive committee present a memorial to Congress showing the importance and necessity of rendering the east wing of the Smithsonian building fire-proof, requesting an appropriation therefor, and, if the means are furnished, to proceed with the work."

"It will be remembered that in January, 1865, a fire occurred in the Smithsonian building, which destroyed a large portion of the main edifice, with its adjacent towers, and a very large amount of valuable public and private property.

"The main building was restored with fire-proof materials; but the east wing, composed entirely of wood and plaster, and which had escaped injury, remains in its previous dangerous condition. Originally a lecture room, it was fitted up many years ago with apartments for the residence of the late Secretary and his family. This application of the wing, however, was discontinued after Professor Henry's death; but the rooms thus set apart are entirely unsuited to the operations of the establishment, and, while in every way objectionable, the timbers have decayed, and no arrangements are provided for proper lighting, heating, and ventilation.

"The main building and western extension are occupied by the collections of the Government; the east wing embraces the offices of the Secretary, chief clerk, corresponding clerk, and registrar, and also accommodations for the extensive operations of the department of international exchanges, the benefits of which accrue not only principally to the Library of Congress but to all the public libraries and scientific societies throughout the United States. The rooms are filled with the archives, files of correspondence, original scientific manuscripts, vouchers, the stock of Government and Smithsonian publications for distribution at home and abroad, &c.; and their destruction by fire, to which they are constantly exposed, would be greatly detrimental to the interests of the Government and the general public.

"In addition to this, an extensive fire in the east wing would endanger and possibly destroy the main portion of the Smithsonian building, the upper and lower halls of which contain rare specimens belonging to the Government, and most of which could not be replaced.

"Congress has recognized the importance and propriety of gradually reconstructing the interior of the Smithsonian building, in fire-proof materials, by making appropriations for the purpose at various times between 1870 and 1875; and the last Congress, in 1879, appropriated \$3,000 'for providing additional security against fire in the Smithsonian building.'

"It is now proposed to remodel the interior of the east wing so that, without disturbing its present architectural style, the internal capacity will be doubled by a new arrangement of floors, partitions, and roofs, and all the rooms be adapted to the efficient prosecution of the work of the Institution and the various interests intrusted to its management by Congress.

"Inclosed I beg to send a copy of the report of the Board of Fire Inspectors (appointed by the District Commissioners) upon the condition of the Smithsonian building.*

"I have the honor to ask, in the name and on behalf of the Board of Regents, that the following appropriation be made at the present session of Congress, viz:

"For continuing and completing the fire-proofing of the Smithsonian Institution, \$50,000."

National Museum Building.—The Museum building was received from the hands of the architects in so complete a state that but little remained to be done beyond the tinting of a portion of the walls and the filling up of some of the alcoves with canvas frames, &c. There is yet much to be done, however, in the construction of the necessary cases for the accommodation of collections. A large addition to the number was made during the year. It will require, perhaps, two more consecutive appropriations, of the usual amount, before all the space contained in the building can be suitably occupied with the necessary means of

* "The commission to inspect buildings in the District beg leave to submit herewith report No. 5.

"By invitation of Professor Baird, the east wing and connecting corridor to the main building of the Smithsonian Institution were visited and inspected. In this portion of the building are all the records and valuable documents belonging to the Institution. The interior is entirely of wood and illy arranged, making it especially unsafe and liable to accident from fire, thus endangering the entire building. As a matter of safety, this wing and corridor should be completely cleared out and rebuilt of fire-proof material, and furnished with improved modes of communication and egress."

exhibition. As heretofore, the cases have been, for the most part, built by contract outside of the Museum, some in Washington, some in Philadelphia, and others in Baltimore, but a good deal of work has been done within the building by carpenters and other workmen employed by the day.

A very great change has been made during the year in the appearance of the interior, and a very decided approach towards the general completion of the work accomplished. In order to accommodate the increasing number of books required for the use of the curators and students connected with the Museum, the original library room was connected with the one above it by means of a stairway, so that practically two stories—the lower one with a gallery—have been provided. It is thought that at least 10,000 volumes can be accommodated in this manner.

The accommodations for the storage of coal having been found insufficient, the vaults under the western end of the south front of the Museum were more than doubled in extent during the year, and space gained in addition for a blacksmith's shop and machine shop.

Armory Building.—Very important changes have been made during the year in the Armory building and its surroundings. This edifice was assigned by Congress, a number of years ago, for the special service of the National Museum; to which, at a later period, was added by law that of the United States Fish Commission. The original intent of the assignment was for the purpose of accommodating the collections obtained at the Centennial Exhibition in Philadelphia; but as these were removed, from time to time, to the National Museum building, after its completion, the space gained was taken possession of by the Fish Commission. The lower story, or ground floor, was converted into a great fish-propagating establishment, for the hatching of shad, salmon, and other food fishes; and it was used, also, as a magazine for the distribution of carp, black bass, &c. The second floor was converted into a series of offices, laboratories, and rooms for the messengers connected with the fish-transportation service. The third floor was used as a depot for supplies and materials of the Fish Commission; and the fourth story is still occupied by the property of the National Museum.

In order the better to accommodate the service of the Fish Commission, a switch or branch railroad track was, by the permission of the Superintendent of Public Buildings and Grounds, and of the Commissioners of the District of Columbia, introduced into the area at the south of the building, on which the distribution cars of the Fish Commission can be kept, and loaded directly from the Armory building. Later in the year a shed in the shape of the letter L was built on the lot, the short branch being used for the cars, and the long one as a depository for the collections obtained from the proprietors of exhibits in the Permanent Exhibition building in Philadelphia. The construction of a

fence inclosing the interior court of the Armory yard gives great security to the large amount of valuable Government property stored in the main building and its annexes.

Laboratory of Natural History.—By the transfer of Mr. T. W. Smillie and his photographic apparatus from this building to the new photographic rooms specially arranged in the southeastern pavilion of the National Museum building, it became possible to offer accommodations for photographic work to the force employed by Major Powell, in connection with the Geological Survey and Bureau of Ethnology. Mr. Hillers, photographer, has utilized the rooms of the building particularly in the preparation of enlarged photographs of the scenery and the aborigines of the West for the windows of the National Museum. It is proposed to introduce these photographs in a large number of the windows of the Museum building, selecting for each room the subjects most appropriate to its contents.

An Additional Museum Building required.—Large and capacious as is the new Museum building, it has proved already inadequate to the existing requirements of the National Museum. This building was designed primarily to accommodate the vast number of industrial and economical exhibits presented to the United States by foreign Governments at the close of the Philadelphia Exposition of 1876. A special appropriation was made by Congress for their transfer to Washington and the Armory building in the square between Sixth and Seventh streets was assigned for their reception. It required nearly sixty large-sized freight cars to transport the mass.

Before the building was completed in 1881, and available for its purposes, almost equally enormous additions had been made to the collections of the various Government expeditions and of the Ethnological Bureau, which, together with many thousands of objects previously in charge of the Smithsonian Institution, but for which there was no room in the old building, constituted a much larger mass than was originally estimated. It is well known that at the close of the Centennial Exposition a company was organized to take charge of a large portion of the collections exhibited on that occasion, and with these and such additional articles as might be obtained to establish what was known as the "Permanent Exhibition" in the main Centennial building, which covers nearly eighteen acres. This organization, after struggling for existence for several years, finally became unable to continue the effort, and the collections in its charge were speedily scattered. Many of these had been presented to the National Museum with the understanding that they were to be left with the Permanent Exhibition Company for a period of at least a few years. Others, however, including many of the most valuable series, were obtained for the National Museum through the efforts of Mr. Thomas Donaldson. All these collections were carefully

packed under his charge and stored in a building erected by him adjacent to the Centennial building.

An appropriation was made by Congress to meet the cost of packing, shipping to Washington, and storing the collections in question. About twenty cars were required to transport them. They are now contained in a wooden building adjacent to the Armory, there being absolutely no space for them in the National Museum.

In addition to this a cabinet of at least double the magnitude, made by the Institute of Mining Engineers and deposited with the Pennsylvania Art Museum of Philadelphia, has been offered to the Government simply on the condition of transfer to Washington and proper exhibition. This is an extremely important collection, illustrating the mining resources and metallurgy of the United States and foreign countries, and will constitute a most important addition to the means of instruction at the command of the Government. An appropriation will be asked, and it is hoped obtained, for the purpose of transferring the collection to Washington; but some measures must be taken for its ultimate display.

An even greater mass of additional material to be provided for will be found in the industrial collections of the United States census of 1880, and in the collections of the United States Geological Survey. The census collections embrace more particularly the building stones of the country, the ores (especially of the precious metals), the combustibles, such as coal, petroleum, &c., and the forest timber.

All these collections are of great magnitude, representing as nearly as possible a full series from all parts of the country. They are carefully labelled and recorded, and will be accompanied by full descriptions.

The building-stone collection is especially valuable, consisting, as it does, of many thousands of samples of marble, granite, sandstone, and other substances, for the most part dressed in 4-inch cubes, each of the faces showing a different surface and treatment.

It is not believed that any established quarry remains unrepresented in this series, while many extremely valuable deposits of ornamental and building stones are presented therein for the first time. Preparations are in progress for testing the strength, resistance to torsion and crushing force, and economical properties of all these samples. The collection is now so far advanced that when a public building is to be erected either by the States or the General Government it will be possible to show specimens of all the best building stones in the vicinity of the locality involved, and to present all the necessary data as to availability, durability, cost of production, &c. Much use has already been made of the collection by the commissioners of State capitals, county court-houses, &c., as well as by agents of the General Government.

The collection of ores made by the census agencies is also very extensive, that of iron being particularly large. Nearly every iron mine

of any prominence in the United States has been visited, and samples carefully selected, by experts. These have been analyzed under the direction of Professor Pumpelly, and reports presented as to their chemical, and metallurgical properties, and economical value. All the originals of this research are in charge of the Smithsonian Institution, awaiting exhibition. The same may be said of similar researches in regard to the ores of all the other metals.

The work of the United States Geological Survey, also of enormous magnitude—begun under Mr. Clarence King and continued under Maj. J. W. Powell—has resulted in the accumulation of several tons of specimens of fossils, rocks, minerals, ores, and the like. Very few of these can at present be exhibited for want of the necessary space. The Survey requires a large number of experts and assistants, and is at present very badly accommodated. Some twenty rooms in the new Museum building have been assigned as quarters for the Director of the Survey and his assistants.

This, however, causes great inconvenience to the other work of the Museum, and as the survey now occupies a large building in Washington, for which it pays considerable rental, and for want of quarters in Washington is obliged to scatter its stations over various parts of the United States, it is thought desirable to ask Congress for an appropriation to erect a second museum building—corresponding in general character to the first, but on the opposite side of the square, along the line of Twelfth street.

This building it is proposed to devote almost entirely to the mineral department of the National Museum; and when completed to transfer to it everything of a geological and mineralogical nature, and also to prepare a portion of it especially for the accommodation of the Geological Survey, which is at present so inconveniently provided for. By way of economy it is proposed at first to construct what will represent the western side of the building, in which office-rooms and chemical and other laboratories can be provided for.

It had been proposed to erect a separate building for the Geological Survey, disconnected from the National Museum; but there being no ground available for this purpose, it was thought expedient to ask for an appropriation to furnish the required quarters on the Smithsonian reservation, which is at present ample for the purpose.

On the 10th of April last the following bill was accordingly introduced into the House of Representatives and referred to the Committee on Public Buildings and Grounds. The subject is still before that committee, and it is impossible to state what will be its fate during the present session. I would recommend action on the part of the Board of Regents in this connection, since long before the edifice can be completed the need for it will become extremely urgent.

"A BILL (H. R. No. 5781) for the erection of a fire-proof building on the south portion of the Smithsonian reservation, for the accommodation of the United States Geological Survey, and for other purposes.

"*Be it enacted, &c.*, That the sum of two hundred thousand dollars be, and hereby is, appropriated, out of any money in the Treasury not otherwise appropriated, for the erection of a fire-proof building on the south portion of the Smithsonian reservation for the accommodation of the United States Geological Survey, and for other purposes: *Provided*, That the consent of the Regents of the Smithsonian Institution be first obtained thereto, and that the building be under their direction when completed: *And provided further*, That the building be erected by the Architect of the Capitol, in accordance with plans approved by the Director of the United States Geological Survey, the Secretary of the Smithsonian Institution and the Architect of the Capitol acting as a board therefor."

MEETINGS OF SCIENTIFIC BODIES.

The Board of Regents authorized the Secretary "to provide in the building of the new Museum such accommodations as the National Academy of Sciences may need at its meetings in Washington, and in connection with the executive committee to extend similar hospitality to other organizations of cognate character and importance."

Under the authority thus conferred, meetings were held during the past year in the new Museum by the National Academy of Sciences (April 18, 1882), the American Institute of Mining Engineers (February 21, 1882), and the National Dental Association (August 3, 4, 5, 1882).

The hall of the Museum has also been used for the bi-monthly meetings of the Biological Society of Washington, and for lectures on Saturday afternoons in the months of March and April, 1882, under the auspices of the Anthropological and Biological Societies of Washington.

The following is a list of these lectures:

Introductory Address. By Maj. J. W. Powell, Director, United States Geological Survey.

Scientific and Popular Views of Nature Contrasted. By Prof. Theo Gill.

What is Anthropology? By Prof. Otis T. Mason.

Contrasts of the Appalachian Mountains. By Prof. J. W. Chicker-
ing, Jr.

Outlines of Sociology. By Maj. J. W. Powell.

Little Known Facts about Well-Known Animals. By Prof. C. V. Riley.

Paul Broca and the French School of Anthropology. By Dr. Robert Fletcher.

Deep Sea Explorations. By Prof. Wm. H. Dall.

How we See. By Dr. Swan M. Burnett.

I would state that a formal visit was made to the Institution on the 2d February, 1882, by the newly appointed Chinese minister, Mr. Cheng

Tsao Ju, with his staff, accompanied by Hon. Peter Parker, one of the Regents. These gentlemen seemed much interested in the work of the establishment, and promised hearty co-operation on the part of the Chinese Government in the way of exchanges, contributions to the Museum, &c.

ROUTINE WORK OF THE INSTITUTION.

Administration.—The *personnel* of the Smithsonian Institution has remained practically unchanged since the last report.

Correspondence.—In all the public Departments, the correspondence constitutes a very large part of the office work, and the fact that the Smithsonian Institution has come to be, in a measure, a bureau of information, adds greatly to the number of letters received and requiring responses.

It is a rule of the Institution, observed from its earliest days, that no respectful request for information ever goes without an answer—either supplying what is wanted, or expressing inability to do so. In the latter case references are frequently given, which answer the desired object.

The known interest of the Institution in the subject of Anthropology induces many notices to be sent to it of the discovery of Indian relics, their characteristics, and other details; the more interesting portions of which are usually extracted and published in the annual report. The number, however, has become so great that at present it is impossible to give them in detail, as heretofore; but a careful abstract is made, for publication in the annual report, by Prof. O. T. Mason, the editor in charge of this subject.

The correspondence with all parts of the United States—largely, however, through members of Congress—in connection with the supposed discovery of valuable minerals, has, as heretofore, represented a very considerable portion of the business.

Applications for position in the Institution and its allied departments still continue to be numerous. At best there can be but very few vacancies in the administrative and laboring force, and hence it is rarely possible to give a favorable response to any such application, whatever the merit of the applicant, or however strong and satisfactory the testimonials presented. The unpleasant necessity accordingly remains of almost uniformly declining the urgent appeals of those seeking official position and occupation.

RESEARCHES AND EXPLORATIONS.

During no previous year has the Smithsonian Institution been connected with so many different and important explorations of various regions, especially of America, as during that which has just closed; and the results of the work are of commensurate value.

Among the subjects to which the Institution has always devoted special attention has been that of developing a knowledge of the ethnology and physical and natural history of the less known portions of the globe; confining, however, its attention more particularly to America. There are yet so many regions to be investigated, that whatever funds are available for its purposes can always be advantageously employed; and the limitations in this respect have always been keenly felt.

It is, of course, the policy of the Smithsonian Institution, in this and in all other subjects, to occupy no ground that is covered by other sufficient agencies; and where the United States Government or any other body is at work in exploration the Institution does not interfere, except in so far as it can act concurrently to advantage. For the third of a century the Institution has worked harmoniously with the various branches of the Government in this connection; and by calling attention to the importance of special inquiries, not originally contemplated in the official research, by securing the appointment of competent experts, by taking charge of the notes and collections made, and assisting in their elaboration and preparation for publication, and in various other ways, it has been able to guide effort, and to secure the accomplishment of its object on a very large scale.

The number of exhibitions that the Institution has been more or less connected with during the period mentioned is very great, and it is difficult to calculate the influence that it has thus exerted in the development of knowledge in ethnology and natural history in general, and particularly in that of northern and middle America.

Of later years the strongest ally and associate of the Smithsonian Institution and its work, has been the United States Signal Service; first, under General Meyer, and next under General Hazen. Both these officers have always exhibited the utmost readiness to render all the aid in their power toward the furtherance of the objects of the Institution, and especially by permitting it to nominate persons to the charge of, or to act as assistants in, the principal observation stations who, while competent meteorological observers, were at the same time naturalists and able to utilize their opportunities to the utmost. The Institution in these cases has usually met all the expenses in addition to what was required for the purely meteorological service; supplying outfit, arsenic, ammunition, &c., and taking charge of the collections and having them properly elaborated for publication.

The previous reports of the Institution contain many references to this most satisfactory co-operation; and this has been even more marked and efficient during 1882 than formerly; as will be readily realized by the following account, in which I propose to take up the several regions, and show the more important work that has been done either by the Institution alone, or in conjunction with the Signal Service and other parties.

Greenland.—It will be remembered that in 1881 Lieutenant Greeley was sent, by the Chief Signal Officer, in charge of a party to establish an international meteorological station at Lady Franklin Bay, in latitude $81^{\circ} 35'$ north. The party was taken to its destination on the steamer "Proteus," a sailing vessel chartered in Newfoundland, and was safely landed, with all its stores, on the north shore of Lady Franklin Bay, at Camp Conger. The naturalist and surgeon of the party in charge, Dr. Pavey, had preceded the expedition to Greenland by about one year, being occupied during the interval in studying the natural history and ethnology of the country. In 1882, with an appropriation made by Congress for the purpose, a relief party was organized by the Signal Office to carry out stores and supplies. As Dr. Pavey intimated his desire to return during 1882, the Institution, at the request of General Hazen, selected Dr. Hoadley to fill the place, as a surgeon of ability and an experienced naturalist. This relief party, with the supplies and stores, left Newfoundland on the steamer "Neptune" on its way to Lady Franklin Bay; but, on account of the ice, was unable to reach its destination; and after depositing the stores on the shore and marking their position by intelligible indications, it returned to the United States. During the voyage, Dr. Hoadley was able to utilize the slight opportunity at his command in collecting some interesting specimens of birds and other objects of natural history. The commander of the party brought back a very finely constructed skin boat, which has been deposited by the Chief Signal Officer in the National Museum.

Labrador.—A very important beginning towards the exploration of Labrador has been made during the year by the establishment, by the United States Signal Service, of an international meteorological station on Ungava Bay, its northern extremity. Mr. Lucien M. Turner, who has been connected with the service for many years in stations at St. Michael's, Alaska, and at many points along the Aleutian Islands, was selected to establish a new station on the eastern coast of the continent, and one that should be at a suitable distance from the Greenland station, and those more or less adjacent to it of the German and English Governments. The courtesy of the Hudson's Bay Company, which had been so signally exhibited to the Smithsonian Institution in connection with the researches of Mr. Kennicott and others more than twenty years ago, was again displayed, in its hearty consent to make Fort Chimo, in Ungava Bay, the seat of the settlement in question; and Mr. Turner accordingly left Quebec on a schooner for Rigolette Station, where, taking the Hudson's Bay steamer, he proceeded to Ungava. His equipment for making collections of all kinds was very complete, and was also transported by the Hudson's Bay Company. He had received authority from the Institution to obtain the necessary goods at the post, and to secure such objects by barter with the Eskimo as could not

otherwise be readily obtained. The vessel returned very soon after, leaving Mr. Turner and his equipment; but his letters indicate his entire satisfaction with the prospect, of efficient work both in meteorology and in natural history. We are assured by the company's officer at Fort Chimo of his hearty co-operation; and are also gratified at the assurance that, in their season, the variety of objects of natural history is very great, especially of birds, with their nests and eggs. Four boxes of collections were received from Mr. Turner by way of London, and found to contain many articles of much interest. In accordance with the understanding with Mr. Turner, the collections will all be retained, so that he may work them up at the proper time.

This may be an appropriate place to mention that, before leaving the country, Mr. Turner completed his elaborate report upon the natural and physical history of Alaska, and left it in the hands of the Chief Signal Officer for such use as he might see fit to make of it.

A second exploration of Labrador during the year was prosecuted by Mr. Winfred A. Stearns, a New England naturalist who has been in the habit of spending several years successively on the coast, although considerably farther south than the station occupied by Mr. Turner. That gentleman applied to the Institution for the necessary alcohol to preserve objects of marine zoölogy, and has forwarded to Washington a satisfactory return. A report by him on the various species of animals observed during his successive visits to Labrador has been presented to the Institution, and will shortly be published in the Proceedings of the National Museum.

Arctic Ocean.—The ill-fated voyage of the *Jeannette* came to a close by the wrecking of the vessel, and the loss of two out of the three divisions into which the party was made up in the effort to reach the actual settlements on the Siberian coasts. Among those saved was Mr. Raymond L. Newcomb, the gentleman nominated by the Institution as naturalist to the expedition. Mr. Newcomb was able, in spite of all the privations and trials of the return, to save many of his notes and four specimens of one of the rarest of known birds, namely, Ross' Gull, which is a small species, characterized by a wedge-shaped tail, and having, also, a black ring around the neck, in striking contrast with the otherwise white plumage. Mr. Newcomb knowing well the interest to naturalists of these specimens, carried them with him, and delivered them to the Smithsonian Institution. They are, naturally, not in very good condition, but would be prizes under any circumstances.

The disastrous history of the *Jeannette*, almost unexampled among Arctic explorations in its fatalities, does not come within my province to detail.

Alaska.—Of all the stations in this vast and comparatively unknown region, the most important occupied during the year is that at Point Barrow, situated in latitude $71\frac{1}{2}^{\circ}$ N., the northernmost point of conti-

mental North America, and forming a part of the purchase by the United States from Russia in 1867.

In 1881 a thoroughly organized party was sent to that region by the Chief Signal Officer, under the command of Lieutenant Ray, with Dr. Oldmixon as surgeon, and Professors Smith and Murdoch as meteorological observers and naturalists; the latter gentlemen having been nominated by the Smithsonian Institution at the request of General Hazen. Both of them trained and accomplished naturalists, and of much experience in practical work, a great deal is hoped from them, as well as from the party generally, in the thorough investigation of the anthropology and biology of the northern coast.

A vessel sent by the United States Signal Office to Point Barrow with supplies, under Lieutenant Powell, found the party in admirable condition, and brought back a large number of very interesting specimens; which have already greatly increased our knowledge of the Eskimo and of the animal life of the region. The labor of getting settled, and of organizing the station, prevented the full utilization of the occasion by the naturalists of the expedition. It is expected, however, that by the next year's return the objects secured will be of very great interest, surpassing even those that have already come to hand.

Among the most noted features of the collections returned from the expedition are the many implements, such as hammers, chisels, scrapers, &c., made of a form of Jadite, closely allied to the precious Jadite of China and New Zealand; and many other objects of Eskimo workmanship are scarcely less interesting.

Among the birds, the eggs of three species of Arctic wading birds constitute important novelties in the collections of the National Museum. There were also some rare fishes, marine invertebrates, &c.

Among the most important collections received from Alaska during the year are the ethnological objects transmitted by Mr. J. J. McLean, Signal Service observer at Sitka. This gentleman has well utilized the opportunities at his command by securing several very fine collections both of modern and prehistoric workmanship of the Alaskan Indians; adding much to the richness of the material in the National Museum.

While engaged in his surveying work in Alaskan waters, on the Coast Survey steamer *Hassler*, Commander Henry E. Nichols of the Navy has continued his important service begun several years before on the Gulf of California, in obtaining rare specimens of animals, especially fishes. A large collection of marine animals, made by him, is now on its way from California.

Saint Michael's.—No collections were received during the year from Saint Michael's; a station which while in charge first of Mr. Turner, and next of Mr. Nelson, has been so great a source of supply to the National Museum. It is, however, expected that a consignment of interest will be received next year.

Nushagak.—This station, also one of the important points of service of the Signal Office, is in charge of Mr. C. L. McKay, who went there in 1881 with the usual supply of apparatus for meteorological observation, and of outfit by the Smithsonian Institution. Few localities on the coast are more important than Bristol Bay, on which Nushagak is situated; and it is expected that Mr. McKay will do full justice to the opportunity; having been well trained, both as an observer and collector, under Professor Jordan, of Bloomington, Ind. A large amount of extremely valuable material has been furnished by Mr. McKay, those of most interest being the ethnological objects. Many interesting species of birds and their eggs, of mammals, and of fishes have also been sent.

Some interesting collections have been received from Pribylov, one of the fur-seal islands, furnished by Mr. J. H. Moulton. Of these a very fine walrus head with tusks has been mounted by Mr. Hornaday, taxidermist of the National Museum.

Kodiak.—A very accomplished naturalist and collector, Mr. W. J. Fisher, is now established at Kodiak as tidal observer of the United States Coast Survey, and from him the Institution has received a number of extremely interesting objects. These are, for the most part, ethnological and zoölogical; and will be referred to in another part of this report. The most interesting acquisition of Mr. Fisher is a new species of petrel, which has been called *Æstrelata fisheri* by Mr. Ridgway, after the discoverer.

The fishes collected by Mr. Fisher are particularly interesting; as he is well versed in Pacific ichthyology, and able to make a judicious selection where it is required.

From the other islands of the Aleutian group not much has come to hand in 1882; a few specimens collected in previous years only having been received.

Commander Islands.—Not in any way inferior in importance to the other work of the year have been the results of an expedition made to the Commander Islands by Dr. L. Stejneger. This gentleman, an accomplished naturalist of Norway, visited the Smithsonian Institution in 1881 for the purpose of studying the collections of aquatic birds in the National Museum, and when this was done, offered his services to the Institution for any exploration that might be desired. His first idea was that of research in the Sandwich Islands, and next in the West Indies; but finally the interest of an exploration in the Commander Islands induced the Institution to make the necessary arrangements to send him to that region. It may be stated, in this connection, that this group of small islands is situated about 100 miles off Petropaulovski on the coast of Kamchatka, and that its special interest lies in the fact of its originally having been the locality of the northern sea-cow—the *Rhytina gigas*—a marine mammal closely allied to the dugong and manatee but of enormous size, measuring 30 feet and

upwards in length, and weighing many tons. When the islands were discovered by the Russians in November, 1741, the species was very abundant; but in a few years it was entirely exterminated, and it is believed to be considerably more than one hundred years since the last survivor perished. Quite naturally, the possession of some remains of this animal is a great desideratum among museums; and until recently the only relics were in the museum of the Academy of Sciences in St. Petersburg. In completing his famous voyage over the European seas, around by the Arctic Ocean and the Pacific, Professor Nordenskjöld, obtained at Bering Island, of the Commander group, a number of bones of the *Rhytina*, of the acquisition of which he was justly proud. Desirous of obtaining specimens of the animal for the National Museum, the Smithsonian Institution very gladly availed itself of the offer of the Alaska Commercial Company, the lessee from the Russian Government of the Commander Islands, to transport Dr. Stejneger in the vessel which carries the usual annual supplies to the station, and hopes soon to report success in its efforts.

Oregon and Washington Territory.—During the year several very acceptable transmissions of objects of ethnology and natural history, especially of fish products, have been made by Mr. James G. Swan, of Port Townsend. This gentleman's name has appeared for many years in the Smithsonian report, as a valued contributor, not only of materials but also of interesting memoirs which have been published in the Smithsonian Contributions to Knowledge, and in the Annual Reports.

Mr. Swan has been specially occupied during the year in collecting material for the American display at the International Fishery Exhibition, to be held in London in May next; and it is believed that his collection, when received, will leave but little to be desired in the way of a satisfactory representation of the aboriginal and other fisheries of Puget Sound.

Capt. Charles Bendire, while stationed at Fort Walla Walla and at Fort Klamath, has continued his researches into the bird life of the Northwest; and, with his usual success, has secured many rare specimens of the nests and eggs of birds, as well as of their skins.

To Captain Bendire we are also indebted for important collections of reptiles, fishes, and small mammals, also fossil remains of both animals and plants.

California.—Mr. R. E. C. Stearns has been engaged in collecting material along the coast of California for the London Fishery Exhibition, and has also visited Puget Sound, Washington Territory, and Oregon in the same connection; and to him we owe some interesting collections of specimens in archæology obtained in the interior of California.

Mr. Gustav Eisen, a well-known naturalist, has also contributed some acceptable collections in archæology from the vicinity of Fresno.

Lower California.—The earlier volumes of the report of the Institution contain allusions to the important work of Mr. John Xantus in the exploration of lower California, resulting in the discovery of a peculiar fauna at Cape Saint Lucas, represented by numerous undescribed species of birds, reptiles, fishes, &c. In the lapse of time, the collections made by Mr. Xantus have been greatly reduced, and it is considered eminently desirable to renew them.

Mr. L. Belding, of Stockton, Cal., undertook, largely at his own expense, to visit the region in question and explore it in the interest of the Smithsonian Institution. This was done by him with very great success, his work resulting in the recovery of most of the species obtained by Mr. Xantus, with a number of additions. So promising, indeed, was the field, that the available time during the winter and early spring of 1882 was not sufficient to complete the work, and he therefore returned again towards the end of 1882, and is now occupied in his mission. As Mr. Belding is a trained naturalist, especially in the department of ornithology, much is expected from his researches. He proposes to prepare, for publication by the Institution, a methodical account of the vertebrate natural history of Lower California.

New Mexico and Arizona.—From New Mexico and Arizona the contributions have, as usual, been chiefly in the line of ethnology, the Ethnological Bureau having continued its work on a very large scale. A special account will be found in another part of the report of the work of this Bureau in the region referred to and elsewhere. It will be, therefore, unnecessary to do more than mention the names of Maj. J. W. Powell, Director of the Bureau, and Messrs. F. H. Cushing and James Stevenson, in this connection.

From Mr. H. H. Rusby some interesting collections of plants and specimens from Silver City have been received.

The United States Geological Survey has also collected very many minerals, fossils, and rocks in these Territories, all of which are for the present in charge of the Survey.

Interior of the United States.—No very important explorations have been made in the interior of the country, other than those mentioned, excepting the work of the Ethnological Bureau, which, as already stated, will be found detailed elsewhere.

Prof. D. S. Jordan, however, has prosecuted extensive inquiries into the fishes of Texas, and Prof. Hay into those of the Southern States.

Florida.—Florida has been the scene of great activity in exploration. Mr. S. T. Walker has been engaged on the western coast of the State, principally in collecting the archæological material; Mr. James Bell, of Gainesville, has furnished large numbers of birds and living reptiles; Dr. Henshall, collections of fishes; and Mr. Whitfield of reptiles.

The most important collections, however, in Florida are those of the fishes, made by Professor Jordan and Mr. Silas Stearns, of Pensacola, the latter gentleman in continuation of very many previous transmissions. Indeed, to no one are we more indebted than to Mr. Stearns for a knowledge of the ichthyology of the Gulf of Mexico, his business connection with the fish and fisheries, prosecuted from Pensacola as a basis, enabling him to secure novelties as they present themselves. Several papers describing a number of new species have been published by the Institution on the collections made by Mr. Stearns, and other species remain to be described.

Eastern portion of the United States.—In the eastern portion of the United States the principal results have, as heretofore, been produced by the United States Fish Commission, the continued investigations of the steamer "Fish Hawk" along the continental plateau having brought to light many new forms of fishes and invertebrates, besides securing numerous rarities, as well as duplicate specimens for distribution.

A special feature, in addition, has been the work connected with the acquisition of material for the display of the London Fishery Exposition, opening in May next. An appropriation was made by Congress for the purpose of securing suitable illustrations of the apparatus, processes, products, and results of the American fisheries; but the present limits will not permit me to go into details, and a formal report will hereafter be made on the subject.

The collections made in previous years by the Gloucester fishermen, have not been continued to any great extent, in view of the fact that the greater part of the objects coming within the limits of their work have been obtained, the work of the "Fish Hawk" superseding largely the less productive yield of the trawl and hand line.

West Indies.—From the West Indies a few objects of much interest have been obtained, although no extended series. Mr. Guesde has continued his contributions of illustrations of a very valuable collection of Carrib antiquities. Dr. Nicholls, of Dominica, Mr. Wells, of Grenada, and Mr. F. A. Ober, have all made contributions of more or less interest.

Mexico.—The receipts from Mexico are for the most part represented by several collections from Prof. A. Dugès, of Guanajuato. This accomplished naturalist has been in the habit, for many years, of sending to the Institution specimens of animals and plants for identification.

It is with deep regret that I am obliged to mention, in another part of this report, the death of Mr. F. Sumichrast, of Tuchitan; who has been, by far, our most important coadjutor in that country.

Central America.—The researches prosecuted in Central America, under the auspices of the Smithsonian Institution, have been of unusual importance in the results obtained, both of specimens and of information; and of these quite a number are to be mentioned.

Dr. J. F. Bransford, a surgeon in the Navy, under the auspices of both the Ethnological Bureau and the Smithsonian Institution, made a special visit to Copan by way of Guatemala, and also spent a portion of his time in Costa Rica and elsewhere. In his work he was able to secure the hearty co-operation of Mr. Keith, the engineer of the Costa Rica railroad, who kindly furnished some very valuable archæological specimens for investigation. The collections of Dr. Bransford have been also of very great value, especially in objects manufactured of jade. Much of Dr. Bransford's work on the Gulf of Nicoya, a region previously but little known to us, is very interesting. He is now engaged in the preparation of an elaborate report of his travels, which will be published at an early day.

Mr. C. C. Nutting, of Illinois, was sent by the Institution to explore especially the fauna of the Gulf of Nicoya and Costa Rica, and with the help of Señor José C. Zeledon, a long-trying collaborator of the Institution, he was able to make some interesting collections both on the coast and in the interior of Costa Rica. No new species were brought to light, but many rare and interesting forms were secured.

Mr. Nutting returned from the work of the winter of 1881-'82 in April, and went back again by the steamer of the 20th December, to continue his researches on the northern border of Costa Rica and the eastern coast of that state and Nicaragua.

Mr. Zeledon himself has furnished some interesting additions to the very large collections of Costa Rica vertebrates previously received from him, among them some new species of birds.

It is but proper to state that the labors of Mr. Nutting and Dr. Bransford were very greatly furthered by the hearty co-operation of Capt. John M. Dow, the agent of the Pacific Mail Steamship Company at Panama, who has been so well known for many years as a coadjutor in all researches of a scientific nature, whether under the auspices of Americans or foreigners. No man is better known along the Isthmus; and a simple request secures his assistance to scientific enterprise at whatever point in Central America it may be in the course of prosecution.

Mr. Gustav Eisen, a correspondent of the Institution, formerly a resident of California, but during the past year living in Guatemala, has made important researches among the antiquities of Copan, Santa Lucia, &c. An extended memoir by him has been prepared for publication by the Smithsonian Institution. He has also supplied some interesting collections of natural history.

The Isthmus of Panama itself has been represented by the collections of reptiles sent by Dr. Nelson, of the English Mail Steamer service, and of fishes by Mr. Gilbert.

The report upon the work of 1880 and 1881 contained an account of the labors of Mr. Charles H. Gilbert in the way of ichthyological investigations along the western coast of America. This gentlemen returned to

Central America by the steamer of the 20th December, and expects to devote a number of months, under the auspices of Captain Dow, to the investigation of the fishes of the two shores of the Isthmus. It is proper to say that for the co-operation which the scientific enterprises of both Messrs. Nutting and Gilbert have received from the Pacific Mail Steamship Company, and the amount of service rendered generally by the company in question in the explorations of the Smithsonian Institution, it is difficult to express our appreciation in words. For more than twenty years, in all successive stages of administration, it has been ready to respond to any reasonable request for service, not only carrying the agents of the Institution free of charge, but also franking the collections transmitted by them to Washington.

South America.—From South America but little of importance has been received, excepting from the Geological Survey of Brazil under Prof. E. H. Derby. From him valuable collections of corals, fossils, &c., have been received, to be exchanged for some from the National Museum.

Dr. Hering, of Surinam, has sent collections of living reptiles, of objects in alcohol, and specimens of anthropology, which have proved very acceptable.

Mr. Thomas Herron, of Baranquilla, has also contributed some valuable archæological specimens.

Mr. W. F. Lee conducted an exploration in Peru and Ecuador with some success during the months of July and August. He was obliged to discontinue work on account of the hostility of the natives, who had been prejudiced against explorers on account of the indiscretions of a collector who had preceded Mr. Lee.

China and Japan.—The researches of Dr. Dale and Mr. P. L. Jouy, in China and Japan, respectively, have been continued during the year with very important results. Collections of great value of birds, mammals, and other objects have come safely to hand from them. Dr. Dale returned to the United States in the early part of the year, but Mr. Jouy remained in Japan and visited some comparatively little known portions of the country, where he found objects of very great interest.

Nothing of special moment has been received from the Old World, beyond some occasional specimens of natural history exchanged with museums or individuals. These, with the details of the collections generally, will be found recorded in the list of accessions to the National Museum during the year.

PUBLICATIONS.

Smithsonian Contributions to Knowledge.—In 1860 the Institution published as one of the series of "Contributions to Knowledge," the register of meteorological observations made at Providence, R. I., by Prof. Alexis Caswell, extending over a period of twenty-eight and a half years, from December, 1831, to May, 1860. After the death of Professor

Caswell, manuscript containing additional observations for sixteen years and a half, or to the end of the year 1876, was placed at the disposal of the Institution. It was accordingly decided to publish summaries of the entire series of observations, and the necessary reductions, arrangement, and revision were placed under the direction of Messrs. Charles A. Schott and E. H. Courtenay.

The result, a condensed epitome of continuous records for forty-five years, of observations of the barometer and thermometer, of winds, clouds, rain, snow, &c., has been published during the year, forming a quarto volume of 38 pages, entitled "Results of Meteorological Observations made at Providence, R. I., extending over a period of forty-five years." This will doubtless prove a useful work of reference, not merely for students of meteorology, but for engineers and others.

Miscellaneous Collections.—Two volumes of this series have been completed during the past year, Vol. XXII and Vol. XXIII. The former is composed of the Proceedings of the United States National Museum for 1880 and 1881, and forms an octavo volume of 1200 pages, with 18 wood-cuts and 4 plates.

The twenty-third volume is made up of the following papers:

Bibliography of Fishes of the Pacific coast of the United States. By Theodore Gill.

On the Distribution of Fishes of the Alleghany Region of South Carolina, Georgia, and Tennessee, with a synopsis of the family *Catostomidae*. By D. S. Jordan and A. W. Brayton.

Flora of Saint Croix and the Virgin Islands. By H. F. A. Eggers.

Catalogue of the Collection to illustrate the animal resources and the fisheries of the United States, exhibited at Philadelphia in 1876 by the Smithsonian Institution and the United States Fish Commission, and forming a part of the United States National Museum. By G. Brown Goode.

Contributions to the natural history of Arctic America, made in connection with the Howgate Polar Expedition, 1877-78. By L. Kumlien.

These five articles formed Bulletins of the National Museum, Nos. 11 to 15, and are now collected in one volume of 1003 pages.

Mr. F. W. Clarke has prepared for the Institution another of the series devoted to the discussion and more precise determination of various constants of nature, forming the fifth contribution to that subject published in the Smithsonian series. It is entitled "A Recalculation of the Atomic Weights," and forms an octavo volume of 293 pages. It may be regarded as practically supplementary to the "Digest of Atomic Weights," by Mr. Geo. F. Becker, published by the Institution in 1880, and of which an account was given in the report for that year.

One of the articles of the Miscellaneous Collections (No. 469, Smithsonian series), is a list of the foreign correspondents of the Institution, corrected to January, 1882. It was prepared by Mr. Geo. H. Boehmer, in

charge of the exchange system, includes about 3,000 titles, and forms an octavo volume of 174 pages, being No. 469 of the Smithsonian publication.

The various papers on anthropological subjects, contributed by Dr. Chas. Rau to the Smithsonian Annual Reports, from 1860 to 1877, have been collected and issued in one volume, with a preface by the author containing notes as to changes and additions rendered necessary by recent observations and researches.

The work forms an octavo volume of 180 pages, with 53 wood-cuts, and constitutes No. 440 of the Smithsonian series of publications.

The steady increase of publications by the Institution renders necessary a frequent reissue and extension of the printed list of the same. The last check-list (to the end of 1881) presented 438 titles, stated in brief, and occupying 20 pages 8vo. It was at the time designed to have a more complete catalogue prepared, giving the title-page of each work in full. Mr. William J. Rhees has accordingly undertaken the labor of compiling such a catalogue, in a much more thorough and satisfactory form than has heretofore been attempted. This list (including 40 additional titles) has been brought down to the 1st of July, 1882. The whole number of titles is 478; and in addition to a full bibliographical description of each work, in the case of volumes which embrace several independent articles (as the Contributions, Collections, Reports, Bulletins, and Proceedings), the contents of each are given. This catalogue (of 89 pages) is followed by a classified list of all the separate publications, under general heads. A very full alphabetical index of all the articles contained in each of the publications (with abundant cross-references) concludes the work. The whole (including 14 pages of prefatory information), comprises 342 pages, 8vo. In order to make this catalogue still more available, it is intended to supplement it with a complete subject-matter index of all the subjects treated of in the different publications, including the miscellaneous papers furnished in the annual reports.

A history of the rise and progress of the Smithsonian system of exchanges has been prepared by Mr. George H. Boehmer, of the Institution. The account is prefaced by a sketch of some earlier efforts at interchanges of a limited character, in order to show more clearly the distinctive features of the Smithsonian system as an agency of universal exchange among learned societies and others, irrespective of special returns to itself. The history includes the work of the Institution with reference to the distribution of Government publications; and also a notice of the organization by the Paris convention of 1875, in promotion of a system of international exchange of scientific and literary memoirs, together with the proceedings subsequently taken by other nations in the matter. The whole forms a pamphlet of 162 pages, 8vo.

The interest attached to *Tuckahoe*, or *Indian bread*, as a well-known and largely diffused article of food among the aborigines of our country,

has led Prof. J. H. Gore to make a thorough examination into the nature and properties of this fungus. By means of circulars of inquiry, widely distributed by the Institution, a considerable amount of material and information has been collected. This substance is found growing in irregular masses of mycelium around the roots of trees—especially the conifers—and is met with in certain districts as far north as New Jersey and Pennsylvania, and even in parts of New York, and as far south as Florida and Texas. Professor Gore has shown that the somewhat varied accounts given by earlier writers result from a loose application of the term *tuckahoe* to different substances and tubers, and that the genuine article is destitute of starch, and, though abundant in pectinous matter, possesses in itself but a small nutritive value. The essay is comprised in a pamphlet of 13 pages.

Since the publication by this Institution in 1862 of a work on the ‘Classification of the Coleoptera of North America,’ by Dr. John L. Le Conte, and in 1873 of a second part to the same, not only has the collection of specimens been largely increased by the industry of entomologists, but many new genera previously unknown have been added to this large and important order or group of insects. It has therefore been thought desirable to have the original treatise thoroughly revised and brought up to the present condition of the science. This laborious work has been undertaken by the joint efforts of Drs. John Le Conte and George H. Horn; and the new edition now nearly completed, has been put in print as far as to page 480. Not more than a hundred pages will now be required to finish this extensive systematic arrangement and description of the Coleoptera, and the work will be published early in 1883.

In October of the past year, the Institution commenced the printing of a General Catalogue of Scientific Periodicals published in all parts of the world since 1665, compiled by Prof. H. Carrington Bolton, of Trinity College, Hartford, Conn. The plan of this catalogue does not include the proceedings and transactions of societies, nor does it include art journals or professional journals, that is, periodicals devoted to the subjects of law, medicine, or theology. This work originally brought down to the year 1874, by Prof. Bolton, it was at first supposed would be published by Congress under the auspices of the Congressional Library. The subsequent publication by Mr. Samuel H. Scudder of his admirable ‘Catalogue of Scientific Serials of all countries (including the transactions of learned societies), from 1633 to 1876,’ seemed for the time to supersede the work on which Professor Bolton had been so long engaged. As the latter, however, included the large field of ‘‘applied’’ science (so called), such as the periodical literature of manufactures, agriculture and horticulture, pharmacy, and technology in general (not embraced in Mr. Scudder’s catalogue), and as it presented the great advantage of a purely alphabetical arrangement instead of the geographical classification adopted by Mr. Scudder, the Institution undertook its publication on condition that it should be continued to

the year 1882. This additional labor was cheerfully undertaken by the author, and it is hoped that the work will be completed during the year 1883. It will contain geographical, chronological, and subject-matter indexes, and also—what is regarded as a valuable feature in a bibliographical work of the kind—an appendix stating the American libraries in which any of the periodicals catalogued (and indicated by a number) are to be found. To attain this information, circulars have been prepared and will be sent to some two hundred librarians (including twelve in Canada), explaining the project and soliciting their co-operation in this particular. It is probable that this proposed bibliographical aid to scientific students will embrace references to at least a hundred libraries. The work when completed will form an octavo volume of probably somewhere between 700 and 800 pages.

For the purpose of ascertaining the methods employed in various public and private offices, of indexing and filing letters and other papers, and of thence determining by a comparative review the most convenient and practical system, a circular was issued in January, 1882, requesting our correspondents to furnish the institution with a detailed account of the method employed by each. Thankful acknowledgments are due to the various Government officials and to a large number of others who have courteously responded to this inquiry. A large amount of interesting information on this subject has been thus collected, which will be properly digested and published by the Institution hereafter.

The usual activity in the preparation and publication (through the agency of the Interior Department) of the "Bulletins" and "Proceedings" of the United States National Museum has been displayed during the past year.

Bulletin No. 24 of the Museum has been issued, and consists of a "Check-list of North American Reptilia and Batrachia, with catalogue of specimens in the United States National Museum, by H. C. Yarrow, M. D., honorary curator of the department of reptiles." This work may be regarded as a revision and extension of the excellent list prepared for the Museum by Prof. Edward D. Cope, and published in 1875 in Bulletin No. 1. The material selected as a reserve stock for the Museum, including typical forms heretofore described, those identified by Professor Cope in his original study of the museum reptiles, those of the same species found in different geographical areas, and those characterized by any abnormality in parts, coloration, or scale covering, forms a collection of over 4,000 specimens, illustrating 469 species, and is believed to form a series unrivaled by that of any American museum. The large extension of material here indicated is mainly due to the discovery of new species and sub-species in California and Lower California by Messrs. Gustav Eisen and L. Belding, and in Texas by Professor Cope and Mr. Marnock.

The first part of the work consists of a simple "check-list" of the 469 species, in which an attempt has been made to introduce some kind of

uniformity in the popular designation of a species, to supersede the numerous local names in use, by giving an English equivalent of the technical Latin and Greek titles employed by naturalists. The next, and larger portion of the work is devoted to a specification of the locality, source, and nature of the various preserved examples of each species, with a bibliographical reference to a good published description thereof. Following this is a "List of specimens *desired* by the National Museum," numbering in all 132, of which, however, 78 are duplicates wished for of examples already in the collection, leaving but 54 new species desired to complete the Museum series. The whole is followed by copious indexes; 1st, to the generic and specific names; 2d, to the common names; 3d, to the localities whence obtained; 4th, to the names of contributors; and lastly, the general index. This bulletin forms an octavo volume of 254 pages. This work is to be followed by a supplementary one giving a careful and concise description of each species of the class. This is now in preparation.

Bulletin No. 22 of the National Museum has been published during the year. It is entitled "Guide to the Flora of Washington and vicinity," by Lester F. Ward. The work, besides the catalogue of the flora of the District, with full notes, contains a sketch of the early botanical labors undertaken by former students, the range of the flora, notices of localities of special interest, the flowering-time of plants, and many interesting facts relating to autumnal flowering, albinos, and double flowers, a statistical view of the flora, a comparison with others, notes upon abundant and scarce species, classification, common names, &c. There is also included a check-list of the plants for the use of those who may be forming herbaria and an excellent map of the region considered. An appendix is devoted to directions for collecting, which gives ample instruction for the preparation of an herbarium, the collection, preservation, and identification of plants, as well as the proper way to arrange duplicates for readily making exchanges. This is also published in separate form as No. 460 of Smithsonian series. A full and complete index forms a useful feature of the work, the whole making an octavo volume of 265 pages.

Another Bulletin of the National Museum, No. 11, which had been for a long time in the hands of the printer, was issued during 1882. It is entitled "Bibliography of the Fishes of the Pacific Coast of the United States to the end of 1879," by Theodore Gill. The author gives an enumeration in chronological order of the memoirs and articles of all kinds that have been published on the fishes of the Pacific coast of the United States. The Bulletin forms an octavo volume of 77 pages.

The important work of Mr. Samuel H. Scudder, referred to in the report for 1880, relative to the names which have been given by writers on natural history to genera, has been published in part during the year. It forms Bulletin No. 19 of the National Museum, and is entitled "Nomenclator Zoologicus. An alphabetical list of all generic names

that have been employed by naturalists for recent and fossil animals from the earliest times to the close of the year 1879." In two parts. Part I. "List of Generic names employed in Zoology and Paleontology to the close of the year 1879, chiefly supplemental to those catalogued by Agassiz and Marschall, or indexed in the Zoological Record." It forms an octavo volume of 398 pages.

Of the class of "Proceedings of the National Museum," volume IV has been published. This work, commenced in April 1881, printed by signatures as matter was prepared, and completed in August, 1882, comprises biological and other notices by S. F. Baird, T. H. Bean, C. Bendire, C. H. Boyd, W. E. Carlin, W. H. Dall, F. M. Endlich, W. G. Farlow, C. H. Gilbert, T. Gill, W. C. W. Glazier, G. Brown Goode, G. W. Hawes, E. Ingersoll, S. H. Johnson, D. S. Jordan, P. L. Jouy, G. N. Lawrence, W. N. Lockington, O. Lugger, C. L. McKay, M. A. Moore, A. Pirz, F. M. Plateau, J. Y. Porter, R. Rathbun, C. Rau, R. Ridgway, J. A. Ryder, R. W. Shufeldt, R. Smith, S. B. Smith, L. Stejneger, F. W. True, L. F. Ward, and C. A. White. These papers are followed by an appendix of 141 pages, comprising 18 circulars issued by the Museum. The whole forms an octavo volume of 680 pages, illustrated by 1 plate of 13 figures, and by 15 figures in the text.

For several years past, under the co-operation of the Smithsonian Institution and the United States Coast and Geodetic Survey, a collection has been made of the data obtainable as to the relative heights of points over the surface of the continent of North America, with a view to gather these together for permanent record and publication, and to form the groundwork of a hypsometrical map.

This collection has been intrusted to Mr. W. L. Nicholson, topographer of the Post-Office Department, who has devoted as much leisure time as he could command to the extensive correspondence required and to the co-ordination of the large mass of material gathered. But the engrossing nature of the duties of his office, having delayed the progress of this work, a transfer has been made during the past year of all this material from the Smithsonian Institution—under whose more immediate direction the work has been prosecuted—to the Coast and Geodetic Survey, one of whose officers may be assigned for the continuation of this important subject.

Smithsonian Annual Report.—I regret to state that up to this time, the annual report of the Regents for 1881 has not been published. It was transmitted to Congress on the 1st of March, 1882, and has ever since been in the hands of the Public Printer.

This work includes the usual Journal of Proceedings of the Board of Regents, with the reports of the Secretary, of the Executive Committee, and of the National Museum Building Commission. The "General Appendix" contains first a "Record of recent scientific progress." Introduction by the Secretary; astronomy, by E. S. Holden; meteorology,

&c., by Cleveland Abbe; physics, by G. F. Barker; chemistry, by the same; botany, by W. G. Farlow; zoology, by Theodore Gill, and anthropology, by O. T. Mason; next, miscellaneous papers and abstracts relating to anthropology, and the papers by J. Howard Gore, on *tuckahoe* or Indian bread; and by G. H. Boehmer, on the history of the Smithsonian system of exchanges; both of which have already been described. The whole will form an octavo volume of something over 800 pages, illustrated with 83 cuts.

ASTRONOMICAL ANNOUNCEMENTS BY TELEGRAPH.

The service undertaken by the Institution in 1863, in the interests of astronomical science, of acting as the central medium of reception and transmission of telegraphic announcements of discoveries, continues to be rendered, with general satisfaction to observers. It is of course understood that this Institution is merely the channel of an *international* exchange of astronomical research, and that it undertakes to act only as the intermediary between foreign and domestic observatories, though it has long been a desideratum to have the announcements of American discoveries fully distributed in our own country—a result which has to some extent been effected by the constant practice of the Institution to have both foreign and American discoveries promptly transmitted to the New York and National Associated Press for immediate publication.

The Atlantic Cable Company and the Western Union Telegraph company still continue with their accustomed liberality to forward the Smithsonian dispatches free of charge; an enlightened appreciation of the public value of such researches, and a courteous and hearty co-operation in scientific work which should always receive our most thankful recognition.

The following is the list of astronomical discoveries of minor planets and comets made during the past year:

List of planetoids discovered in 1882.

No.	Name.	Date.	Discoverer.	Discoverer's No.	Observatory.
221	Eos	Jan. 18	Palisa	30th.	Pola.
222	Lucia	Feb. 9	Palisa	31st.	Pola.
223	Rosa	Mar. 10	Palisa	32d.	Pola.
224	Oceana	Mar. 30	Palisa	33d.	Pola.
225	Henrietta	April 19	Palisa	34th.	Pola.
226	Weringia	July 19	Palisa	35th.	Pola.
227	Philosophia	Aug. 12	Prosper Henry	8th.	Paris.
228	Agathe	Aug. 19	Palisa	36th.	Pola.
229	Adelina	Aug. 22	Palisa	37th.	Pola.
230	Athamantis	Sept. 3	L. de Ball	1st.	
231	Vindobonda	Sept. 10	Palisa	38th.	Pola.

It will be noticed that while only *one* new planetoid was observed in 1881 (the year of the last report), *eleven* have been discovered in the year 1882. The irregularity of numbers added to the list in successive years has not been observed to follow any assignable rule. The following table gives a synopsis of the whole range of planetoidal discovery by years, including the first four leading bodies of the group observed at the beginning of the present century :

Whole number of planetoids yearly discovered.

1801.....1	1848.....1	1855.....4	1862.....5	1869.....2	1876.....12
1802.....1	1849.....1	1856.....5	1863.....2	1870.....3	1877.....10
1804.....1	1850.....3	1857.....9	1864.....3	1871.....5	1878.....12
1807.....1	1851.....2	1858.....5	1865.....3	1872.....1	1879.....20
1845.....1	1852.....8	1859.....1	1866.....6	1873.....6	1880.....8
1846.....0	1853.....4	1860.....5	1867.....4	1874.....6	1881.....1
1847.....3	1854.....6	1861.....10	1868.....12	1875.....17	1882.....11

From this table it is seen that while only 13 of these bodies had been detected in the first half of the century, the remaining 218 all belong to the past thirty-two years. Or, while the first quarter gave 4, the second quarter gave 9, the third quarter 144, and the last quarter gives the still higher rate of more than 10 per annum. Or, still more specifically (following the columns of the table), the first forty-seven years gave 8, the next seven years 25, the next seven years 39, the next seven years 35, the next seven years 50, and the last seven years 74.

Distribution of the discovery of planetoids.

1 discovered in 1801, 1802, 1804, 1807, 1845, 1848, 1849, 1859, 1881.	8 discovered in 1852, 1880.
2 discovered in 1851, 1863, 1869.	9 discovered in 1857.
3 discovered in 1847, 1850, 1864, 1865, 1870.	10 discovered in 1861, 1877.
4 discovered in 1853, 1855, 1867.	11 discovered in 1872, 1882.
5 discovered in 1856, 1858, 1860, 1862, 1871.	12 discovered in 1868, 1876, 1878.
6 discovered in 1854, 1866, 1873, 1874.	17 discovered in 1875.
	20 discovered in 1879.

List of comets observed in 1882.

No.	Name.	Date.	Discoverer.	Observatory.
I	Wells' comet.....	Mar. 17	Charles S. Wells ..	Albany, N. Y.
II	Crull's comet.....	Sept. 7	Mr. Finlay	Cape of Good Hope, S. Africa.
III	.....	Sept. 13	E. E. Barnard	Nashville, Tenn.

The following brief notice of these interesting objects has been kindly furnished by Prof. Asaph Hall, of the U. S. Naval Observatory.

"Comet I, 1882, was discovered by Charles S. Wells at the Dudley Observatory, Albany, N. Y., March 17, 1882. Observations were made in the southern hemisphere until July 25, 1882. No definitive orbit has been determined yet, but probably the orbit is nearly parabolic." [That is, a very elongated ellipse.]

"Comet II, 1882, was the great comet of the year. It was seen with the naked eye, at many places in the northern hemisphere; but the first accurate observations seem to be those made by Mr. Finlay at the Cape of Good Hope on September 7. This comet was very bright, and was remarkable on account of several condensed parts that were seen in its nucleus, and which led to statements of a separation of this nucleus. But these brighter parts were always connected by fainter parts of the coma. It is probable that these apparent separations have led to discordancies in the observations, which will make it difficult to combine the numerous positions of this comet into a homogeneous system. Several elliptic orbits have been computed, the periodic times varying from five hundred to a thousand years."

"Comet III, 1882, was a faint object. It was discovered by Mr. E. E. Barnard, at Nashville, Tenn., September 13, 1882. Observations were made in the southern hemisphere on December 8, and probably it was followed longer. The orbit seems to be parabolic."

The wide interest felt by astronomers in the Smithsonian international announcements of planetary and cometary discoveries is evinced by the number of proposals and suggestions received at the Institution, for increasing the range and efficiency of the service. On one hand, frequent applications have been made to the Institution urging that American discoveries should be widely telegraphed at home as well as abroad. On another, it has been repeatedly urged that in view of the comparatively ephemeral character of the appearances of most of the comets, frequent and prompt announcements should be telegraphed of observed changes of position from day to day, as well as of provisional computations of orbits. Valuable as such early information would evidently be, the Institution has not been able (in the support of its other multitudinous interests) to incur the additional expense of such transmissions. And the liberality of the various telegraphic companies has already been so extended beyond original purpose and proposal, that we can hardly, with propriety, solicit this large increase of concession.

The "Science Observer," published at Boston, has (with a commendable enterprise), in connection with the Harvard College Observatory, entered this field of active usefulness, and by means of "special circulars" has acceptably supplemented the work of the Institution in this department. The peculiar cable code employed by the "Science Observer" has not however commended itself for adoption by the Smithsonian Institution.

There has been some difference of opinion among astronomers as to the best form of presentation of the elements of position of a new comet or planetoid. From want of care, or of attention by some to the published formulæ in announcing their discoveries, difficulties of interpretation have occasionally arisen. A portion of the correspondence of the Institution on this subject is given in the appendix to this report.

INTERNATIONAL EXCHANGES.

The Smithsonian system, so long conducted with benefit to libraries and individuals in this country and abroad, has received new impetus and extension during the past year. I have already referred to an elaborate history of the system, and of the efforts made to promote interchange of the literary and scientific productions of different countries, published by the Institution during the year, and it is only necessary here to present the usual statistics of the service. For a full account of the details of operations I refer to Mr. Boehmer's report in the appendix.

The total number of establishments outside of the United States with which correspondence and exchange have been conducted amounts to 3,726, an increase of about 800 over the list of 1881. The number of packages received from Europe for distribution in the United States during the past year amounted to 7,187; the number of packages from the United States received for transmission abroad has amounted to 19,292; making an aggregate of 26,479 packages.

The parcels received from Europe for distribution in America are generally forwarded to their respective destinations in smaller bundles, or in paper wrappers. The parcels received for transmission to foreign countries are carefully packed in boxes. Of these there were shipped during the past year 422, occupying a bulk of 2,950 cubic feet, and weighing 105,500 pounds.

As heretofore, the Institution is greatly indebted to the lines of ocean steamers between the United States and other countries of the world; and grateful acknowledgment is due particularly to the agents of the following companies for the continuation of their important favors in the free transmission of Smithsonian packages: Anchor Steamship Company, Atlas Steamship Company, Compagnie Générale Transatlantique, Cunard Steamship Company, Hamburg American Packet Company, Inman Steamship Company, Merchants' Line of Steamers, Netherlands American Steam Navigation Company, New York and Brazil Steamship Company, New York and Mexico Steamship Company, North German Lloyd Steamship Company, Pacific Mail Steamship Company, Pacific Steam Navigation Company, Panama Railroad Company, Steamship Lines for Brazil, Texas, Florida, and Nassau, N. P., White Cross Line of Antwerp.

The railroad companies connecting Washington and Baltimore and New York have also continued their favor of special rates of charges for freight. These are the Pennsylvania Railroad, the Baltimore and Ohio Railroad, and the Baltimore and Potomac Railroad.

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.

Receipts.

	In 1880.	In 1881.	In 1882.
1. For foreign distribution:			
From Government Departments (packages).....	2,071	4,326	6,470
From Smithsonian Institution.....	3,156	5,436	7,056
From scientific societies.....		3,631	5,119
From individuals.....	8,948	768	647
	14,175	14,161	19,292
2. For home distribution.....	6,670	7,890	7,187
3. For Government exchanges.....	15,200	15,550	31,568
Total receipts, packages.....	36,045	37,551	58,047

Transmissions during the last eight years.

1. FOREIGN EXCHANGES.

	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.
Number of boxes.....	208	323	397	309	311	268	407	422
Bulk, in cubic feet...	1,513	2,261	2,779	2,160	2,177	1,976	2,800	2,950
Weight, in pounds...	45,300	80,750	99,250	69,220	69,975	60,300	100,750	105,500

2. DOMESTIC EXCHANGES.

Total addresses to institutions.....	329	310	392	392	444	385	600	548
Total addresses to individuals.....	281	328	374	370	341	560	454	399
Total number of parcels to institutions.	3,619	3,705	3,868	4,059	5,786	4,021	7,086	7,192
Total number of parcels to individuals.	1,042	1,148	1,094	1,233	1,185	1,566	1,347	1,167
Total number of parcels	4,661	4,853	4,962	5,292	6,971	5,587	8,433	8,359

3. GOVERNMENT EXCHANGES.

total number of boxes.	64	122	73	73	67	35	98	122
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Foreign institutions in correspondence with the Smithsonian Institution.

Africa.....	41	Europe.....	3,344
America.....	173	Polynesia.....	2
Asia.....	77		
Australia.....	89		
			3,726

Comparative table of same during the last ten years.

1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.
2,145	2,146	2,207	2,275	2,330	2,333	2,481	2,602	2,908	3,726

Government Document Exchange.—In addition to its general function of intermediary between the institutions of the New World and the Old, the Smithsonian Institution has been for some years the agent of the Government for the exchange of public documents and other official publications, in the interest of the Library of Congress, and under the provisions of law. By act of Congress, fifty copies of all publications of the United States Government, whether ordered for the use of Congress or of the Departments, are available for distribution, under the direction of the Joint Library Committee of the two houses of Congress, to such foreign Governments as agree to make a corresponding return. These returns, when received, are forwarded directly to the Library of Congress, without being entered on the records of this Institution. A detailed report in an appendix gives all the information possessed under this head, including the aggregate of such distribution, the agencies through which it has been effected, and the parties interested in the exchange.

List of Governments to which boxes "16" and "17" were sent in 1882.

Argentine Confederation.	Denmark.	India.	Russia.
Buenos Ayres.	France.	Italy.	South Australia.
Bavaria.	Germany.	Japan.	Spain.
Belgium.	Prussia.	Mexico.	Sweden.
Brazil.	Saxony.	Netherlands.	Switzerland.
Canada.	Württemberg.	New South Wales.	Tasmania.
Ontario.	Great Britain.	New Zealand.	Turkey.
Chili.	Greece.	Norway.	Venezuela.
Colombia, U. S. of	Hayti.	Portugal.	Victoria.
	Hungary.	Queensland.	

Colombia, Hungary, and India were furnished with the entire set of 17 boxes (A to R). France has received 2 sets of all the documents except box "17," of which only one was sent, the practice of sending double sets having been discontinued.

LIBRARY.

The large increase in the number of books and pamphlets received in 1881 (the total number amounting to 11,959 pieces) has been well maintained during 1882, by the accession of 11,789 pieces, as detailed in the following statement. This, compared with the 8,570 pieces received in 1880, represents a very gratifying increase.

As already explained, the books and articles received by the Smithsonian Institution (excepting only such as are needed for immediate reference by the specialists of the Institution and National Museum) are deposited at once in the Library of Congress, and represent a very large part of the mass there which is at present calling so earnestly for proper accommodation.

Reference has been made in a preceding report to the arrangements for obtaining a special library for the service of the National Museum;

the effort being made in all cases to secure duplicate copies of the transactions, monographs, &c.; one to be transferred to the Library of Congress, the other to be placed in the library in question.

The report of Mr. True, in charge of the National Museum Library, shows a stock of nearly 10,000 volumes and pamphlets; nearly all duplicates, as already explained, with the exception of certain works presented by myself. In the increasing amount of routine work with which I am charged in the several capacities of Secretary of the Smithsonian Institution, Director of the National Museum, and Commissioner of Fish and Fisheries, it has become entirely out of the question to continue those special researches in zoology, to which I devoted so much time in the early years of my connection with the Smithsonian Institution, and for which I had accumulated, at my own expense, a large number of important works. These I have now formally presented to the Library of the National Museum, feeling assured that they will do the most good in that connection.

The most important source of supply to the Library of the National Museum consists in the direct exchanges of publications for those of foreign museums, and of scientific societies, and of specialists in natural history. Little, if anything, however, comes in not obtained under similar circumstances by the exchanges of the Smithsonian Institution.

Under the regulations of the Museum, the curators in charge of special divisions are permitted to withdraw from the central library all works relating exclusively to the departments of which they have charge. Mixed works, however, or those covering the scope of at least two or more divisions, are retained in the central library; a record of the transfer being kept in the central office, so that an applicant for a particular book can be directed to the office where it is to be found.

It is very desirable that some arrangement be made by which a record of all books in the various public libraries in Washington can be kept in some central office; so that a person wishing to refer to a particular title may have the means of knowing whether it is in the city, and which of several depositories may be the most convenient to him. This can best be done through the natural center of reference—the Library of Congress.

If a law were passed making it obligatory upon the librarians of the various Departments, Bureaus, &c., to prepare card catalogues according to the rules of the Congressional Library, and to deposit therein a duplicate set, they could be then collectively arranged in proper alphabetical or systematic sequence, and be available for the objects in question. Of course this would involve a considerable amount of clerical labor, but a moderate appropriation might be made to meet it at the outset; after which the annual accretions of the libraries could easily be recorded without extra expense.

The following is a statement of books, pamphlets, maps, and charts

received by the Smithsonian Institution during the year 1882, and transferred to the Library of Congress or to that of the National Museum:

Volumes:

Octavo or smaller	993	
Quarto or larger	303	
		1, 296

Parts of volumes:

Octavo or smaller	3, 005	
Quarto or larger	5, 034	
		8, 039

Pamphlets:

Octavo or smaller	1, 932	
Quarto or larger	370	
		2, 302

Maps and charts

152

Total..... 11, 789

Totals received for the last ten years.

1873.....	5, 697	1878.....	8, 729
1874.....	5, 546	1879.....	10, 203
1875.....	7, 047	1880.....	8, 570
1876.....	7, 585	1881.....	11, 959
1877..	8, 726	1882.....	11, 789

It should be mentioned that the Secretary of the Interior has granted to employés of the National Museum the use of the library of his Department on Mondays between 2 and 4 o'clock p. m.

NECROLOGY.

I have to record the lamented death of Mrs. HARRIET A. HENRY, widow of Professor HENRY, which took place in this city on the 25th of last March. This estimable lady, a native of Schenectady, N. Y., whose maiden name was Harriet L. Alexander, was married to Prof. Joseph Henry, at Albany, N. Y., in May, 1830. For forty-eight years she enjoyed a happy domestic life, respected and beloved by all who knew her. The death of her honored husband in 1878 was a severe blow, from which she never fully recovered.

The melancholy duty devolves upon me of announcing the death of two employés of the Smithsonian Institution during the past year. The two whose loss I have to record are Dr. George W. Hawes, curator of the department of mineralogy and economic geology in the National Museum, who died on the 22d of June, 1882; and Mr. Joseph B. Heron, janitor of the National Museum, who died on the 9th of April, 1882.

The following sketch of the life and scientific labors of Dr. Hawes has been prepared by Mr. F. P. Dewey, curator of metallurgy in the National Museum:

“GEORGE WESSON HAWES, son of Rev. Alfred Hawes and Clarissa P. Partridge, was born December 31, 1849, at Marion, Ind., where his father was engaged in missionary labor. But a small portion of his life, however, was spent in his native place, as both his parents died when he was quite young, in consequence of which the family was broken up, and he removed to Worcester, Mass., where he was taken care of and brought up by kind friends. His early education and preparation for the Sheffield Scientific School was obtained in the public schools of Worcester. In 1865 he became a member of the Sheffield Scientific School at New Haven, where he remained two years, at the end of which time he went to Boston to go into business. Business life, however, did not at all suit him, as his natural love for science and investigation and the acquirement of knowledge for its own sake was unusually strong, so that, despite a very flattering offer to remain in Boston, in 1871 he returned to New Haven, and graduated from the Sheffield Scientific School in 1872.* The year after graduation he was Prof. S. W. Johnson's private assistant in his laboratory at New Haven. At the beginning of the college year 1873, he became assistant to Prof. Geo. J. Brush, and instructor in mineralogy and blowpipe in the Sheffield Scientific School, a position which he filled very successfully and uninterruptedly until 1878, and with some intermissions until the end of 1880. His duties in this position were very congenial to his tastes and allowed him to devote considerable time to his favorite studies and lay a permanent foundation for his after work. It was during the early portion of this period that microscopic lithology began to come into prominence, and he was among the first in this country to study that subject carefully and thoroughly, and so impressed was he with its possibilities that he made it his specialty and during the remainder of his life gave it his best efforts, doing all in his power to aid in its development. He was so successful that at the time of his death he was the recognized authority upon the subject in this country. In the spring of 1878, he went abroad and spent the summer semester at Breslau, under Prof. A. Von Laslaux, studying chiefly microscopic lithology. The winter of 1878-79 was spent at New Haven, and in the spring of 1879 he again went abroad and remained until June, 1880. During this visit he divided his time between mineralogy and crystallography at Bonn, with Professor Vem Rath, and lithology at Heidelberg, with Professor Rosenbusch, from whom he won golden opinions. Before returning he took the degree of Doctor of Philosophy at the latter university. The remainder of 1880 was spent at New Haven, but at the end of November he was appointed a special agent of the tenth census to investigate the quarry industry of the United States, and on the 1st of January, 1881, curator of the geological department in the National Museum, which occasioned his removal to Washington, D. C.

*The summer of 1872 was passed at Eastport, Maine, one of the party of the United States Fish Commission, then prosecuting its fishery investigations in the waters of the Bay of Fundy.

“Up to this time his life, although quite prolific in results, had been mainly one of study and preparation, and very few, indeed, of his age could be found so well prepared to undertake extensive and far-reaching investigations. Upon coming to Washington the investigation of the quarry industries of the country, which was undertaken under the joint auspices of the Smithsonian Institution and the census, opened up a broad and almost unoccupied field for his activities, and he undertook it with all the earnestness and zest of one well prepared and confident of accomplishing much good in the increase of knowledge. The plan of this work as laid out by Dr. Hawes was very broad and comprehensive in its scope. Besides the collection, arrangement, and study of the statistics of the industries, it included the study and description of the occurrence and preparation of building stones; the collection of specimens from all the regions of production which, when properly dressed, should form a graphic representation of the natural materials of construction of the whole country; the thorough examination of these specimens microscopically, chemically and physically; and, in fact, the thorough and complete study of the subject in all its branches; so that had he lived to complete the work there can be no doubt that it would have been very fruitful of good results. His earnestness and zeal, however, led him to overtax himself, and it was not long before it became evident to his friends, although not to himself, that his health was being seriously undermined; but near the end of the year even he became alarmed at the evident signs of consumption that had developed themselves, and he decided to take a respite from active work, which he did by a trip to Bermuda. This, however, failed to afford any relief, and he gradually sank after his return, until finally, as a last resort, he went to Colorado. But the disease was too far advanced to be checked, and he lived but a short time after his arrival in Colorado. The final dissolution came rather suddenly, as up to the day before his death he was able to be up and dressed and about the house. His remains were interred at Worcester, Mass., June 28.

“The removal of one so well prepared and adapted to undertake extensive investigations is a great loss to the world of science. Had he lived there can be no doubt that he would have reached many valuable results, and his untimely death was sadly deplored by all who knew him. Dr. Hawes’s contributions to science were mainly in the line of his specialty—microscopic lithology—and consist of some twenty articles published in the *American Journal of Science*; three in the *Proceedings of the National Museum*; an annual report upon geology and mineralogy in the *Annual Report of the Smithsonian Institution for 1880*, and part IV of *Volume III of the Report of the Geological Survey of New Hampshire*, entitled the ‘*Mineralogy and Lithology of New Hampshire*’. The latter covers 251 pages quarto, embellished by twelve plates, and is his most valuable and important completed work. It includes the results of the examination of between two and three hundred thin sections of rocks,

some of which were very important and instructive. This report embodies the results of much field work; containing much careful, honest labor and establishing the author's reputation as a microscopic lithologist, which was afterwards strengthened by further studies under Professor Rosenbusch. Of the results achieved by Dr. Hawes in the examination of the building stones of the country little can be said, as it was a work of great magnitude, requiring a great deal of care and exertion for its proper inauguration, and he had barely gotten the investigation into good working condition when he was obliged to abandon its prosecution, much against his will. Personally, Dr. Hawes was a very pleasant and genial man, and possessed a remarkable faculty of making warm friends wherever he went. Although his immediate family relatives were few in number and widely scattered, his death was mourned by a large number who had been won to him by the sterling qualities of his character, his truth, purity, unselfishness, and earnestness. The writer had the pleasure of being one of his first students in blowpiping and also of being associated with him in his work upon the building stones, and is abundantly able to speak of the nobleness of his character, and thus to bear testimony to the warm regard in which he held him."

JOSEPH B. HERRON, a native of the State of Ohio, was born August 7, 1839, at New Cumberland, Tuscarawas County. He was engaged in the military service of his country at the period of the late civil war, having enlisted in 1862, in the 98th Regiment of Ohio Volunteers, at the age of 23 years.

It was but a few months after his enrollment in the national defense that he took part in the battle of Perryville, Ky., on which occasion he received a bullet wound through his body, the ball entering the chest on the left side, passing through his lung obliquely, narrowly escaping the heart, and out at his back on the right side of the spinal column, near the right shoulder blade. He unfortunately lay on the battle-field from Wednesday until Saturday before receiving any medical attendance. From the effects of this severe and dangerous wound he never fully recovered. He was, however, restored to a moderate degree of health and strength, and was able to attend to light duties.

In 1866, on the recommendation of General J. A. Garfield and General E. R. Eckley, he was appointed by Professor Henry janitor of the Museum at the Smithsonian Institution, which position he held until his death. He was always gentle and courteous in his deportment; and though the injury to his lungs incapacitated him for exerting any special activity, or any great physical effort, he was always punctual and attentive to his duties. He was a member of the Society of the "Army of the Cumberland," and of the "Grand Army of the Republic." He was one of the Guards of Honor to the remains of President Garfield while they lay at the Capitol in Washington, and accompanied the funeral of the deceased President from this city to Cleveland. In these exertions he probably overtasked his strength; for on returning to

this city from the state funeral, he went into a somewhat rapid decline, and though able to walk about his house to the last day of his life, he died rather suddenly of pulmonary consumption at his residence in Washington, on Sunday morning, April 9th at 7 o'clock, at the age of 43 years, after a service in this Institution of sixteen years.

One of the collaborators of the Institution, whose death we have to deplore, is LEWIS H. MORGAN, author of a very original and elaborate "Smithsonian Contribution to Knowledge." He was born in Aurora, Cayuga County, New York, November 21, 1818, and died at Rochester, N. Y., December 17, 1881. His first communication, published by the Institution, was a short paper comprising "Suggestions relative to an Ethnological Map of North America," which appeared in the Smithsonian Report for 1861. Devoting himself to the study of anthropology, he published various treatises in relation to the North American Indians. His most important work is a discussion of "Systems of Consanguinity and Affinity of the Human Family," a large quarto of 616 pages, which forms Volume XVII of the "Smithsonian Contributions," published in 1869. His last work, entitled "Houses and Home-life of the American Aborigines," forms Volume IV of the Contributions to American Ethnology.

It is also my painful duty to announce the death of another esteemed collaborator and eminent man of science, Dr. HENRY DRAPER, of New York, a son of the distinguished philosopher, Dr. John Draper, and a member of the National Academy of Sciences. He was born in Virginia, May 7, 1837, and died in New York, November 20, 1882, at the age of 45 years, in the prime of his mental activity and usefulness. He distinguished himself by his original researches in astronomy, chemistry, and in celestial photography. In recognition of his valuable work in connection with the transit of Venus in 1874, a gold medal was struck in his honor, by order of Congress, at the Philadelphia mint. Perhaps his most celebrated work was the difficult discovery, in 1877, of oxygen in the sun.

Like most original investigators he was a skillful manipulator and artisan. He prepared for the Institution in 1864 a memoir "On the construction of a silvered glass telescope, fifteen and a half inches in aperture, and its use in celestial photography," which was published in the "Smithsonian Contributions," Vol. XIV. This work has been very popular, and is recognized as the standard authority on the subject. The demand for it has been constant, and still continues.

In the death of JOSEPH DUNCAN PUTNAM, president of the Davenport Academy of Sciences, and one of the correspondents of the Institution, December, 10, 1881, a great loss has been sustained by the workers in natural history and anthropology, particularly in the western part of our country. He was a valued correspondent of the Institution and

devoted himself untiringly and unselfishly to the advance of science and the elevation of public sentiment in regard to abstract research.

In the death of Don FRANCISCO SUMICHRAST, of Tonali, Mexico, on the 26th December, the Institution lost one of its oldest and most valued correspondents outside of the United States.

This gentleman (a Swiss by birth) was occupied for many years in a close and critical study of the natural history of Mexico; the stations occupied by him being Orizaba, Tuebitan, Tonala, &c.; the Isthmus of Tehuantepec having received special attention from him.

The numerous contributions of specimens of natural history of the country, with notes upon their habits and characteristics, especially birds, mammals, and reptiles, have given to the National Museum a large material, and enabled the Institution to publish a number of extremely valuable memoirs. One of these was edited by Dr. Thomas M. Brewer, and another by Mr. George N. Lawrence, of New York.

It is proper to state that all the assistance rendered by Professor Sumichrast to the Institution was done without any compensation whatever, and solely for the sake of securing a prompt and complete knowledge of the natural history of his adopted country.

MISCELLANEOUS.

The Mercer Bequest.—Among various noteworthy items in connection with the history of the Smithsonian Institution during the year 1882, may be mentioned the circumstance of its being made a copartner in the administration of a beneficiary trust, by Rev. Dr. Mercer, of Newport, R. I. That gentleman, dying on the 3d day of November, 1882, left quite a large property, a portion of which was to be paid directly to certain specified heirs, and the interest on the remainder to be given to persons mentioned during their lifetime. After the decease of these beneficiaries, the property was to be divided into three parts; of which one-third was to be administered by a Board, consisting of Harvard College, Yale College, and the Smithsonian Institution; together with three individuals mentioned, or their survivors, to establish scholarships in some institution for the education of deserving and needy young men. Although the money cannot be used directly by the Smithsonian Institution, yet there seems to be no impropriety in accepting the trust under the conditions named. It is not likely, however, that any occasion for administering it will arise for probably a quarter of a century to come.

In the history of the Institution thus far three bequests have been made to it. The first was that of the residuary legateeship of the property belonging to Mr. Wynne, who died in Brooklyn, N. Y., the estate being valued at the time at from \$50,000 to \$60,000. As, however, the daughter married, and is, as far as known, still living, with a large

family of children and grandchildren, the chances of an inheritance by the Smithsonian Institution are practically none.

The next bequest was that of \$1,000, made by Mr. James Hamilton, of Carlisle; and the third and last, by Dr. Habel, amounting, with a small addition made from the income of the Smithsonian Institution, to \$500; or \$1,500, the two combined.

These two sums have been, in accordance with the law, paid into the Treasury of the United States, as an addition to the principal.

The endowment of the Smithsonian Institution, at the present time, amounts to \$703,000, deposited in the United States Treasury, and it is authorized to increase this amount to \$1,000,000. A large part of the expenses of the Institution consists in what may be called statical items, such as salaries, repairs of building, &c.; and it is very evident that the amount available for active operations is not at all represented by the annual income of the fund. It is quite probable that the increase of the endowment by 40 or 50 per cent. would permit the Institution nearly to double the work accomplished, as it would require no increase of force or incidental expenditure.

Naval Cadets.—In the American naval service, the cadets start with four years' study in the Naval Academy at Annapolis. They are then sent to sea for two years, and do not obtain the rank of midshipman until they have passed an examination at the end of this period, or of six years after their entrance. They are then sent to sea again, or placed on waiting orders.

About a year ago the Navy Department made inquiry of the Smithsonian Institution as to its willingness to receive six recently appointed midshipmen, and assign them to some duty in the Institution or National Museum that would enable them to take advantage of any opportunities they might have for natural-history research during their future cruises, with the understanding that they were to be treated in every way as regular employés of the Institution, and required to do regular work.

The proposition was responded to favorably and the six cadets were assigned respectively to the curators of Ichthyology, Marine Invertebrates, Ethnology, Paleontology, Geology, and Mineralogy. The experiment, somewhat unexpectedly, has proved to be a very great success. The young gentlemen devoted themselves earnestly to their work, and became quite proficient in it.

A course of special instruction was given in regard to the taxidermy of mammals and birds, which all the midshipmen attended with great diligence, becoming quite expert in the preparation of skeletons and in making excellent skins of mammals and birds.

The two assigned to ichthyology and marine invertebrates were detailed for service on board the Fish Commission steamer "Fish Hawk," where they had ample opportunity of becoming familiar with collecting

at sea; as also with the methods and appliances of deep-sea dredging, temperature observations, &c., all, of course, directly in the line of their future vocation.

The other four accompanied one or the other of Professor Powell's parties into the Far West, and have had every opportunity for field work.

The results of this experiment were so satisfactory that six more midshipmen have been detailed to the Institution, the first six to continue another year, making the entire course one of two years.

The selections for this detail are made by the Navy Department after conference with the Superintendent of the Naval Academy, from among those who, while pursuing their educational course, have shown most interest in scientific matters.

The measure is extremely popular among the younger officers, although of course it is decried by others, who consider it an innovation in the established routine.

One special object of the experiment is to have, as a part of the regular force of the Navy, officers competent to do the scientific work for which it has generally been necessary to employ civilians, as also on any cruise to be able to utilize, to some extent at least, the opportunities of research which constantly present themselves to the inquirer.

The following is an account of the work accomplished by these young officers, now recognized by law as "Ensigns":

Of the class of '79, six were ordered to the Institution early in January, 1882.

Ensign *R. H. Miner* chose ichthyology, made a summer cruise on the "Fish Hawk," resumed his studies in the fall, and was detached in December and ordered to the Fish Commission steamer "Albatross."

E. E. Hayden chose mineralogy, went on the U. S. Geological Survey to Nevada, and in the winter took up the study of fossil botany.

H. S. Chase chose mineralogy, went on a geological expedition to Montana in the summer, and is now studying the same branch.

L. M. Garret chose geology, was in Montana in the summer, and has resumed the same branch.

C. C. Marsh chose ethnology, went on an ethnological expedition to Moquis, Ariz., in the summer, and has since taken up fossil botany.

J. B. Blish chose marine invertebrates, went on the "Fish Hawk" in the summer, resumed the same branch in the fall, and was lately detached at his own request and ordered to the "Jamestown."

Of the class of '80, six were detailed last fall.

H. G. Dresel is studying ichthyology.

J. B. Bernadou is engaged in the chemical laboratory in quantitative and qualitative analysis and assaying.

A. A. Ackerman is studying mineralogy.

A. P. Niblack is studying ethnology.

E. Wilkinson has chosen mineralogy.

W. E. Safford has chosen marine invertebrates.

Each one is engaged in the practical work of the respective departments in identifying, and classifying, as far as able, the collections received from various sources.

Special Objects received.—Among the articles received during the year may be mentioned a lock of Sir Walter Scott's hair presented by Hon. George Ainslee, Delegate in Congress from Idaho, whose father was a neighbor and friend of Scott. The presentation was made through one of our regents, Hon. S. S. Cox.

A fine large specimen of agate, found off Keweenaw Point, in Lake Michigan, near Manitou Island (which lies off the shores of Northern Michigan) by S. H. Broughton, has been received by the Institution. It was left to the Smithsonian Institution by bequest of the late Mrs. Broughton, and was deposited by J. P. Newland, executor of Mrs. Broughton's will.

Set of United States Weights and Measures.—By act of Congress, March 3, 1881, the Secretary of the Treasury was directed to deliver to the Smithsonian Institution a complete set of all the weights and measures adopted as standard by the United States Government.

Naval Museum of Hygiene.—Congress having established a "Naval Museum of Hygiene" in connection with the Bureau of Medicine and Surgery of the Navy Department, we have, in accordance with the principle of co-operation adopted by the Institution, placed in its custody a large exhibit of tile and terra-cotta pipe, for sewers and traps, and other articles having sanitary relations.

Manuscript Declaration of Independence.—In the report for 1880 reference was made to the appointment of a commission, of which the Secretary of the Institution was one, to consider the restoration of the faded and now nearly illegible manuscript of the original Declaration of Independence. The subject was referred to the National Academy of Sciences, and a report was made by a special committee on the 17th January, 1881. Nothing however, has been done in regard to the matter.

Peale's Portrait of Washington.—In the last report of the Institution it was stated that a claim had been made by Mr. Titian R. Peale for a portrait of Washington painted by his father, Charles Wilson Peale, on deposit in this establishment. This claim was originally made in 1871. In 1873 the executive committee reported adversely to the claim, on the ground that sufficient proof of ownership of the portrait had not been presented.

During the last session of Congress, however, the matter was taken up and investigated, and as the contesting claimants made a compromise the portrait was finally purchased by the Library Committee of Congress, and it is now the property of the United States.

NATIONAL MUSEUM.

The work of organization of the departments of the Museum has been carried on vigorously during the past year. For a full account of all its operations I would refer to the report of Mr. G. Brown Goode, the assistant director, given in the appendix to this report. The fullness of this account seems to render any *résumé* of the operations and present condition of the Museum unnecessary here.

BUREAU OF ETHNOLOGY.

The appropriation made by Congress for the prosecution of ethnological researches among the North American Indians, under the direction of the Secretary of the Smithsonian Institution, was continued, and the work remained in charge of Maj. J. W. Powell.

Field Work.—A large amount of field work was accomplished during the year. The general excavation of mounds was placed in the charge of Prof. Cyrus Thomas, with several assistants, through whose exertions large collections were made, chiefly in the Mississippi Valley.

Dr. Edward Palmer has continued his explorations in Tennessee and in Arkansas along the Mississippi, White, and Arkansas Rivers. A short time was devoted to examination of the mounds and other works in Southwestern Indiana.

Mr. F. S. Earle was engaged a short time in examining and locating the mound groups of Southeast Missouri, and in opening mounds and stone graves in Southern Illinois.

Mr. James D. Middleton, after Mr. Earle withdrew, continued the work in Southern Illinois until stopped by the cold, when he was transferred to the South, and is now in Alabama.

Col. P. W. Norris entered upon the work in August, his field of labor being the west bank of the Mississippi, from Dubuque, Iowa, to the Arkansas line.

Hon. William M. Adams has been engaged to work up the mounds in Madison County, Illinois, including the Cahokia group. He had already completed the map of them and commenced opening them when the cold weather stopped him.

The result of operations so far may be summed up briefly as follows:

A very good and valuable collection, almost exclusively of mound relics, consisting of pottery, stone implements, clay and stone images, clay and stone pipes, plates of mica, gorgets, shell ornaments, engraved shells, fragments of copper ornaments, fragments of wooden ornaments, fragments of matting, pieces of burned clay which have been stamped, an ancient Catholic medal of brass, a brass Chinese medal or coin (the two latter are surface finds, the first found on a mound in Southern Illinois, the other on the site of an old French fort in Arkansas), quite a number of crania and tibiae. The collection of pottery is quite large

and includes representatives of all the types hitherto found in the mounds except one of Ohio and one of Iowa.

The most important results appertain to the mounds and works themselves. The statement in the Smithsonian Report of 1872 in reference to the Elephant mound is confirmed; the Seltzertown mound is proven to be a myth; at least no sign of it could be found on examination.

The mounds and graves on the Wabash are found to be, to a considerable extent, of Indian origin, and comparatively modern, as shown by the articles of European manufacture found in them and by the mode of burial.

Dr. Palmer had with him for a month an excellent artist who has furnished a number of very valuable drawings of mounds and other works. From these it is noticed that the mounds of Arkansas are in many cases quite large and of the truncated pyramidal form, often terraced. Artificial canals and lakes, such as described by Garcilasso and the *Gentleman of Elvas*, are found in Northeastern Arkansas. Several of the hard clay floors of the large houses of the aborigines, as described by Le Tonti, Joutel, and others, have been found in the very section visited by these travelers.

An inclosure of considerable size, including mounds and house sites, precisely such, even to minute details, as that examined by Professor Putnam, near Lebanon, Tenn., has been discovered in Southern Illinois.

On the whole, the results, considering the time the parties have been at work, are very satisfactory, and will have a very important bearing on the question, Who were the mound builders, and what is the age of the mounds?

Professor Thomas made an examination of some groups of mounds in Southern Illinois and Southeastern Missouri.

Further successful explorations were conducted in New Mexico and Arizona, under the immediate superintendence of Mr. James Stevenson. Mr. Victor Mindeleff was in charge of a party which made extensive collections in the province of Tusayan, in Arizona, supplementing the large collections obtained in previous years from twenty or more pueblos in New Mexico. The collections obtained by these expeditions have been deposited, with proper arrangement, in the National Museum, and have been catalogued and described. The field work, with special reference to linguistic research, has been performed by Mr. James C. Pilling, who visited several missions along the St. Lawrence and Ottawa Rivers, examining many manuscripts and procuring numerous titles in connection with linguistic bibliography; by Mrs. Erminnie A. Smith, who continued studies on the Iroquoian dialects at St. Regis, Caughnawaga, &c.; by Mr. A. S. Gatschet, who, among the Shetimasha and other tribes in Louisiana, and by Rev. J. Owen Dorsey, who, among the Kansas in Indian Territory, studied the respective languages.

The visitors to the three last-named regions also pursued other branches of ethnic research, including social organization, traditions, and customs; and Dr. W. J. Hoffman was engaged in investigations in gesture language and pictographs among the several Indian tribes of California and Western Nevada. The highly valued researches of Mr. F. H. Cushing among the Zuñi pueblos have been continued, several months of the year, however, being occupied by his conducting a delegation of six of those Indians to the East, a course which was important to his further success.

Publications.—Several publications have been issued by the Bureau during the year, as follows:

The First Annual Report, embracing the fiscal year 1879-'80, the contents being: On the evolution of language, by J. W. Powell; Sketch of the mythology of the North American Indians, by J. W. Powell; Wyandot government, by J. W. Powell; On limitations to the use of some anthropologic data, by J. W. Powell; a further contribution to the study of the mortuary customs of the North American Indians, by Dr. H. C. Yarrow; Studies in Central American picture writing, by Prof. E. S. Holden; Cessions of land by Indian tribes to the United States, by C. C. Royce; Sign language among North American Indians, by Col. Garrick Mallery; Catalogue of linguistic manuscripts in the library of the Bureau of Ethnology, by J. C. Pilling; Illustration of the method of recording Indian languages, from the manuscripts of Messrs. J. O. Dorsey, A. S. Gatschet, and S. R. Riggs.

Vol. IV, Contributions to North American Ethnology, containing: Houses and house-life of the American aborigines, by Lewis H. Morgan.

Vol. V, Contributions to North American Ethnology, containing: Observations on cup-shaped and other lapidarian sculpture in the Old World and in America, by Charles Rau; On prehistoric trephining and cranial amulets, by Dr. Robert Fletcher, U. S. A.; A study of the manuscript Troano, by Cyrus Thomas, with an introduction by Dr. D. G. Brinton.

The papers prepared for the press and in whole or part printed during the year, though not issued therein, are as follows:

To appear in the Second Annual Report: Myths of the Iroquois, by Erminnie A. Smith; Animal carvings from the mounds of the Mississippi Valley, by Henry W. Henshaw; Navajo silversmiths, by Dr. Washington Matthews, U. S. A.; Art in shell of the ancient Americans, by William H. Holmes; Illustrated Catalogue of the collections obtained from the Indians of New Mexico and Arizona in 1879, by James Stevenson; Illustrated catalogue of the collections obtained from the Indians of New Mexico in 1880, by James Stevenson.

About 500 pages were put in type of Mr. James C. Pilling's Bibliography of American linguistics, containing many fac-similes of titles,

syllabaries, &c. Part 1 of Vol. II of Contributions to North American Ethnology, consisting of the Klamath-English dictionary, by Mr. A. S. Gatschet, with grammatical notes, was put in type; also over 500 pages of Rev. J. Owen Dorsey's ϕ egiha language, and 400 pages of Rev. S. D. Riggs' Grammar and dictionary of the Dakota language, which will appear in Volumes 6 (in three parts) and 7 (in two parts) of the last-mentioned series.

The papers prepared and intended for the Third Annual Report are as follows: Introduction to the study of tribe government, by J. W. Powell, as an introduction to the three following papers, viz: The Muskoki confederacy, by J. W. Powell; The government of the Omahas, by Rev. J. Owen Dorsey; and the government of the Zuñis, by F. H. Cushing; Introduction to the study of pictographs, by Col. Garriek Mallery; On certain Maya and Mexican MSS., by Prof. Cyrus Thomas; The art of weaving among the Navajos, by Dr. Washington Matthews, U. S. A.; An illustrated catalogue, by W. H. Holmes, of Mr. James Stevenson's collection from Zuñi and Walpi; and two other miscellaneous collections. Mr. Gatschet has also furnished a paper on the chief deities of the American Indians.

Work not yet sufficiently complete for immediate publication has been continued by Mr. Gatschet in the synonymy of the tribes of North America; by him and Colonel Mallery, on an ethnographic chart of the distribution of those tribes when first met by Europeans; by Mrs. Erminnie A. Smith, on a vocabulary and grammar of several Iroquoian dialects; by Mr. H. W. Henshaw, on Indian industries; by Dr. H. C. Yarrow in completion of his monograph on Mortuary Observances; and by Prof. O. T. Mason, on Indian industries. Colonel Mallery has been engaged in completing a monograph on sign language, and collecting the materials for another on pictographs, these two closely connected subjects comprising the direct visible expression of ideas, of which the signs are transient and the pictographs the permanent expressions. Mr. Victor Mindeleff prepared a relief model of the pueblo of Zuñi, on the scale of one (1) inch to five (5) feet, which is now in the National Museum and is an object of great interest.

During the year many linguistic MSS. were received from various collectors.

UNITED STATES GEOLOGICAL SURVEY.

In accordance with the practice of the Institution to supply an annual account of the work of the United States Geological Survey, the following brief summary, is given, furnished by the courtesy of its Director, Maj. J. W. Powell:

Of the three phases which the field work of the Survey assumes, the collection of representative rocks, minerals, and fossils is more directly and manifestly contributory to the Institution and the Museum

under its care, than the topographic and stratigraphic work; but the whole possesses interest as being part of a common endeavor to develop and disseminate scientific truth.

Among the operations of the Survey that may be cited in this connection are the following:

Field studies upon the much discussed Laramie group have been prosecuted in Eastern Montana and Northeastern Dakota, covering particularly a belt of about 80 miles along the Upper Missouri, and upwards of 100 miles adjacent to the Yellowstone, resulting in large collections and important stratigraphic data. Similar combined stratigraphic and paleontologic investigations have been in progress upon the paleozoic series of the Eureka and Pine River districts of Nevada, with a view to the more certain determination of the stratigraphy of those important mining regions. The exploration of the interesting ancient lake deposits of the Great Basin has been continued, the silts of the ancient Lake Lahontan being the special subject of study. The Permian and Carboniferous strata of Northern Arizona, in the vicinity of Kanab, have been further examined, and important collections made from them.

One of the more significant subjects of exploration was furnished by the Grand Cañon group, an immense series of 12,000 feet thickness, now demonstrated to lie between the upper Cambrian and the crystalline Archæan rocks. Beside critical stratigraphic work, a large collection, involving a problematic organic form, was made, which yet awaits exhaustive study. The investigations in the great mining districts of Colorado and Nevada have been continued, with a view to supplementing and perfecting the data previously gathered and the extension of the work to new ground.

Investigations have likewise been in progress upon the great metaliferous series of the Lake Superior region, including the practical completion of the work upon the copper-bearing formation, as at present planned, and the commencement of that upon the iron-bearing series.

In the interior basin, a special study of the great moraines that mark the limit of the second glacial advance, and constitute datum lines of great importance in glacial studies, has been in progress, and about 3,000 miles of an essentially continuous morainic chain are now mapped.

In addition to these more comprehensive studies, special collectors have been in the field, gathering fossils from localities of exceptional richness, or from critical and decisive horizons. Among these have been the collections of Tertiary fossils, especially vertebrates, from Oregon, and of Jurassic and Eocene remains from Wyoming. A special effort has also been made to secure a full representative collection from the marine Tertiary beds of the Lower Mississippi Valley.

Triangulation and topographic work, preparatory to geologic investigation, has been prosecuted in the quicksilver districts of New Alpa-

den, New Idria, Knoxville, and Sulphur Bank, California, and also in the northern part of that State. Similar work has been done in Western New Mexico, in Southern Montana, in Central Colorado, in Western and Northwestern Nevada, and in the Appalachian region. In the last district, portions of Southwestern Virginia, Eastern Kentucky, Western North Carolina, and Eastern Tennessee have been covered by primary triangulation and topographic contours.

Some minor investigations have received attention, and an unusual amount of office and laboratory work, upon previously gathered material and in preparation for further studies, has been in progress.

UNITED STATES FISH COMMISSION.

General Object and Results.—Twelve years ago the United States Fish Commission was established by law of Congress, and under a provision authorizing the President to select a Commissioner from among the civilian employés of the Government, to serve without additional pay, I was chosen and have continued to hold the position ever since. The work, commencing on a very small scale in the year mentioned, has broadened until it has now become the most important and extensive of its kind in the world; and it is hoped that the practical results gained have vindicated the propriety of the initial experiment as well as of continuing the work to such a period of time as the case may require.

First as Assistant Secretary of the Smithsonian Institution, and then as its Secretary, it has been my duty to show to the Board of Regents the occasion and reason for the occupation of a considerable portion of my time, and thus to add not an uninteresting chapter to the report of the Smithsonian Institution.

A detailed report of the doings of the Commission is published annually by order of Congress; that of each year constituting a volume of nearly one thousand pages, with a considerable number of illustrations. In addition to this a Bulletin of the Fish Commission has been authorized by Congress, to contain short articles of information and instruction in reference to matters of fish culture and the fisheries. This is restricted to five hundred pages annually; and this, with the annual report, forms an annual contribution to practical science on the part of the United States Government of nearly fifteen hundred pages. For the more speedy dissemination of the information furnished in the Bulletin, it is distributed to specialists in fish culture and the fisheries, and to the leading newspapers, so that the facts come fresh from the press, and are largely reproduced in the serial literature of the day. Two volumes of the Bulletin (for 1881 and 1882) have now been published.

The Smithsonian report for 1881 gave an account of what had been done by the United States Fish Commission during that year, and the

general facts for 1882 are not materially different, except to some extent in regard to the scale of operations.

By act of Congress the work of the Commission is divided into two subjects: (1) the investigation into the condition of the fishery and the search for improvements in the methods and products of the fisheries; and (2) the multiplication and dissemination of the more important species; the first representing what is known as the *inquiry* branch of the Commission, and the second that of *propagation*.

As the subject of the investigation of the fisheries was that first intrusted to the Commission by Congress in 1871—that of the multiplication of fish not being authorized until the succeeding year—it has generally been customary to take up the two divisions in that order. The method of this inquiry has been to visit successively the principal points along the coast of the United States where research can be prosecuted, establishing stations for a season to study very carefully the nature and distribution of the animal life, the character of the water as to temperature, salinity, currents, &c., and the general facts in regard to methods of prosecuting the fisheries. In this manner, in the course of successive years, the minute details or conditions of the marine life of the Atlantic coast, and to a considerable extent that of the Pacific and the Gulf of Mexico, have been worked out either through the establishment of the stations referred to or by sending special experts of the Commission for the purpose. The general results of these investigations are to be found partly in the published reports of the Commission, partly in those still in press, and to a very large degree in the special reports prepared by the Commission for the census of 1880. A quarto report, ordered by Congress and now in press, will contain a large amount of original information in regard to the natural history and condition of the fishes and useful invertebrates of the ocean, lakes, and rivers, illustrated by numerous well-executed figures.

The approximate completion of the inshore research has allowed the Commission to undertake more fully an examination of the deep seas; and a systematic survey is now being made of the grounds where fishermen have hitherto plied their vocation, with a view of determining the extent and condition of the fishing banks, and also to find out what additional localities heretofore undiscovered yet remain to reward the labors of the "toilers of the sea." Much success has already been experienced in this latter respect, and new and extensive ranges for the prosecution of their vocation have been opened up. It is believed, however, that much yet remains to be done, and it is hoped that in succeeding years areas of important fishing ground of great extent will be brought to light, especially in the South Atlantic and the Gulf of Mexico.

For the better prosecution of this latter research Congress authorized the construction of a first-class sea-going vessel, and in March, 1882, the contract was awarded to Messrs. Pusey & Jones, of Wilmington, Del., for an iron vessel 200 feet long on the water line, 27 feet beam, and

of about 1,000 tons of displacement. Lieut. Z. L. Tanner, U. S. N., at the time in charge of the steamer "Fish Hawk," was assigned to the duty of the superintendence of its construction, and subsequently to its command. The vessel was actually completed in December, 1882, and started on its trial trip to Washington on the last day of the year, arriving in Washington a few days later. This trip, while bringing to light some points in which alterations and improvements were necessary, presented a very remarkable success in all essential respects, the boat being extremely stable in the sea-way and promising to answer admirably the purpose of her construction.

After receiving in Wilmington the necessary alterations the vessel returned to the Washington navy-yard, and is now being fitted out for her first trip off the Middle Atlantic coast. It is proposed to devote the early spring to the special investigation of the movements and habits of the mackerel and menhaden, with a view of facilitating the search for these fish on the part of the many fishing vessels of the Atlantic coast.

The establishments of the Commission, summer by summer, at different points on the coast have been already referred to. As this inshore survey may be considered as practically completed, it was thought desirable to establish a permanent station at some convenient point on the coast, from which the vessels of the Commission could extend their researches to distant points of the ocean, and to which they could return for the delivery of their collections and material, and for a permanent harbor. Wood's Holl, on the south coast of Massachusetts, was chosen for this purpose, as it offers a convenient center at which to carry on the work of hatching the sea fish, such as the codfish, the mackerel, halibut, and other species on a large scale. For this purpose a point on the Great Harbor was selected, on which it is proposed to construct the necessary buildings. There being no appropriation by Congress available for the purpose, liberal friends of science, desirous of seeing the Commission established at Wood's Holl, contributed the necessary funds to purchase the land and presented it to the United States; and in addition to this a large tract of ground forming a part of the water line was presented by Mr. Joseph S. Fay, so that the control of the Commission was assured over all parts of the shore of the Great Harbor where there was any danger of erection of buildings or factories likely to emit poisonous refuse inimical to the work of the Commission. It is hoped that the next report will chronicle the successful occupation of this station for the purpose in question.

By the courtesy of the Light-House Board, the laboratory buildings on the light-house wharf at Wood's Holl were made use of, as in previous years; and the "Fish Hawk," under command of Captain Tanner, made numerous visits to the adjacent off-shores, bringing in many interesting collections. The most noteworthy result was the ascertaining of what appeared to be the entire destruction of the tile fish (referred to

in the last report) over a large part of its northern range; this in consequence, as is supposed, of the killing of the fish by cold currents extending beyond their usual limitations. This suspected destruction was suggested by the discovery of millions of these fish found dead and floating out in mid-ocean without any apparent indication of disease.

The usual scientific research was continued during the summer at this station, and, as heretofore, large numbers of duplicate specimens of natural history were collected for distribution to the colleges and academies throughout the country. Of these, two hundred sets are in preparation and will be distributed to that number of applicants. This policy on the part of the Commission and the Smithsonian Institution is thoroughly appreciated by friends of education throughout the country as furnishing material for instruction in the way of objects themselves, and making it unnecessary to depend upon imperfect figures and descriptions.

The work of the Commission in the way of propagation of food-fishes was continued in 1882 on a scale larger than that of previous years. The general work of the season may be considered as commencing with the shad in April, and was carried on for the most part with the two stations of Washington and Havre de Grace as centers. On the Potomac River the practice of the Commission is either to keep men permanently stationed at the different landings or to send them every day to attend to the haulings of the seines, so that the ripe fish may be taken as they are brought in, the eggs stripped from them and immediately fertilized by the milt from accompanying males. The eggs are then either transferred to the "Fish Hawk," as a floating station, or sent to the hatching station at the navy-yard, or to the central station in Washington, heretofore known as the Armory.

Near the close of the season of shad-hatching on the Potomac the "Fish Hawk" was sent to the Susquehanna River at Havre de Grace, to renew her work. What is known as Battery Station, the permanent establishment of the Commission, about five miles below Havre de Grace, was also in full operation. Here the experiment was first made by the Commission of catching its own shad by hauling a seine from Battery Island. The result was very satisfactory and gives much promise for the future. The experiment was also initiated of placing partly unripe fish in a pond on the island until the eggs were sufficiently matured to permit their being stripped.

The young shad as taken at the stations mentioned were forwarded by the special cars of the Commission to different parts of the United States and were planted in many rivers which it is hoped will in time become the seat of important fisheries, this distribution including both the fresh-water herring and shad. The total number of shad taken and distributed during the season amounted to over 30,000,000. This added to nearly 170,000,000 hatched and distributed in previous years represents a very important aggregate,—about 200,000,000 of shad planted in suitable waters.

A formal request from a large number of the members of the legislature of New York, made through the Hon. Frank Hiscock, for the service of the Fish Commission in adding to the supply of shad in the Hudson River, was responded to by sending an entire car-load of the young fish and depositing them in the vicinity of Albany.

Next in importance to shad, and perhaps of even greater promise for the future is the carp, the distribution of which has continued on a very large scale. It has seemed almost impossible to supply the demand, coming as it does, from every county of every State in the Union. All the resources of the Commission are taxed from the first of October until the first of April or even May in sending out the fish in response to requests, and very many thousands of ponds are now stocked with this fish. Its distribution is made partly by express, partly by sending a certain number in charge of special messengers; but the most important mode is by shipment in cars especially constructed for the Commission for the purpose. In these as many as 20,000 carp can be loaded at a time and carried with perfect safety even as far as California and Western Texas, the fish being delivered to applicants who have been authorized to apply for them. So far it has been impossible to meet the demand, and it will probably be many years before the carp are so thoroughly introduced as to render further action of the Commission unnecessary. The calls are loud, and equally strong from Washington Territory, Texas, and Florida as they are from points much nearer home. It is quite safe to say that more than 15,000 ponds have been constructed in the United States especially for the purpose of receiving the fish bred by the Commission. The promise of the carp as an article of food is very great, and the fish is considered entitled to rank among the domesticated animals and to be capable of as profitable cultivation as poultry or pigs, feeding as it does on the same vegetable matters and making a considerably larger amount of flesh with the same materials.

The operations in connection with the California salmon have not been carried on, on as large a scale as usual, in view of the fact that the fish does not seem adapted to the Eastern waters. A few have been distributed east of the Rocky Mountains, but the experiment has proved less satisfactory than had been expected. The several millions placed every year in the Sacramento River have, however, maintained the abundance in that stream to a remarkable degree; and it is believed that at no time since the occupation of the country by the Americans has the yield been greater.

The work with the Penobscot salmon has continued to be very satisfactory. A large number of fish hatched out have been planted for the most part in the streams of Maine, New Hampshire, Vermont, Massachusetts, Connecticut, New York, and Pennsylvania, in waters believed to be best adapted to them. The supply of the salmon in the rivers of Maine, formerly almost exhausted, has greatly increased and is rapidly assuming very large proportions. The other States, less adapted, as

they are, to the growth of the fish, will doubtless yield a fair average or result. The land-locked salmon—a favorite variety of fish—is also bred in large numbers and distributed for the most part in lakes in the States mentioned, as also in Minnesota, Michigan, Iowa, and other portions of the West.

The economical importance of the whitefish of the Great Lakes is fully recognized by the Commission, and the measures begun a few years ago to multiply it have been largely expanded during the year.

The State of Michigan has been the seat of operations in this direction, and the work is in charge of Frank N. Clark, at Northville, Mich. To this station for several years the eggs collected in the adjacent lakes have been brought, and developed to a degree—either hatched out entirely or prepared for shipment to other points. During 1882 a second station was established at Alpena, Mich., and about 70,000,000 of eggs collected in the two establishments. These are now in process of hatching, and while a considerable number will be distributed to various parts of the United States, by far the greater portion will be planted in Lakes Michigan, Huron, Erie, and Ontario, where they cannot but exercise a material influence upon the supply.

The California trout has also received the attention of the Commission. The idea of multiplying it in the East was first suggested by Mr. Seth Green, of the New York commission, who several years ago took a number of the fish to Caledonia Spring, from California, and has since been distributing them in behalf of the State. As the benefits of this work were confined to the State of New York, it was thought best for the Commission to extend them, and several years ago a station was established on the McCloud River, a few miles from the California salmon station, and sub-stations were also started in connection with the establishment of Mr. Clark at Northville, and at the Virginia State hatchery at Wytheville. By this means of multiplication it is expected that large numbers of the eggs and young fish will in time be available for distribution.

The special merits of the California trout consist in its rapid growth and in its ability to resist extremes of temperature which would be fatal to the ordinary brook trout.

Very little beyond experimental work was done with the codfish in 1882. At the suggestion of Mr. E. G. Blackford, of New York, an effort was made to utilize the living spawn of cod brought into the Fulton Market during the late autumn and winter; but the impurity of the water of East River was such as to render it impossible to carry on the work on a large and successful scale. A considerable number of eggs, however, were taken and fertilized, and the fish in large part planted in the Chesapeake Bay as an experiment in stocking that body of water. As soon as the hatching station at Wood's Holl is completed, it is proposed to resume this work on a very extensive scale by catching the nearly ripe fish and placing them in basins at the station until they are

mature, when the eggs will be stripped and hatched in the exceptionally pure water of the harbor.

As in previous seasons, the Commission has to acknowledge the universal favor with which it has met on the part of presidents, managers, and superintendents of railways and steamboats, the various branches of the Government and individuals generally. The formal acknowledgments and details of this courtesy will be found in the report of the Commission. The usual experiments have also been made of the transmission of the eggs of salmon, whitefish, and other species of fish to various portions of Europe, in return for which we have received specimens of Salmonidæ as well as some of the later and improved varieties of German carp.

Bulletin of the Fish Commission.—During the last session of Congress an act was passed (approved February 14, 1881) instructing the Public Printer to print and stereotype, from time to time, the regular number of 1,900 copies of any matter furnished him by the United States Commissioner of Fish and Fisheries, relative to new observations, discoveries, and applications connected with fish-culture and the fisheries, to be capable of being distributed in parts, and the whole to form an annual volume or bulletin not exceeding 500 pages. The edition of this annual work is to consist of 5,000 copies, of which 2,500 are for the use of the House of Representatives, 1,000 for the use of the Senate, and 1,500 for the use of the Commissioner.

Fishery Census of 1880.—The reports of 1880 and 1881 contain details in regard to the co-operation between the United States Fish Commission and the Census of 1880, under charge of Superintendent Francis A. Walker, in collecting the statistics and history of the fisheries of the United States in past years up to the present time. The result has been the accumulation of a large mass of important information of very great value.

The report of 1881 gives an account of the special work of the gentlemen employed for this purpose, and during the year 1882 the reports mentioned below were published, leaving quite a number still to appear as among the series of special reports of the Census.

A number of other reports on fishes, of much interest but of less relationship to the work of the Census, were presented to Congress by the Commission, and their publication ordered in a series of quarto volumes. Of these the first is well advanced and will be out in the course of the year 1883. It is more particularly occupied by an account of the economical and natural history of the food-fishes and invertebrates of the country, with the necessary illustrations.

Another of these reports will include figures and descriptions of all the obsolete as well as more modern forms of apparatus for the pursuit, capture, and utilization of the inhabitants of the waters, together with a very minute account of the apparatus of the whaler.

The great London International Fisheries Exposition.—The success of the Berlin Fishery Exhibition in 1880, and those of Norwich in 1881 and Edinburgh in 1882, induced a number of gentlemen in England to propose an exhibition in London in 1883, that should far surpass any of its predecessors. The necessary arrangements were made, and invitations extended to the United States to participate. This was favorably responded to by an enactment of Congress appropriating \$50,000 for the purpose, and requiring the United States Commissioner of Fish and Fisheries, under the direction of the Secretary of State, to take the necessary measures toward participation by the United States in the display in question. The work of preparation was placed in the hands of Mr. G. Brown Goode, who, with the help of the gentlemen who have been trained for the work by the Census investigations, and of the assistants in the National Museum, and the United States Fish Commission, made every possible effort to secure a satisfactory competition on the part of the United States. Much important material was already on hand, partly gathered for the Fisheries Exhibition at Philadelphia in 1876, partly for that of Berlin in 1880, and to a considerable extent representing the general and incidental gatherings of the Fish Commission.

The exhibition in question will open early in May, 1883, and it is hoped that the report of the result will be as satisfactory to the pride of every American as was that of the Exhibition at Berlin already referred to.

Respectfully submitted,
SPENCER F. BAIRD,
Secretary of the Smithsonian Institution.

APPENDIX TO THE SECRETARY'S REPORT.

CORRESPONDENCE ON ASTRONOMICAL ANNOUNCEMENTS.

In presenting a portion of the correspondence of the Institution with leading astronomers, relative to methods suggested for rendering the telegraphic announcement of astronomical discoveries as free from ambiguity as possible, it seems proper to preface these extracts with a brief notice of the form previously adopted by European observatories in communicating such information between themselves. The Smithsonian system of *transatlantic* or cable telegraphy, introduced in 1873, may be regarded as essentially an extension of this earlier and more local practice. In acknowledgment of the active zeal and assistance of Dr. C. H. F. Peters, of the Clinton Observatory, in establishing the Smithsonian enterprise, much deference has been paid to his judgment in all doubtful questions.

Letter from Prof. F. Karlinski, director of the observatory in Cracow, November 23, 1865.

(Published in the *Astronomische Nachrichten*, Vol. 65, cols. 31, 32.)

It will perhaps not be superfluous if some form should be given in the *Astronomische Nachrichten*, in which we can unite in the telegraphic announcement of astronomical observations, in order that the information may be condensed and still be perfectly and generally intelligible. Our signs \circ ' " , as well as h. m. s., can, of course, not be telegraphed, but to write them out in full makes the dispatch too long. The conversion of the times of observation as expressed in hours, minutes, seconds, into decimal parts of the day, as well as the expression of right ascension and declination in degrees and decimals, can easily lead to errors, and further necessitates a reconversion after the reception of the dispatch. To me it seems that it would be simplest if we agree to give not only the mean local time of observation but also the right ascension and declination by means of 7 or 8 places of figures, of which the first two indicate the number of the hours or degrees of declination, the next two the number of minutes, the next two the number of seconds, and the remaining figure the number of tenths of a second.

The words "right ascension" and "declination" may be entirely omitted and replaced by "northerly," "southerly."

Thus, for example:

"Altona Sternwarte 85 November 22 Krakau 0604597 scheinbar 00430620 nordlich 0247240 Karlinski" would be translated as follows:

“November 22d, 6^h 4^m 59.7^s Cracow mean time. Minor planet No. 85. Apparent right ascension 0^h 43^m 6.20^s. Apparent declination +2° 47' 24.0”.

And this would be entirely expressed in twelve words. Thus, there would remain still eight words for other items, such as the daily motion, brightness, &c., if the whole dispatch is to be kept within twenty words.

However, I leave the perfecting of this form entirely to your views, without desiring to push any project of my own.

Notification by the Imperial Academy of Vienna, December 6, 1869.

(Published in the *Astronomische Nachrichten*, No. 1785, col. 142.)

The telegrams by which the Imperial Academy announces the discovery of a new comet to the various observatories will hereafter be written in an abbreviated form and in general according to the proposition of Professor Karlinski.

The dispatch will contain: first, the word *comet* then the name of the *discoverer*; next the *date* will be given and then the local mean *time* of the position in four consecutive figures, of which the first two indicate the hour and the last two the minute, so that the missing tens for the hour as well as for the minutes will be indicated by *zeros*. Then the *place* of the discovery will be given, followed by the *right ascension in arc*, expressed by means of five figures, of which three indicate the degrees and the next two the minutes, while the missing tens and hundreds will be, as before, shown by the zeros.

Then follows an interval, and, after it, the *polar distance* represented in five figures, of which three indicate the degrees and the last two the minutes, and in which again all the missing figures have their places filled by zeros. The *motion*, to be finally given, is always understood to be daily motion in minutes of arc, first the motion in right ascension and next that in declination, each to be preceded by the sign or word *plus* or *minus*.

The conclusion of the dispatch is to be formed of some words that refer to the external appearance of the celestial body. If, still, an additional figure follows them, this will describe the diameter of the comet in minutes of arc.

The dispatch will be signed “Akademie.” For example, the following telegram from the Academy:

Comet Tempel three November nought nine nought nine nought nought Marseilles three four one nought five. Nought seven five four four bewegung plus six minus twenty four helle kern five Akademie” would be translated as follows:

“Comet discovered by Tempel. On the 3d November, at 9^h 0^m Marseilles meantime, the position is right ascension 341° 5' and north polar distance 75° 44'. The daily motion is +6' in right ascension and -24' in polar distance. Bright nucleus. Diameter of the comet, 5'.

(Signed)

IMPERIAL ACADEMY of VIENNA.”

Letter from the Royal Observatory, Greenwich, October 15, 1879, to the Secretary of the Smithsonian Institution.

SIR: In the telegrams announcing the discovery of comets and minor planets, for which we have to thank you, the Astronomer Royal has frequently found a difficulty as to the date of discovery and the date to which the position given refers. The former is of less importance, but the uncertainty as to the latter has frequently caused much delay in picking up a quick moving body such as a comet.

The Astronomer Royal would therefore suggest that the day of the month, and Washington mean time, to which the position given refers, should be in every case inserted just before the R. A. and Dec. (the magnitude being put at the end of the telegram to avoid confusion).

Thus the telegram just received would run (supposing the position of the planet to be given for Oct. 13, 14^b Washington mean time): "Planet Peters Clinton thirteenth fourteen hours one nought north one twenty motion five south eleventh."

The Astronomer Royal trusts that you will not find any difficulty in making this small addition, which will greatly increase the value of the announcements.

I am, sir, &c.,
W. H. M. CHRISTIE.

Letter from the Smithsonian Institution to Dr. C. H. F. Peters (Clinton, N. Y.), November 4, 1879.

DEAR SIR: The Astronomer Royal of England asks that hereafter, in astronomical announcements, the hour of discovery in Washington time be given.

The Naval Observatory here requests that *local* time of discovery be stated, and that seconds of right ascension be always given.

What would you advise us to instruct observatories in these particulars?

Very truly, yours,
S. F. BAIRD.

Letter from the Litchfield Observatory of Hamilton College (Clinton, N. Y.), November 8, 1879, to the Secretary of the Smithsonian Institution.

DEAR SIR: In reply to yours of 4th inst., regarding the demands of observatories for certain changes in the dispatches of planet discoveries, I take the liberty to make the following remarks. These remarks are, in substance, the same I wrote a short time ago to Prof. Tietjen, of the Berlin Observatory, who proposed as a desideratum similar alterations.

First, as to that the *hour* of discovery be stated, by which I suppose the time for the position communicated is meant, the answer is that such *is* done and has been done always in our dispatches. It is included in the way prescribed (but overlooked or forgotten) in the programme that was issued at the time by the Smithsonian Institution (Smith. Miscel.

Coll'ns, 263). There Art. IV states distinctly: "The right ascension and declination in the dispatch will be understood to give the position (by proper motion approximately reduced) for the *midnight following* the date of the dispatch, Washington time for American discoveries, Greenwich time for European."

If this be borne in mind, it seems unnecessary to burden the dispatch by additional figures, indicating a local time.

Still further, it seems unnecessary to add the daily motion in right ascension. This, for the minor planets between Mars and Jupiter in opposition, we know is always negative—the planets are retrograde—and the numerical value of it will be in the neighborhood of 45^s or 50^s . Taking into account the distance from the equator, the position of the ecliptic, and the motion in declination, a little reflection will easily decide whether to assume a smaller or a larger value sufficiently near for knowing the run in a day or two.

The request of giving with the right ascension also the *second of time* assumes that the discoverer himself knows it, that he has followed up the planet for at least 24 hours, and hence the motion has become known to him with accuracy. But this is usually not the case, as on the other hand it is desirable that the discoverer make the announcement immediately after the first night. The daily motion, consequently, is concluded from single comparisons extending perhaps over an hour, whereby the unavoidable errors are multiplied by a factor greater than 24. The seconds added to the right ascension, therefore, would be only illusory.

When the nearest full minute is given, so that the uncertainty is $\frac{1}{2}$ minute, this seems indeed also sufficient for recognizing the planet. It will be among the stars that are in a field of $15'$, and by studying with a little patience the configuration of these stars, the one searched for will soon betray itself by its change of place. The apparent motion in right ascension, in most cases, is far surpassing that in declination, so that the inconsistency in giving the declination to a minute of *arc* and the right ascension to a minute of *time* only is not so great as might seem. Nevertheless, if found desirable, it is possible to narrow the limits of uncertainty in the right ascension to one-sixth by the addition of only one word more in the dispatch, giving the nearest round tenth number of seconds. And this is the only alteration I should be willing to recommend in the form of the dispatch.

To resume, I suggest, then :

1. The local time (or its equivalent) is to be presented and looked for as before, in conformity with Art. IV of the Smithsonian programme.

2. To give the daily motion in right ascension seems superfluous.

3. After the minute of right ascension to be inserted one of the words, "ten," "twenty," "thirty," "forty," or "fifty," indicating the round tenth of seconds (if *no* word follows, the second is understood to be *zero*).

Thus, taking the example in the Smithsonian Miscellaneous Collections referred to, it might read:

“Planet twenty three thirty five ten north, &c.” *i. e.*, in $23^{\text{h}} 35^{\text{m}} 10^{\text{s}}$ of right ascension, &c.”

Besides the convenience to observers, also consideration ought to be had to the telegraph companies that convey messages free of charge. The first application to the Atlantic Cable Company and which was granted, was made, I remember, for about 10 words in each dispatch and for 12 dispatches as a maximum in the year. When, of late, both of these figures usually have been transgressed we owe the more thanks to the liberality of the company silently acquiescing. But this should be the more reason to use the privilege granted with modesty; (Professor Tietjen proposed even that a second dispatch after 3 or 4 days follow the first;) and I believe the form stated in the Smithsonian programme (with the slight modification now suggested above) as precise and as complete as can be desired.

Permit me, dear sir, to take this occasion for reiterating the assurance of the gratitude the astronomical world bears towards the Smithsonian Institution for the acceleration of intercourse—and believe me, &c., &c.,

C. H. F. PETERS.

Letter from the Secretary of the Smithsonian Institution, November 26, 1879, to Mr. W. H. M. CHRISTIE of the Royal Observatory, Greenwich.

DEAR SIR: In answer to your esteemed favor of October 15 we beg to say that by the original programme adopted by telegraphic announcements of astronomical discoveries, the position given in the dispatch is understood to be that for the midnight following the date, Washington time for American and Greenwich for European discoveries. This seemed to us to render it unnecessary to state local time of discovery. We however referred the matter to Professor Peters, who takes the same view as ourselves.

Very respectfully,

S. F. BAIRD.

Letter from the Royal Observatory, Greenwich, December 22, 1879, to the Secretary of the Smithsonian Institution.

SIR: With reference to your letter of November 26 respecting telegraphic announcements of discoveries the Astronomer Royal requests me to say that there seems to have been a little misapprehension as to what he desired.

Our difficulty has arisen from the frequent absence of any data whatever on the telegram, and even where this is given from an ambiguity as to whether civil or astronomical reckoning is intended. (This ambiguity occurred in the last two telegrams respecting comets discovered by Lewis Swift—in the last the position given appears to have referred

to the date of discovery instead of to the midnight following the date of the dispatch five days later.)

If you could kindly give the *date* of the *dispatch* our difficulty would be entirely removed, it being understood that the convention that the position given should refer to the following Washington midnight will be carried out in the case of comets as well as of minor planets.

As mentioned in my former letter, the date of discovery is of less importance and may well be omitted.

W. H. M. CHRISTIE.

Letter from the Secretary of the Smithsonian Institution, December 3, 1879, to Lord LINDSAY, Dun Echt Observatory, Aberdeen, Scotland.

DEAR SIR: I am in receipt of your circular of the 1st of November, asking for the transmission of information respecting the occurrence of comets and other astronomical phenomena; and I beg to inquire whether the present arrangements, established some years ago by my predecessor, Professor Henry, do not answer your purpose. These consisted in an arrangement with the inland and ocean telegraph companies, by which all discoveries of this kind made in America were transmitted by the Smithsonian Institution to certain observatories in Europe, from which it was supposed they would be forwarded to the more important observatories within their respective districts.

In return, these same observatories transmit similar information to Washington, which is then sent to a specified list of establishments here and also published in the telegraphic dispatches of all the daily papers in the country.

As you will observe, the observatory at Greenwich receives these dispatches from Washington for Great Britain, and I would suggest that arrangements be made with the Astronomer Royal for immediate transmission of all such information to your observatory.

Everything noteworthy in the line of astronomical discovery is at once sent to him.

If you prefer to have a dispatch direct to Aberdeen, I will see what can be done in regard to it, although the telegraph companies, which perform this service gratuitously, only allow us one station in each country.

Very respectfully,
SPENCER F. BAIRD.

Letter from the Observatory, Dun Echt, Aberdeen, December, 1879, to the Secretary of the Smithsonian Institution.

DEAR SIR: I am instructed by Lord Lindsay to thank you for your letter and inclosure of December 3, in reply to the Dun Echt circular of November 1, asking for information respecting the occurrence of comets, &c.

Referring to your letter his lordship wishes me to explain that the scheme which he is endeavoring to carry out is the collection of notices of discoveries of the character indicated from the whole world, in order to distribute them directly amongst observers in the British Islands. In doing so it is intended to supply information to every owner of a telescope in these islands who communicates an address for the purpose, more especially to all those amateurs who may not be in communication with a government observatory. I may add that, in this special endeavor to aid the owners of small observatories, Lord Lindsay published and distributed the summary of Struve's *Mensuræ Micrometricæ*, a work which has already greatly facilitated the observation of double stars, nor has it been found useless in observatories of the first rank. In proof of this, it may be mentioned that it served as a working list for the admirable labors of Professor Pickering and his adjuncts at Harvard College in sidereal photometry.

From the papers you inclose it is evident that the arrangements of the Smithsonian Institution guarantee the certain intercommunication of astronomical discoveries between the United States and five European government observatories. This still leaves a large field unoccupied, nor does it seem to provide at all (at least in Europe) for the distribution of information from the transmitting end. I would point out, for example, that the news of Schmidt's new star in the *Sican* was but very imperfectly distributed in Europe. Although Dr. Schmidt telegraphed to Herr v. Littrow, at Vienna, within three hours of the discovery on November 24, 1876 (see *Astronomische Nachrichten* No. 2113), we first learned of the star's existence from a daily paper at the close of December. The *Astronomische Nachrichten* published the first account on December 23, and, in fact, the earliest observation possible at Dun Echt was on January 2, 1877. In *Astronomische Nachrichten* No. 2115 Dr. Vogel says that the first news reached him at Berlin on December 3.

From this it would seem that the European part of the Smithsonian scheme is not at present adapted for the distribution of news on this side of the Atlantic, and hence it arose that Lord Lindsay was not aware that the telegrams of the Smithsonian Institution embraced more than the discoveries of minor planets, with a partial recognition of other and possibly more generally interesting phenomena, or that they were intended for general distribution.

Apart from this, the information reaches the bulk of observers in these islands through occasional notes in the public journals, but very rarely in their telegraphic summaries. Nor are such notes always accepted; *e. g.*, it is well known that the "Times" declined all the earlier communications respecting the new star in the Crown.

These reasons led Lord Lindsay to devise a plan for distributing intelligence directly amongst British observers by posted circular, leaving it to corporations or individuals to do the same in other countries if the plan was found worthy of extension. Already the plan has been prom-

ised the aid of astronomers in many countries, and a similar and co-operating scheme is starting in France. Stress is laid on the distribution of information by special circular (or telegram, if particularly desired), as it is found impossible to rely on the daily papers.

Trusting that these explanations will show that the Dun Echt scheme is in no way calculated to take up ground already occupied by the Smithsonian Institution. I am,

Very respectfully,
RALPH COPELAND,
Astronomer at Dun Echt.

Letter from the Secretary of the Smithsonian Institution, January 14, 1880, to Prof. C. H. F. PETERS, Clinton, N. Y.

DEAR SIR: In consequence of the difficulty experienced by many astronomers in interpreting telegraphic announcements of astronomical discoveries, we desire to publish in the forthcoming report of this Institution a circular on this subject, which shall prevent ambiguity and misunderstanding in the future.

We therefore inclose a copy of the original circular, as prepared by yourself, and request that you will insert therein such additions, corrections, and explanations as experience has shown to be necessary.

We also send a letter in the same connection, from the Royal Observatory, Greenwich, which we beg you will return with suggestions for its proper answer.

Yours very truly,
S. F. BAIRD.

Letter from the Litchfield Observatory of Hamil on College, Clinton, N. Y., January 21, 1880, to the Smithsonian Institution.

DEAR SIR: I have, as you requested, considered the different points of the programme for telegraphic dispatches, and, in the suggestions which I submit on the annexed pages as a substitute for pp. 7 and following, I believe that the wishes expressed by various astronomers, especially those of Greenwich, are fully embodied. The closing sentence I added in remembering the inaccuracy of Mr. Swift, by which both assistant Paul of the Washington Observatory and myself lost a whole night in fruitless searches for that comet. However, I beg you to strike out or correct as you please.

If, in your answer to Mr. Christie, you refer to your forthcoming circular, which will meet the demands of the Greenwich Observatory, I think they will be satisfied. With reference to the query about astronomical and civil reckoning, I think the expedient I suggested of using simply the name of the week-day (*e. g.*, "Wednesday") will prove satisfactory, while it adds only one word to the dispatch.

C. H. F. PETERS.

[Accompanying this are the additions to the Smithsonian circular, which have been incorporated in the revised edition.]

Acknowledgment from the Smithsonian Institution, January 27, 1880, to Prof. C. H. F. PETERS, Clinton, N. Y.

DEAR SIR: Please accept our thanks for yours of January 21 relative to changes in circular of announcement of astronomical dispatches.

Very truly yours,

S. F. BAIRD.

Letter from the Smithsonian Institution, February 16, 1880, to Prof. C. H. F. PETERS, Clinton, N. Y.

DEAR SIR: The dispatch from the Astronomer Royal of England appears not to follow the convention for telegraphic announcements, affording another instance of the ambiguity to which we have before alluded and which we wish to correct.

As received by us, it reads:

"Gill telegraphs from Cape Town, comet, twelfth February, 0858 cape 12311, motion plus 235, minus 20. Astronomer Royal."

The 0858 cape we think refers to time of discovery and the 12311 to be a mistake of the operators.

Yours very truly,

SPENCER F. BAIRD.

Letter from the Litchfield Observatory of Hamilton College, Clinton, N. Y., February 19, 1880, to the Secretary of the Smithsonian Institution.

DEAR SIR: You are right; there is certainly a mistake in the dispatch from Cape Town about Gill's comet, five figures having been omitted, but it is impossible to say which—either those indicating the R. A. or those of the North Polar Distance. The telegram, as communicated in your letter received this morning, and which is in the cipher-system proposed years ago by Littrow (but hardly applicable in this country, where by law every figure must be written out in words), can be interpreted in the two following ways:

Comet 12th February $S_h 5S_m$ mean time Cape, R. A. $123^{\circ}11'$, N. P. D. [5 figures omitted], motion $+ 235' = 3^{\circ}55'$ in R. A. $- 20'$ in N. P. D.

Comet [etc.] R. A. [5 figures omitted], N. P. D. = $123^{\circ} 11'$ (*i. e.*, Decl. $- 33^{\circ} 11'$) motion, etc.

Probably some telegrapher between Cape Town and Greenwich or Greenwich and Washington got tired of sending ten consecutive figures; and indeed this system of dispatches has been a source of continual blunders, so that Lord Lindsay (whose assistant Mr. Gill was, before he went to take charge of the Cape Observatory) did wrong in reviving it. The system adopted by the Smithsonian Institution was discussed with the late Professor Littrow, Professor Bruhns, of Leipzig, and others, and has worked to satisfaction so far. It will be still more acceptable to all when the additions lately discussed are introduced, and I would recommend (which, perhaps, also, is your intention) to issue the amended

scheme in the form of a circular to the principal observatories interested in it (perhaps sending a number of copies for distribution to Greenwich, Paris, Berlin, and Vienna).

C. H. F. PETERS.

Letter from Dr. B. A. GOULD, at sea, steamship "City of Montreal," August 27, 1880, to the Secretary of the Smithsonian Institution.

MY DEAR PROFESSOR: I have been about six weeks in Germany, France, and England, and have everywhere found the astronomers greatly perturbed in the matter of astronomical telegrams regarding comets, planets, &c., which, they tell me, almost unfailingly go wrong, no matter how great the care with which they are sent.

Finally, the Germans have agreed upon a system to which they have secured the assent of Admiral Mouchez at Paris, and of the Astronomer Royal. And they have asked me to communicate with you on the subject and obtain your assent, which I told them you would surely give, since the European astronomers are all of accord.

It consists of three principal points:

First. That instead of several transatlantic telegrams to different observatories, the Smithsonian should send only one, viz, to Professor Krueger, the new director of the observatory at Kiel and editor of the *Astronom. Nachrichten*. He undertakes to communicate the same telegram instantly to all the European astronomical centers, at the expense of the *Astronomische Gesellschaft*, if necessary.

Secondly. That a second similar telegram should be forwarded next day, or as soon as a second observation of the body has been obtained, thus making only two trans-atlantic telegrams in all.

Thirdly. That for these telegrams a special code should be used, which they have sent me, and which they all recommend. - - -

B. A. GOULD.

Proposed mode of transmitting notices of the discovery of comets, asteroids, &c., across the Atlantic.

1. Only one dispatch to be sent at a time. This, if for Europe, to be addressed to Professor Krueger at the observatory in Kiel; if for America, to Professor Baird, Secretary of the Smithsonian Institution.

A second telegram, however, to be sent as soon as a second observation has been obtained. Thus only two dispatches in all.

2. All numerical data to be expressed by a word for each figure, with out regard to its value as dependent upon its position. Thus "58" to be telegraphed as "five eight," "12" as "one two," "30" as "three nought," &c.

3. All places which would ordinarily be left vacant when the number is written in figures must be filled up by the word "nought." Thus for the right ascension $1^{\text{h}} 5^{\text{m}}.3$ would be written "nought one nought five three" or for *R. A.* $19^{\text{h}} 3^{\text{m}}$ the dispatch would be sent "one nine nought

three nought" (the tenths of minutes being given for right ascensions, but not for other data, as per section 5).

4. Time of observation to be given in round hours of Greenwich mean time, preceded by day and month, and never in any other way. Thus an observation on October 12, at 13^h Gr. M. T., would be announced "one two October one three;" or November 3, 7^h Gr. M. T. as "three November nought seven." In this way the time of observation which is to be given first of all will be expressed by the name of the month preceded by one or two numbers, and followed always by two.

5. Right ascension to follow the date and be given by *five figures* expressing hours, minutes, and tenths of minutes, in time, preceded by the word "ascension."

6. Declinations to be given by four words expressing degrees and minutes, preceded by the word "north" or "south."

7. Daily motion in R. A. to be given in minutes and tenths of minutes of time, preceded by the word "plus" or "minus."

8. Daily motion in Decl. to be given in minutes of arc, preceded by the word "north" or "south."

9. Magnitude, if given, to be preceded by the word "mag."

Thus, in ordinary cases, the essential numerical data will be contained in twenty-four words.

EXAMPLE.

"Comet discovered by Swift, Oct. 12. Place, *R. A.* = 2^h 23^m.7 and *Decl.* = + 35° 2' at 7^h Greenw. M. T. Motion—1^m.2 in *R. A.* and + 8' in *Decl.* 12th magnitude."

DISPATCH.

"Comet Swift one two October nought seven ascension nought two two three seven north three five nought two minus one two north eight mag one two."

Professor Krueger (editor of the *Astronom. Nachrichten*) undertakes to repeat the dispatch throughout Europe at cost of the Kiel observatory or of the *Astronomische Gesellschaft*. The Paris and Greenwich observatories, as well as all the German ones, accept the arrangement.

Acknowledgment from the Smithsonian Institution, October 30, 1880, to
Dr. BENJAMIN A. GOULD, 18 Pemberton Square, Boston.

DEAR DR. GOULD: Your letter, headed "At Sea, *City of Montreal*, August 27, 1880," reached me this afternoon, the 30th of October, at apparently a long interval, if the date is correct.

I write very hurriedly to express my gratification at the prospect of seeing you again in Washington, and to say that I of course desire to follow the wishes of astronomers at home and abroad in the matter of

the telegrams. I would, however, like to have Dr. Peters, of Clinton, and the astronomers of the observatory here concur in the change; but when you visit Washington all this can be arranged.

Very truly, yours, SPENCER F. BAIRD.

Letter from the Smithsonian Institution, November 11, 1880, to Prof. C. H. F. PETERS, Hamilton College, Clinton, N. Y.

DEAR SIR: I inclose herewith a proposition for the modification of the present plan of the exchange of telegraphic announcements between the United States and Europe. Will you kindly give me your views at the *earliest possible moment*? We have in type a new circular on this subject, and of course wish to correct it, should it be desirable.

The proposition submitted, which Dr. Gould has just sent us, is the result of a conference with the leading astronomers of Europe.

Truly yours, SPENCER F. BAIRD.

Letter from the Smithsonian Institution, November 24, 1880, to Prof. C. H. F. PETERS, Hamilton College, Clinton, N. Y., with inclosure.

DEAR PROFESSOR PETERS: Will you kindly send me at your early convenience that promised criticism and memorandum in regard to the accompanying proof of the circular, and all the suggestions of change brought up by Professor Gould? I wish to close this business as soon as possible, with your kind assistance.

Yours, truly, SPENCER F. BAIRD.

Letter from the Litchfield Observatory of Hamilton College, Clinton, N. Y., November 25, 1880, to the Secretary of the Smithsonian Institution.

DEAR SIR: I hasten to answer yours of 11th instant in regard to the telegraphic exchange system of astronomical discoveries. I found it here after my return from New York (delayed by a few days' visit at West Point), and, in order to be brief, I can touch only upon the more essential points.

Of the three points made in the letter (written by Dr. B. A. Gould) of which you send me a copy, the first gives, as the reason, economy in the number of trans-atlantic dispatches. I must wonder, after I had explained twice before during the last year to the astronomers at Berlin that as far as I know only *one* message passes the Atlantic and is distributed then in Europe to the five central stations, that, without evidence to the contrary, this again is used as an argument for having the dispatches from the Smithsonian Institution sent to only one European central station, and this to be (as if of course) in Germany. When Dr. Gould's letter asserts that "the European astronomers are *all* of accord" he says too much for, from a letter of Professor Foerster on the subject (found here likewise at my return) it appears that Vienna does *not* consent; that Pulkowa seems to have been not even asked, and it is

not quite clear besides under what aspect the matter has been presented at Paris and Greenwich, and *how far* these agree with the proposed change of programme. But after all, what is there objectionable to sending the communications from the Smithsonian Institution not to Germany only, but also, as heretofore, to Greenwich, Paris, Vienna, and Pulkowa? I remember when, on a visit to Washington, I laid the first proposition before your illustrious predecessor, I had named only Greenwich, because the nearest place, to send the dispatches to, and it was Professor Henry who suggested to insert besides, Berlin, Paris, and Vienna, to which later was added Pulkowa. Fortunately, from our stand-point on this side of the ocean, we have a broader and more equitable view of scientific life in Europe, free from national jealousies.

As to the second point suggested in Dr. Gould's letter, I cannot deny that sometimes a second communication about the same object of discovery (not the next day, but rather after the lapse of three or five days) would be very welcome, though in most cases such a repetition would not be of *very great* utility. Professor Foerster puts it on the ground to make sure against a mistake in the first dispatch. But then, if the two should *not* agree? Would he then desire even three dispatches (as bank accountants take the sum three times when the first two give it different). While the cable company with great liberality did concede a limited (and later frequently surpassed) number of words and of dispatches per year, it seems hardly proper to ask a duplication of the favor, as long as it has not been clearly shown that such duplication is of absolute desirability.

Thirdly, as to the code to be used, I do not see in the slightest what objection can be made to that adopted by the Smithsonian Institution. It was the result of a consultation with the late Professor Littrow at Vienna, was in the main set up by Professor Bruhns and myself at Leipzig, and approved at the time by the astronomers at Berlin. The new edition of your circular of instructions embraces the modifications and suggestions which you had received from various sides, and Professor Airy, as you will remember, expressed himself satisfied. Professor Pickering, as well as myself, has carefully compared the scheme with the one now presented by Dr. Gould. I cannot find that it is an improvement in *precision* to say for example "one two" for "twelve," "two nought" for "twenty," or always "nought three" for simply "three," &c. Looking at the *economy* of words, Dr. Gould's scheme requires twenty-four, the Smithsonian (even with the additions now introduced) at the utmost only sixteen—a difference of considerable and (for the cable) essential importance.

Dr. Gould says of his code, "which they all recommend," I am sure that what all desire and recommend is only a uniformity of the code in use. The Smithsonian code, being far superior in precision, also more economical and now perfected by the suggestions of experience, will readily be accepted. The difficulty has been that some astronomers

either have not carefully enough read the articles of the programme, or had forgotten them. The complaints that have come to my knowledge from abroad have all been in regard to certain comet announcements telegraphed from this side, and not worded in accordance with the rules of the programme. On the other hand I had to remind the Berlin astronomers (and also those at the Washington observatory) that the time for the position is the "following midnight," while they mistook for it the hour and minute of sending from Washington, added by the telegrapher. The *circular* which you have prepared will prevent for the future these and similar mistakes.

C. H. F. PETERS.

Letter from the Litchfield Observatory, Hamilton College, Clinton, N. Y. December 21, 1880, to the Secretary of the Smithsonian Institution.

DEAR SIR: I have sent to the "*Astronom. Nachrichten*," as you permitted me to do, an article in explanation and elucidation of the form of dispatches we have used, and of the additions that have been made in the new edition.

As you have still under consideration the publication of this revised programme (I infer so from your last letter), I inclose here a comparison, which shows that our form requires only 16 words, while that presented by Dr. Gould requires 26 [or, more correctly, 27]; and it is to be remarked besides that the latter never can have less, because the "noughts" always must be inserted, while ours has usually *less* than 16 words.

Yours, very truly,

C. H. F. PETERS.

EXAMPLE.

Comet discovered by Swift Oct. 12. Place R. A. = 2 hours 23 minutes 7 and decl = + 35° 2' at 7 hours Green. m. t. Motion — 1 minute .2 in right ascension and + 8' in decl. — 12th mag."

DISPATCH.

"Comet Swift [one two october nought seven ascension nought] two twenty [two] three forty [seven] north [three] thirty five [nought] two [minus one two] north (*) eight [mag.] [one two] twelfth Tuesday."

The dispatch as here proposed has 26 words—27 if written by the rules—while in our form it requires only 16 in all.

Letter from the Smithsonian Institution, November 30, 1880, to Sir GEORGE B. AIRY, director of the Observatory, Greenwich, England.

SIR: Herewith we send you a proof copy of a revised circular in regard to the telegraphic announcement of astronomical discoveries, which

* Nought, by rule.

gives—with a few slight modifications—the system of condensed messages which has been in practical use for seven years.

We also inclose a draft of a modified plan proposed to us for the same object, and beg that you will carefully examine both documents and advise us, as soon as may be convenient, in regard to the propriety or expediency of exchanging the one for the other.

Very respectfully, &c.,
SPENCER F. BAIRD.

Letter from the Royal Observatory, Greenwich, London, December 22, 1880, to the Secretary of the Smithsonian Institution.

DEAR SIR: I have waited a few days before answering your letter of November 30 for better consideration of the proposed plan for telegraphic announcements of observations.

It appears to me, and I am entirely supported in this opinion by Mr. Christie, that it will be a great improvement of the former plan, and we heartily recommend it for adoption.

Yours, faithfully,
G. B. AIRY.

Letter from the Smithsonian Institution, November 29, 1880, to the Earl of CRAWFORD AND BALCARRES, Dun Echt, Scotland.

SIR: Inclosed please find a circular we have just prepared in regard to the telegraphic announcement of astronomical discoveries which gives—with a few slight modifications—the system of condensed messages which has been in use for seven years.

We also inclose a draft of another plan proposed for the same object, and beg that you will carefully examine the same, and give us your views, as early as may be convenient, regarding the advisability of its substitution for the former plan.

Very truly yours, &c.,
SPENCER F. BAIRD.

Letter from the Observatory Dun Echt, Aberdeen, January 7, 1881, to the Secretary of the Smithsonian Institution.

SIR: Referring to your letter of November 29, 1880, I may say that our experience at Dun Echt shows that telegraphic announcements of astronomical discoveries should represent the actual known facts of the case in a way to which the majority of the senders and receivers of the messages are accustomed. Thus the message should take the form of an observation as usually published, the name, date, and place being given. Any reduction of the time to a meridian other than that of the observation or any prediction of a future place of the object are equally to be deprecated as likely to introduce errors.*

* The possibility of making a blunder in the simple operation of referring the time to another meridian or of failing to recognize the somewhat improbable nature of a

Besides, by giving the *R. A.* to the nearest tenth of a minute of time and the declination to the nearest minute the observation is available, in the case of a comet for combination to find an approximate orbit. This form, too, gives the dispatches a permanent value.

I give the following partly in confirmation of what I think the best features of the proposed systems and partly as suggestions that may probably be of use.

The greatest clearness seems to be obtained by giving numbers as spoken thus: "12" should be "twelve" and not "one two"

I would suggest that the day of the month counted astronomically be absolutely distinguished from the rest of the message by giving it the ordinal form. Thus "October 12" would be "twelfth October."

For a like reason the *motion* in declination might be given as "northward" or "southward." If the length of a telegram is estimated by the number of words in it and not by their length, it would seem desirable to express "magnitude" in full and not by "mag," which a telegraph clerk would probably confound with "may" or "May."

Again, if "nought" is objected to why not use "cypher" as being in more frequent use than "zero." If the daily motion in *R. A.* and *Decl.* is not given, would it not be better to use the words "preceeding" and "following" or their symbols "p" and "f," in place of "west" and "east," which latter in practice refer to the horizon and not to the equator. Thus "nf" would represent "northeast." But the daily motions in *R. A.* and *Decl.* admit of greater precision.

A complete message would thus contain the word "comet" or "planet," the discoverer's name, the day (expressed as above) and month, the hour in local mean time and the place. The right-ascension to the nearest tenth of a minute of time, the declination to the nearest minute preceded by the word "north" or "south." Next, the daily motion in *R. A.* also to the tenth of a minute of time with the sign "plus" or "minus" then the daily motion in minutes of arc "northward" or "southward," and lastly, the magnitude or any other particulars likely to aid the search.

Thus:

"Comet Swift twenty-fifth October seventeen Rochester twenty-one fifty-nine cypher north fifty-one twenty-five minus twenty-one two northward fifty-seven magnitude ten."

Would mean—

"Comet discovered by Swift on October 25th at 17^h Rochester mean time in right ascension 21^h 59^m.0 and declination + 51° 25'. Daily motion— 21^m.2 and + 57'. As bright as a star of the tenth magnitude."

This form of message, although slightly longer than others that have

dispatch when so transformed, is shown in the example given in the "Proposed Mode of Transmitting, &c.," where the comet Swift (presumably discovered at Rochester) must either have been found at 2 p. m. or the longitude have been applied with the wrong sign.

been proposed, has the advantage of giving a complete approximate observation.

In conclusion, whatever form the dispatches may take, it seems an admirable proposal that for transmission across the Atlantic they shall all pass between two responsible persons; in this way only does it seem possible to prevent the useless distribution of messages which are obviously unintelligible.

CRAWFORD & BALCARRES.

Letter from the editor of the "Science Observer" (and Corresponding Secretary of the Boston Scientific Society, Boston), February 4, 1881, to the Secretary of the Smithsonian Institution.

DEAR SIR: The announcement in *Monthly Notices* Vol. XLI, No. 2, that a letter concerning a somewhat new method for the transmission of comet discoveries to your Institution across the cable, has caused quite a discussion among the members of the Boston Scientific Society, who are now discussing the matter in all its lights. Lack of information on one or two points have been difficulties in the way, and if you can inform us on these subjects you will greatly favor us. These points relate to the transmission over the cable. It is customary for Government messages to be composed of letters and figures, which, by keys at both ends, may be translated into the vernacular. Knowing this to be the case, we would respectfully inquire whether comet announcements in the past have been sent in words or in figures, thus:

Comet Swift twelfth Oct. seven twenty-three seven &c &c, or
Comet Swift 12 Oct 7 2 3 7 &c &c

And furthermore, we would like to know whether the new arrangement contemplates the transmission of the words or the figure characters.

Sincerely yours,
JOHN RITCHIE, Jr.

Letter from the Smithsonian Institution, February 16, 1881, to JOHN RITCHIE, Jr., corresponding secretary of the Boston Scientific Society.

DEAR SIR: In reply to your letter of February 4, relative to the system of telegraphic announcement of astronomical discoveries, I beg to say that the present Smithsonian system and the proposed substitute contemplate the use of words only. One dispatch has been received by us expressed according to Karlinski's code; but in all the other announcements, the data communicated have been given in words.

Inclosed we send you copies of the circulars referred to.

Very truly yours,
SPENCER F. BAIRD.

Letter from the editor of the "Science Observer," Boston, May 13, 1881, to the Secretary of the Smithsonian Institution.

DEAR SIR: It is with pleasure that I am able to call your attention to the success of a scheme devised by Mr. S. C. Chandler, jr., and myself for the transmission by cable of astronomical intelligence. It has just been successfully tested by transmission both ways, of the elements and ephemeris of Swift's comet, and I append a scheme showing how an announcement would look according to both codes.

Yours, &c.,

J. RITCHIE, Jr.

Announcement of Swift's comet per "Science Observer" code:

1	2	3	4	5	6	7
comet	Swift	conge	ratify	torsim	smart-money	tolerate

According to present (European) code:

Comet Swift may zero one zero two zero five ascension zero zero zero zero north three seven two five plus zero three south one* two.

[Translation.]

Comet Swift, May 1, 2^h 5^m; R. A. 0^h 0^m; declination N. 37° 25'; daily motion + 3^m R. A.;—1° 2' declination.

Should words 4, or 4 and 5, in the "Science Observer" code, or words 5, or 5 and 6, or words 4, or 4 and 7, be made unintelligible in transmission, the message would still be as intelligible and the comet as easy to find as was the case before the present European code was adopted, while the loss of word 2 would be of no consequence, being merely the name of the discoverer, and word 3 the time of discovery is as a rule so well determined by the date of message that its loss would not be of detriment to the general sense. By loss I mean the mutilation of a word so as to render it unrecognizable as is sometimes the case in ocean telegraphy.

J. RITCHIE, Jr.

Letter from the Secretary of the Smithsonian Institution, May 16, 1881, to Mr. J. RITCHIE, Jr., editor of the "Science Observer," Boston.

SIR: This Institution hails with satisfaction every attempt at enlarging the channels, and at increasing the fullness and accuracy of scientific information. It is possible that for the purpose of cable transmission of the details of an astronomical ephemeris, an arbitrary signal code (as suggested by you) may have some advantages; though it must not be concealed that it also presents some disadvantages; the complication both of preparation and of translation increasing with the number of elements to be communicated.

With the spread of astronomical knowledge and interest, and the

* I am in some doubt about this figure as I have not the code by me.

growth of desires and needs for more minute information respecting sudden or transitional phenomena, improved methods and formulas will doubtless be correspondingly developed.

For the present purposes of this Institution the system it has adopted will (with probably some slight improvement) prove sufficient.

Yours, very respectfully,

SPENCER F. BAIRD.

Letter from the Litchfield Observatory of Hamilton College, Clinton, Oneida County, New York, April 28, 1882, to the Secretary of the Smithsonian Institution.

DEAR SIR: At the meeting of the International Astronomical Society at Strasburg in September last, the matter of telegraphic communications of astronomical discoveries was considered. In the committee appointed upon this subject, after some discussion about the "Phrase-Code" of the (Boston) "Science Observer," it was agreed that the code of the Smithsonian Institution (Misc. Coll., 263), be recommended for general use—at least for the present. A resolution to that effect was adopted by the Society (S. Report in *Vierteljahrschrift*, vol. 16, page 285 and 351). But there was a strong feeling expressed against the manner in which most of the telegrams of comet discoveries, sent through the Smithsonian Institution, lately had come to hand in Europe. They were worded without the slightest regard to the Smithsonian programme, therefore unintelligible, and worse than no information at all, by reason of causing fruitless painstaking to astronomers searching for the object.

Unwilling that astronomers abroad should be led to throw the blame thereof upon the Smithsonian Institution, I take the liberty to suggest that you would refuse to forward dispatches of the kind, if they are not made out in conformity with the Smithsonian programme. This programme has been distributed so largely throughout the United States (in the Smithsonian Annual Reports and as a circular), that any amateur discoverer who desires to avail himself of the channel of communication so liberally offered by the Smithsonian Institution can hardly be ignorant of it. Any delay, therefore, will be his own fault, if he neglects following the prescribed form.

Yours, very respectfully,

C. H. F. PETERS.

Letter from the Secretary of the Smithsonian Institution, May 10, 1882, to Prof. C. H. F. PETERS, of the Litchfield Observatory, Clinton, N. Y.

DEAR SIR: In reply to your favor of April 28, I am gratified that the astronomical convention at Strasburg has approved of the Smithsonian code for telegraphic announcements. With regard to the irregularities noticed, it may be said that very few of the dispatches received by this Institution comply fully and literally with the published programme.

Thus, notwithstanding that Article IV, section 6, specifies the very concise and explicit statement of the *day of the week* for the date, a majority of notices received substitute the day of the month. It is difficult, therefore, to carry out your suggestion that we should refuse to forward dispatches not in exact form.

Before going to press with our long-delayed astronomical telegraph circular, I will trouble you with extracts from a single additional response to our request for suggestions, asking from you the favor of your consideration and judgment on it.

Copy of extract from a communication received from the Observatory at Dun Echt, Scotland, and dated January 7, 1881.

[Inclosure.—The principal portion of the latter from Lord Lindsay-Earl Crawford.]

On the foregoing extract, I venture to make the following queries :

1. Is there not some force in the suggestion to employ *date of observation* rather than prospective date and predicted place?
2. Is there any advantage in designating *R. A.* in hours, minutes, and *tenths*, over the present form in hours, minutes, and *sixths* (or seconds in tens)?
3. Might it not be well to write the motion in declination, as *northward* or *southward*, in full?
4. To avoid any risk of misapplication, might it not be well to write in full "tenth magnitude"?
5. Is not the word "*zero*" really preferable to either "*nought*" or "*cipher*"?

Your frank opinion and decision on these points will be very acceptable, and I may say will be finally adopted.

Yours, very respectfully,
SPENCER F. BAIRD.

The publication of the revised edition of the *Astronomical Telegraph Circular* was delayed by various circumstances; among which was a contemplated plan for telegraphing American discoveries to our own observatories as well as to those abroad. This had been urged by a large number of American astronomers; the correspondence on which subject it is unnecessary here to publish. Prof. E. C. Pickering (of the Harvard Observatory), under date of January 13, 1882, strongly recommended, in addition to this, the adoption by the Institution of the cipher code of Messrs. S. C. Chandler and John Ritchie, of the *Science Observer*. This whole matter still remains under advisement.

REPORT ON SMITHSONIAN EXCHANGES FOR 1882.

By GEORGE H. BOEHMER.

The growth of the business of receiving and transmitting the scientific and literary exchanges of the Institution has necessitated a change in the method of recording and managing the same; the plans of operation, satisfactory some half a dozen years ago, being no longer available without entailing increased trouble and considerable confusion in tracing the history of transactions.

With increase of duties has arisen the need of more complete organization; and during the past year a system of double entry, or of debit and credit accounts, has been adopted. These accounts are arranged in the form of card-catalogues, representing the societies in correspondence with the Institution; and upon these cards each society is debited for the books forwarded to it, and is credited for the receipts as communicated in return by formal announcement.

This experiment has of course greatly increased for the time the amount of work required from the limited assistance allotted to this department, but in return it gives an increased command over the results, and a much greater facility and economy of time in making references and comparisons.

By this plan, on the arrival of an invoice of parcels or boxes from any establishment in the United States, for foreign distribution, accompanied (as required by the established rules) with a list of the intended recipients, to each of these is prefixed the number assigned to it in our printed list of foreign correspondents, and the same are entered on the proper cards, giving the date of reception, the name of the sender, and the number taken from the entry in the invoice book (representing the whole transmission considered as a single transaction), in which book all receptions are first daily entered in their consecutive order.

The books or parcels receive the same numbers and are then laid away in bins, each of which represents a certain city or cities or part of them, in any given country. A sufficient number of books having accumulated to justify a sending to any country, the card-catalogue serves as a basis from which the invoices for the respective societies are made up. This is done in advance, and while the books are being removed from the bins and made up in bundles. In this manner sendings which required a week, on the old plan of making up the invoices from the parcels on hand, while being assorted and packed, may now be completed in two days.

This system has been introduced in the exchanges with Great Britain

and Ireland and with Germany and Austria-Hungary, and is found to work so well that its adoption for all other countries is deemed advisable. Such a course, however, will require the detail of two assistants exclusively for this purpose; but, considering that the receipts during the past year averaged 90 parcels per working day—exclusive of 31,568 parcels for the Government—the work required will be such as to keep them both well employed.

The duty of the assistant in charge of the card-catalogues does not cease here, but includes the entry to the credit of the respective societies, of any acknowledgments of the receipt of parcels sent them through this office, while the duties of the receiving clerk include the verifying and distributing of all incoming exchanges.

Another feature introduced during the year is a form of duplicate invoice which is to be mailed to every recipient within the United States and British America, of exchange parcels from abroad, to be returned to the Institution and transmitted as occasion offers to the sender of the respective parcels.

During the past year over eight thousand parcels were sent out under the system of domestic exchanges, requiring this number of entries in the book of transmission. Each parcel had to be addressed and properly wrapped. This domestic branch of the service required the writing of nearly 13,000 letters of advice and invoices, and the directing of the parcels and envelopes. All this work has been performed by the entire force at intervals between foreign transmissions. Great punctuality, of course, cannot possibly, be expected in each case, and it is respectfully recommended that one assistant be appointed exclusively for these duties.

The arranging and sending off of the foreign exchange, and the duties pertaining to the transmission of Government document exchange should be intrusted to one assistant, to the exclusion of any other duty.

One of the most important works begun during the past year is that of completing the sets of Smithsonian publications furnished to foreign societies. Several attempts have been made at different times to supply such deficiencies, and circulars have been sent out on different occasions requesting the foreign establishments to report the number of Smithsonian volumes in their respective libraries.

In connection with this work, a thorough examination of the number of publications in the Smithsonian library, of the societies applying for completion of our sets of publications, is required, for an equitable apportionment. The preliminary steps to this have been taken, but the magnitude and importance of the work, and the pressure of other business, have made it impossible to complete the undertaking.

It has been the aim of the assistants of this Department not to allow any accumulation whatever in the current work, and although with the limited force it required great exertion, still the close of the year finds the service unincumbered by any work of the previous year.

List of correspondents.

Mention was made in the report for 1881 of the sending of a circular to all scientific establishments in correspondence with the Institution, asking for corrections and additions of any addresses of public libraries, learned societies or scientific bureaus of Governments. The Institution also requested secretaries of societies to furnish a list of the names and addresses of persons actively engaged in scientific or literary investigations, together with the particular branch of learning to which each was devoted, with a view of facilitating communications and exchanges with specialists in all parts of the world. Another item of information desired related to the literary productions and the libraries of the respective establishments.

Prompt responses having been very generally made to this circular, a new list of foreign correspondents was prepared and issued in the early part of the year, showing an increase of almost 600 new societies over the list published in 1878. Copies of this new list were sent to all corresponding establishments, and, as a result of further corrections since the date of publication, an "addition sheet" for the year 1882 is herewith presented:

AFRICA:		EUROPE:	
Algeria	2	Austria-Hungary	45
Cape Colonies	2	Belgium	11
Egypt	1	Denmark	3
	— 5	France	50
AMERICA:		Germany	172
British America	9	Great Britain:	
Central America:		England	395
Guatemala	2	Scotland	20
Mexico	4	Ireland	9
West Indies	2	Wales	9
South America:		Greece	1
Argentine Confederation	4	Italy	17
Brazil	6	Netherlands	5
Chili	1	Norway	1
Colombia	6	Portugal	4
Ecuador	1	Roumania	1
Peru	2	Russia	4
Venezuela	1	Spain	2
	— 38	Sweden	4
ASIA:		Switzerland	4
India	5		— 758
Japan	4	Total	818
Java	1		<u> </u>
	— 10		
AUSTRALIA:			
New South Wales	1		
Queensland	2		
Victoria	4		
	— 7		

Card catalogues.

The information received from the foreign establishments in reply to the circular relative to the preparation of a new list of foreign correspondents served in the preparation of three card catalogues, of which one is to represent a list of scientific persons together with the particular branch of learning to which they are devoted. The second one is to represent an account kept, with each establishment, of the Smithsonian publications on hand, as reported by the librarians, and shows the successive sendings. As an illustration the card for the British Museum, London, England, is given:

No. 1819.

Country.		City.			Name of establishment.				
England		London			British Museum.				

When established.	Books in library January 1, 1881.				Smithsonian publications sent.				
	Total.	Smithsonian publications.			Date.	S. C.	M. C.	R.	Miscellaneous.
		S. C.	M. C.	R.					
1753..	1,300,000	1-22	1-5 8-17	1846-54 1856-78	1831, May 15 1882, April 10 1882, Dec. 29	23	18-22	1879 1880 1855	....................

The third card catalogue represents a general account of all transactions of exchanges for any one establishment. For the sake of illustration we will again select the card for the British Museum, London, England (No. 1819, of the list of foreign correspondents):

ENGLAND.

No. 1819.

LONDON.

Date.	Sender.	Sent.	Acknowledged.
1882. Jan. 28.	1 Engineer (1209) .....	.....	.....
	3 New York Academy of Sciences .....	.....	.....
	1 Museo Mexico	P'ck. 1410...	May 18, 1882
March	1 Census Office .....	.....	.....
	1 Buffalo Society .....	.....	.....
	1 Wisconsin Geology, vol. 3 and atlas .....	.....	.....
	Inclosures:		
	A. W. E. O'Shaugenessy .....	.....	.....
	A. Butler .....	.....	.....
	S. Bird .....	.....	.....

ENGLAND.

No. 1819.

LONDON.

Date.	Sender.	Sent.	Acknowledged.
1882. March.	Inclosures: H. Woodward		
	R. Owen	Mar. 14, 1882	
May 1.	Smithsonian Report, 1880	May 15, 1882	June 23, 1882
May	1 Boston Athenæum (140)		
	1 Boston Academy (140)		
	1 Naval Observatory (143)		
	1 Museo Mexico		
	1 American Philosophical Society (209)		
	1 Saint Louis Academy (205)		
	1 Census; 6 Congressional Directory (133)		
	1 Agricultural Department (162)	May 24, 1882	Sept. 14, 1882
June 20.	1 Prof. N. H. Winchell (271)		
27.	1 Minnesota Academy (286)		
July 20.	1 Boston Society (356)		
Aug. 22.	1 Engineer Bureau (365)		
23.	1 Naval Observatory (366)		
Oct. 3.	1 New York Academy (399)		
6.	1 Boston Academy (403)		
Sept. 30.	1 Buffalo Society (395)		
Oct. 10.	1 Washburn Observatory (408)		
18.	1 Dr. John Mason (436)	Nov. 15, 1882	

In order to fully understand this card, it must be mentioned that each lot of books sent to the Smithsonian Institution for transmission according to directions forms one single entry in the in voice book of incoming exchanges, in which the daily receptions are entered consecutively. The number of this entry is noted on the list of addresses (which has to accompany each sending, specifying the nature and contents of the respective parcels) and on the parcels themselves. This number will be found on the above card catalogue, appended to the name of the sender, thus simplifying inquiry into the nature of the sending, should it become necessary.

Rules relative to scientific and literary exchanges.

In consequence of the great inconvenience occasionally experienced by this office from indiscriminate sendings to it, for foreign transmission, of exchange packages, without specification of contents or any list of addresses, involving an increase of work and the risk of misunderstandings, the following rules regarding the scientific and literary exchange have been adopted, and they are now rigidly adhered to.

1. Transmissions through the Smithsonian Institution to be confined exclusively to books, pamphlets, charts, and other printed matter sent as *donations* or *exchanges*, and not to include those procured by purchase. The Institution and its agents will not receive, for any address, apparatus and instruments, philosophical, medical, &c. (including microscopes), whether purchased or presented; nor specimens of natural history, except where special permission from the Institution has been obtained.

2. A list of the addresses and a statement of contents of each sending to be mailed to the Smithsonian Institution at or before the time of transmission.

3. Packages to be legibly addressed, and to be indorsed with the name of sender and the contents.

4. Packages to be enveloped in stout paper, and securely pasted or tied with strong twine—never sealed with wax.

5. No package to a single address to exceed one half of one cubic foot in bulk.

6. To have no inclosures of letters.

7. To be delivered to the Smithsonian Institution or its agent free of expense.

8. To contain a blank acknowledgment, to be signed and returned by the party addressed.

9. Should returns be desired, the fact is to be explicitly stated on or in the package.

10. Unless these conditions are complied with, the parcels cannot be forwarded by the Institution.

RECEIPTS.

1. For foreign transmission.

Whence received.	1882.				1881.	
	Packages.	Weight.	Packages.	Weight.	Packages.	Weight.
a. From Government Departments:						
Adjutant-General's Office ...	1	4	.....	.....	.....	.....
Agricultural Department ...	389	1,682	.....	.....	.....	.....
Bureau of Education, Interior Department.	2	48	.....	.....	.....	.....
Bureau of Ethnology, Interior Department.	2,081	14,356	.....	.....	.....	.....
Bureau of Statistics, Treasury Department.	9	68	.....	.....	.....	.....
Census Office	1,005	2,095	.....	.....	.....	.....
Comptroller of Currency	1,000	1,062	.....	.....	.....	.....
District Commissioners	24	76	.....	.....	.....	.....
Engineer Bureau, War Department.	334	2,847	.....	.....	.....	.....
Geological Survey of the Territories.	2	102	.....	.....	.....	.....
Geological Surveys west of 100th meridian.	345	1,701	.....	.....	.....	.....
Hydrographic Office, Navy Department.	1	3	.....	.....	.....	.....
Interior Department (exclusive of Bureaus).	15	97	.....	.....	.....	.....
Library of Congress	122	30,500	.....	.....	.....	.....
Light-House Board, Treasury Department.	1	8	.....	.....	.....	.....
Naval Observatory	783	2,528	.....	.....	.....	.....

RECEIPTS—continued.

1. For foreign transmission.

Whence received.	1882.				1881.	
	Packages.	Weight.	Packages.	Weight.	Packages.	Weight.
<i>a.</i> From Government Departments:						
Navy Department (exclusive of Bureaus).	1	5	.....	.....	.....	.....
Signal Office, War Department.	114	1,312	.....	.....	.....	.....
Surgeon-General's Office	4	40	.....	.....	.....	.....
Treasury Department (exclusive of Bureaus).	1	3	.....	.....	.....	.....
United States Fish Commission.	213	730	.....	.....	.....	.....
United States Marine Hospital Service.	1	3	.....	.....	.....	.....
United States National Museum.	10	604	.....	.....	.....	.....
War Department (exclusive of Bureaus).	12	244	.....	.....	.....	.....
			6,470	60,118	4,326	22,903
<i>b.</i> From Smithsonian Institution.	7,056	13,447	7,056	13,447	5,436	17,499
<i>c.</i> From scientific societies:						
Academy of Sciences, Davenport, Iowa.	175	196	.....	.....	.....	.....
Academy of Sciences, New York City.	376	310	.....	.....	.....	.....
Academy of Sciences, Saint Louis, Mo.	261	378	.....	.....	.....	.....
Academy of Natural Sciences, Philadelphia, Pa.	236	262	.....	.....	.....	.....
Academy of Natural Science, Minnesota.	52	36	.....	.....	.....	.....
American Association for the Advance of Science.	134	339	.....	.....	.....	.....
American Entomological Society.	18	41	.....	.....	.....	.....
American Geographical Society.	108	168	.....	.....	.....	.....
American Journal of Arts and Sciences.	211	72	.....	.....	.....	.....
American Medical Association.	59	150	.....	.....	.....	.....
American Philological Association.	35	291	.....	.....	.....	.....
American Philosophical Society.	1,272	1,562	.....	.....	.....	.....
American Statistical Association.	23	40	.....	.....	.....	.....
Augustana College, Rock Island, Ill.	1	110	.....	.....	.....	.....
Board of Public Charities, Philadelphia.	25	50	.....	.....	.....	.....
Boston Academy of Arts and Sciences.	687	1,587	.....	.....	.....	.....
Boston Athenæum.	5	25	.....	.....	.....	.....
Boston Society of Natural History.	286	880	.....	.....	.....	.....

RECEIPTS—continued.

1. For foreign transmission.

Whence received.	1882.				1881.	
	Packages.	Weight.	Packages.	Weight.	Packages.	Weight.
<i>c.</i> From scientific societies:						
Buffalo Society of Natural Sciences.	232	73	.....	.....	.....	.....
Cincinnati Observatory	83	54	.....	.....	.....	.....
Essex Institute, Salem, Mass.	170	236	.....	.....	.....	.....
Geological Survey, Wisconsin	264	360	.....	.....	.....	.....
Historical Society, Philadelphia.	81	80	.....	.....	.....	.....
Johns Hopkins University, Baltimore.	5	69	.....	.....	.....	.....
Michigan Horticultural Society.	1	2	.....	.....	.....	.....
Museum of Comp. Zoology, Cambridge.	47	146	.....	.....	.....	.....
Peabody Museum, Cambridge	3	44	.....	.....	.....	.....
Public Library, Boston	1	17	.....	.....	.....	.....
Secretary of State, Illinois.	1	8	.....	.....	.....	.....
Secretary of State, Michigan.	1	67	.....	.....	.....	.....
Geological Survey, Michigan.	2	88	.....	.....	.....	.....
Washburn Observatory, Wisconsin.	264	360	5, 119	8, 101	3, 631	6, 816
<i>d.</i> From individuals:						
Barclay, James.	51	21	.....	.....	.....	.....
Bean, Dr. T. H.	1	2	.....	.....	.....	.....
Bernhardt, Dr. P. W.	1	7	.....	.....	.....	.....
Bessels, Emil.	3	142	.....	.....	.....	.....
Brown, Martin J.	1	7	.....	.....	.....	.....
Collins, Captain.	1	4	.....	.....	.....	.....
Collins, F. S.	5	9	.....	.....	.....	.....
Curley, James.	1	3	.....	.....	.....	.....
Curtiss, A. H.	1	38	.....	.....	.....	.....
Dall, C. H.	2	12	.....	.....	.....	.....
Dement, H. D.	1	7	.....	.....	.....	.....
Dow, J. M.	1	100	.....	.....	.....	.....
Earl, R. E.	97	40	.....	.....	.....	.....
Eaton, Dan. C.	1	21	.....	.....	.....	.....
Ferguson, T. B.	1	2	.....	.....	.....	.....
Gill, Dr. T. N.	1	2	.....	.....	.....	.....
Goode, G. Brown.	3	14	.....	.....	.....	.....
Gray, Prof. Asa.	1	3	.....	.....	.....	.....
Haines, Mary P.	1	4	.....	.....	.....	.....
Hasselquist, A.	1	170	.....	.....	.....	.....
Hering, C. J.	1	100	.....	.....	.....	.....
Hewson, A.	2	3	.....	.....	.....	.....
Holden, E. S.	2	3	.....	.....	.....	.....
Holden, Mrs. M. C.	1	5	.....	.....	.....	.....
Horn, Geo. H.	1	4	.....	.....	.....	.....
Hough, F. B.	3	20	.....	.....	.....	.....
Hough, R. B.	1	3	.....	.....	.....	.....
Howard, L. A.	2	1	.....	.....	.....	.....
Ingersoll, Ernest.	3	6	.....	.....	.....	.....
Kuhlman, Mr.	1	1	.....	.....	.....	.....
Lesquereux, L.	2	17	.....	.....	.....	.....
Mason, Dr. John.	59	463	.....	.....	.....	.....
Mills, Henry.	1	1	.....	.....	.....	.....

RECEIPTS—continued.

1. For foreign transmission.

Whence received.	1882.				1881.	
	Packages.	Weight.	Packages.	Weight.	Packages.	Weight.
<i>d.</i> From individuals:						
Mohr, Chas.....	1	5	.....	.....	.....	.....
Nicholson, W. L.....	1	21	.....	.....	.....	.....
Phillips, Henry, jr.....	1	4	.....	.....	.....	.....
Pickman, B.....	1	2	.....	.....	.....	.....
Poore, B. Perley.....	250	180	.....	.....	.....	.....
Ran, Prof. Charles.....	24	43	.....	.....	.....	.....
Ridgway, R.....	1	1	.....	.....	.....	.....
Riley, Prof. C. V.....	1	15	.....	.....	.....	.....
Schott, Chas. A.....	1	2	.....	.....	.....	.....
Stevenson, J. J.....	60	337	.....	.....	.....	.....
Worthen, A. H.....	2	35	.....	.....	.....	.....
Wiley, Henry.....	1	9	.....	.....	.....	.....
Winchell, N. H.....	49	165	.....	.....	.....	.....
			647	2,054	768	2,937
Total.....	.....	.....	19,292	83,720	14,161	50,155

2. For domestic transmission.

The receipt of exchanges for domestic transmission during the year was 8,676 parcels, of which 1,471 were contributed by home institutions and 7,205 by establishments abroad, as follows:

Country.	1882.			1881.		
	No. of boxes.	No. of parcels.	Weight.	No. of boxes.	No. of parcels.	Weight.
			<i>Pounds.</i>			<i>Pounds.</i>
From Argentine Confederation ..	2	211	1,112	.....	.....	.....
From Australia.....	2	199	378	.....	.....	.....
From Belgium.....	5	495	1,480	.....	.....	.....
From Central America.....	2	2	200	.....	.....	.....
From Denmark.....	4	65	385	.....	.....	.....
From East Indies.....	1	5	20	.....	.....	.....
From France.....	13	584	2,833	.....	.....	.....
From Germany.....	*44	2,698	9,322	.....	.....	.....
From Great Britain.....	59	1,510	12,746	.....	.....	.....
From Holland.....	2	111	460	.....	.....	.....
From Italy.....	3	342	1,344	.....	.....	.....
From Mexico.....	3	315	370	.....	.....	.....
From Norway.....	7	300	1,770	.....	.....	.....
From Russia.....	1	47	84	.....	.....	.....
From Sweden.....	2	156	950	.....	.....	.....
From Switzerland.....	2	165	200	.....	.....	.....
Total.....	152	7,205	33,654	111	7,890	33,291

*This number includes two boxes lost at sea, the first accident known to occur to any cases of exchanges between Germany and the United States.

3. For Government transmission.

Whence received.	1882.			1881.		
	No. of boxes.	Packages.	Weight.	No. of boxes.	Packages.	Weight.
From England, for Library of Congress	16	16	2,420			
From Germany, for Library of Congress	1	1	130			
From France, for Library of Congress	1	1	200			
From Public Printer, 631 parcels of official documents, each containing 50 copies.....		31,550	26,000		15,550	
Total.....	18	31,568	28,750		15,550	

In the report for 1881 special attention was called to the large increase in the reception of exchange parcels, which in that year reached 22,051, exclusive of 15,550 copies of Government documents for distribution by the Smithsonian Institution to foreign Governments. This number, although very large in comparison with previous years, has been exceeded during the present year (1882) by about twenty per cent.; the number amounting to 26,479, exclusive of 31,568 copies of Government publications. They were received from the following sources:

	Packages.	Pounds.
1. For foreign transmission:		
(a.) From Government Departments.....	6,470	60,118
(b.) From Smithsonian Institution	7,056	13,447
(c.) From scientific societies	5,119	8,101
(d.) From individuals	647	2,054
Total	19,292	83,720
2. For domestic transmission.....	7,187	30,904
Total	26,479	114,624
3. For Government exchanges	31,568	28,750
Total	58,047	143,374

TRANSMISSIONS.

1. Foreign transmissions.

The year 1882 began and ended without any accumulation of exchanges in this office, and all the transmissions made during the same represent the actual receipts.

The total number of boxes sent during the year is 422, which is an excess of 15 boxes over the year 1881, and is the highest on record. Of these 422 boxes, 298 contain books, and 2 boxes specimens sent by

the National Museum. In the year 1881, with 407 boxes, only 264 contained books, while 45 entire boxes of specimens were sent by the National Museum and Fish Commission.

The transmissions of 1882 compare with former years as follows:

	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.
Boxes.....	208	323	397	309	311	263	407	422
Bulk, in cubic feet.	1,503	2,261	2,779	2,160	2,177	1,976	2,800	2,950
Weight, in lbs.	45,350	80,750	99,250	69,220	69,975	60,300	100,750	105,500

In all cases the number of boxes given in this report includes the boxes sent under the system of Government document exchange to the various Governments specified in the special report appended, and the transmissions to Canada, which will be found specified in the detailed report on domestic exchanges.

The 422 boxes sent during the year 1882 were distributed as follows:

Country.	Government boxes.	Smithsonian boxes.	Total.
AFRICA:			
Algeria.....		1	1
Cape Colonies.....		3	3
Liberia.....		1	1
Egypt.....		2	2
		7	7
AMERICA:			
British America.....	4	2	6
Mexico.....	2	3	5
<i>Central America:</i>			
Costa Rica.....		2	2
Guatemala.....		2	2
Nicaragua.....		1	1
<i>West Indies:</i>			
Barbadoes.....		1	1
Cuba.....		1	1
Guadeloupe.....		1	1
Haiti.....	2		2
Jamaica.....		1	1
Trinidad.....		1	1
<i>South America:</i>			
Argentine Confederation.....	4	2	6
Bolivia.....		1	1
Brazil.....	2	2	4
Chili.....	2	1	3
Colombia, United States of.....	17	1	18
Guiana.....		1	1
Ecuador.....		1	1
Peru.....		1	1
Uruguay.....		1	1
Venezuela.....	2	1	3
	35	27	62

Country.	Government boxes.	Smithsonian boxes.	Total.
ASIA:			
China.....		3	3
India.....	17	3	20
Japan.....	2	2	4
	19	8	27
AUSTRALASIA:			
New South Wales.....	2	2	4
New Zealand.....	2	2	4
Queensland.....	2	1	3
South Australia.....	2	1	3
Tasmania.....	2	1	3
Victoria.....	2	3	5
	12	10	22
EUROPE:			
Austria-Hungary.....	17	9	26
Belgium.....	2	9	11
Denmark.....	2	3	5
France.....	3	43	46
Germany.....	10	68	78
Great Britain.....	2	57	59
Greece.....	2	3	5
Iceland (with Denmark).....			
Italy.....	2	14	16
Netherlands.....	2	5	7
Norway.....	2	3	5
Portugal.....	2	4	6
Russia.....	2	6	8
Spain.....	2	5	7
Sweden.....	2	6	8
Switzerland.....	2	9	11
Turkey.....	2	3	5
	56	247	303
POLYNESIA:			
Sandwich Islands.....		1	1
RECAPITULATION.			
Africa.....		7	7
America.....	35	27	62
Asia.....	19	8	27
Australasia.....	12	10	22
Europe.....	56	247	303
Polynesia.....		1	1
Total.....	122	300	422

Transportation companies.

The agents of a number of transportation companies have continued to grant free freight on the boxes and packages bearing the Smithsonian stamp. These companies are:

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

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

Bland, Thomas, 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.

Merchants' Line of Steamers, New York.

Netherland-American Steam Navigation Company (F. Cazeaux, agent), New York.

New York and Brazil Steamship Company, New York.

New York and Mexico Steamship Company, New York.

North German Lloyd Steamship Company (Oelrichs & Co., New York, and Schumacher & Co., Baltimore).

Pacific Mail Steamship Company, New York.

Pacific Steam Navigation Company, New York.

Panama Railroad Company, New York.

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

White Cross Line (Funch Edye and Co.), New York.

In addition to the above transportation companies, a number of 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.

C. de Castro, New York, to Chili.

Hypolito de Uriarte, New York, to Spain and Cuba.

Francis Spies, New York, to Ecuador.

D. W. Botassi, New York, to Greece.

Jacob Baez, New York, to Guatemala.

M. Rappo, New York, to Italy.

Samro Takaki, New York, to Japan.

Juan N. Navarro, New York, to Mexico.

Christian Bors, New York, to Norway and Sweden.

Henrick Braem, New York, to Denmark.

Gustav Amsink, New York, to Portugal.

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, France.
Argentine Confederation	Consul Carlos Carranza, New York.
Antigua.....	Thomas Dennison, New York.
Austria-Hungary	North German Lloyd, Baltimore.
Belgium.....	Red Star Line, New York; White Cross Line, New York.
Brazil.....	Consul Charles Mackall, Baltimore.
British America	Baltimore and Ohio Express Company.
British Guiana.....	Transfer made in London by Smithsonian agent.
Cape Colonies	North German Lloyd to Smithsonian agent, London, England.
Chili.....	Consul C. de Castro, New York.
China.....	Salter & Livermore, New York.
Colombia, United States of..	Consul-General Lino de Pombo, New York.
Costa Rica	Pacific Mail Steamship Company, New York.
Cuba.....	Consul-General Hipolito de Uriarte, New York.
Denmark.....	Consul Henrick Braëm, New York.
Dutch Guiana	Thomas Bixby & Co., Boston, Mass.
East India	North German Lloyd to Smithsonian agent, London, England.
Ecuador.....	Consul Francis Spies, New York.
Egypt.....	S. L. Merchant & Co. New York.
Finland.....	North German Lloyd, Baltimore, to F. A. Brockhaus, Leipzig, Germany.
France.....	Compagnie Générale Transatlantique, New York.
Germany.....	North German Lloyd, New York or Baltimore. Hamburg-American Packet Company, New York.
Great Britain.....	North German Lloyd, Baltimore or New York. Cunard Royal Mail Steamship Line, New York.
Greece.....	D. W. Botassi, consul New York.
Guatemala	Consul Jacob Baez, New York.
Hayti.....	Atlas Steamship Company, New York.
Iceland.....	Consul Henrick Braëm, New York. Transfer made by Smithsonian agent in Copenhagen, Denmark.
Italy.....	Consul-General M. Raffo, New York.
Japan.....	Consul Samro Takaki, New York.
Liberia.....	America Colonization Association, Washington, D. C.
Madeira.....	North German Lloyd to Smithsonian agent in London, England.
Malta.....	
Mauritius.....	
Mozaubique.....	
Mexico.....	Consul Juan N. Navarro, New York.
Netherlands.....	Consul R. C. Burlage, New York.
Netherland Indies	
New Caledonia	North German Lloyd to Gordon & Gotch, London, England.
New South Wales.....	R. W. Cameron & Co., New York.
New Zealand	R. W. Cameron & Co., New York.
Peru.....	Joseph S. Spinney, New York.
Philippine Islands	Spanish consul, San Francisco, Cal.
Polynesia	Consul Severance, San Francisco, Cal.
Portual.....	Consul Gustav Amsink, New York.
Queensland.....	North German Lloyd, Baltimore to Queensland Department, London, England.
Russia.....	Hamburg-American Packet Company, New York. Transfer made by Russian consul-general, Hamburg.
St. Helena.....	North German Lloyd to Smithsonian agent, London, England.

Country.	Shipping agent.
South Anstralia	R. W. Cameron & Co., New York.
Spain	Consul Hipolito de Uriarte, New York.
Strait Settlements	North German Lloyd to Smithsonian agent, London, England.
Sweden and Norway	Consul Christian Börs, New York.
Switzerland	North German Lloyd to Consul von Heymann, Bremen, Germany.
Syria	Presbyterian Rooms, New York.
Tasmania	North German Lloyd to Crown agents for the colonies, London, England; or G. W. Wheatley & Co., 156 Leadenhall street, London, England.
Turkey	Ottoman Legation, Washington, D. C.
Turk's Island	Wilson & Asmus, New York.
Uruguay	Consul W. H. T. Hughes, New York.
Venezuela	Dallett, Boulton & Co., New York.
Victoria	R. W. Cameron & Co., New York.
CENTERS OF DISTRIBUTION.	
Algeria	Commission Française des Échanges Internationaux, Paris, France.
Argentine Republic	Museo Publico, Buenos Ayres.
Austria-Hungary	Dr. Felix Flügel, Leipzig.
Belgium	Commission Belge des Échanges Internationaux, Brussels.
Brazil	Brazilian Commission of International Exchanges, Rio Janeiro.
British América	McGill College, Montreal; Geological Survey, Ottawa.
British Guiana	Observatory, Georgetown.
Cape Colonies	William Wesley, London, England.
Chili	Universidad, Santiago.
China	United States consul-general, Shanghai.
Colombia, United States of	National Library (Commission of Exchanges), Bogota.
Costa Rica	Universidad, San José.
Cuba	R. Universidad, Habana.
Denmark	K. D. Videnskaberne Selskab, Copenhagen.
Dutch Guiana	Koloniale Bibliotheek, Surinam.
East India	William Wesley, London, England.
Ecuador	Observatorio, Quito.
Egypt	Institut Egyptien, Cairo.
Finland	F. A. Brockhaus, Leipzig, Germany.
France	Commission Française des Échanges Internationaux, Paris.
Germany	Dr. Felix Flügel, Leipzig.
Great Britain	William Wesley, London.
Greece	Bibliothèque Nationale, Athens.
Guatemala	Sociedad Economica de Amigos del Pais, Guatemala.
Hayti	Secrétaire d'État des Relations Extérieures, Port-au-Prince.
Iceland	Islands Stiptisbokasafn, Reykjavik.
Italy	Biblioteca Nazionale Vittorio Emanuele, Rome.
Japan	Minister of Foreign Affairs, Tokio.
Liberia	Liberia College, Monrovia.
Madeira	William Wesley, London, England.
Malta	William Wesley, London, England.
Mauritius	William Wesley, London, England.
Mozambique	William Wesley, London, England.
Mexico	El Museo Nacional, Mexico.
Netherlands	Bureau Scientifique Central Néerlandais, Harlem.
Netherland Indies	Batavia'sche Genootschap van Kunsten en Wetenschappen, Batavia.
New Caledonia	Gordon & Gotch, London, England.
New South Wales	Royal Society of New South Wales, Sydney.
New Zealand	Colonial Museum, Wellington.
Norway	K. N. Fredericks Universitet, Christiania.

Country.	Shipping agent.
Philippine Island.....	Royal Economical Society, Manila.
Polynesia	Royal Hawaiian Agricultural Society, Honolulu.
Portugal	Escola Polytechnica, Lisbon.
Queensland.....	Government Meteorological Observatory, Brisbane.
Russia	Commission Russe des Échanges Internationaux (Imperial Public Library), St. Petersburg.
St. Helena.....	William Wesley, London, England.
South Australia.....	Astronomical Observatory, Adelaide.
Spain	Real Academia de Ciencias, Madrid.
Strait Settlements	William Wesley, London, England.
Sweden	K. S. Vetenskaps Akademien, Stockholm.
Switzerland	Eidgen. Bundes Canzlei, Bern.
Tasmania	Royal Society of Tasmania, Hobartton.
Trinidad	Scientific Association, Port of Spain.
Turk's Island	Public Library, Grand Turk.
Venezuela.....	University, Caracas.
Victoria	Public Library, Melbourne.

2. Domestic transmissions.

List of packages received by the Smithsonian Institution from Europe and distributed to the following named institutions and individuals in the United States and British America.

ALABAMA.		Governor of the State	2
Tuscaloosa :		Health Department.....	3
Geological Survey of Alabama.....	1	Lick Astronomical Department University of California.....	3
Montgomery :		Mercantile Library Association	4
State Library.....	1	Microscopical Society	1
ARKANSAS.		Office of the Lick Trust	1
Little Rock :		COLORADO.	
State Library.....	4	Denver :	
CALIFORNIA.		Governor of the State.....	1
Mount Hamilton :		Territorial Library.	2
Lick Observatory.....	3	CONNECTICUT.	
Berkeley :		Hartford :	
University of California.....	1	American Philological Association.	2
Sacramento :		Connecticut Society of Natural History	1
Agassiz Institute	2	Hartford Medical Library	1
Agricultural and Horticultural Society	3	Historical Society of Connecticut..	1
Irrigation Survey.....	1	Library Young Men's Institute....	1
Medical Society	1	Middletown :	
State Agricultural Society	1	Wesleyan University	1
State Library.....	5	New Haven :	
San Francisco :		American Journal of Arts and Sciences.....	57
Alta California	1	American Oriental Society	29
Bancroft Pacific Library	1	Connecticut Academy of Arts and Sciences.....	136
California Academy of Sciences....	112	New Haven Colony Historical Society.....	1
California Historical Society	3		
Corporation of the city of San Francisco	2		
Geographical Society of the Pacific	2		
Geographical Survey of California.	2		

Observatory of Yale College	5	Navy Department (exclusive of bureaus).....	2
Sheffield Scientific School.....	5	Ordnance Bureau, U. S. Army	3
State Board of Agriculture.....	1	Patent Office	68
Winchester Observatory	1	Smithsonian Institution.....	1091
Yale College.....	32	State Department	20
Newington:		Statistical Bureau of Treasury Department.....	51
Private Observatory.....	1	Surgeon-General, U. S. Army	127
		Treasury Department (exclusive of bureaus)	11
		War Department (exclusive of bureaus).....	11
		Washington Philosophical Society.....	20
DELAWARE.			
Wilmington:			
Delaware Historical Society	1		
DISTRICT OF COLUMBIA.			
Georgetown:			
Georgetown College	5		
Observatory of Georgetown College.....	2		
Washington:			
Agricultural Department	124		
Anthropological Society	6		
Army Medical Museum.....	4		
Belgian Legation.....	3		
Board of Health	15		
Botanic Garden.....	1		
Census Bureau.....	49		
Chinese Legation.....	20		
Chief Signal Office, U. S. Army.....	67		
Coast and Geodetic Survey.....	74		
Columbian University.....	2		
Cosmos Club	1		
Education, Bureau of	57		
Engineer Bureau, U. S. Army.....	38		
Entomological Commission.....	16		
Fish Commission	15		
French Legation.....	1		
Geological Survey of the Territories	261		
Geographical Surveys West of the 100th Meridian	39		
Hydrographic Office	12		
Index Medicus.....	4		
Indian Commissioners	1		
Interior Department (exclusive of bureaus)	17		
Land Office.....	34		
Library of Congress	216		
Light-House Board	4		
Marine Hospital Service	5		
Medical Association (American).....	55		
Medicine and Surgery, Bureau of.....	1		
Mint Bureau	1		
National Academy of Sciences.....	152		
National Museum.....	82		
Nautical Almanac office.....	14		
Naval Observatory	99		
Navigation, Bureau of	1		
		FLORIDA.	
		Saint Augustine:	
		Historical Society of Florida.....	1
		GEORGIA.	
		Savannah:	
		Historical Society of Georgia.....	3
		State Library	1
		ILLINOIS.	
		Aledo:	
		Mercer County Scientific Association	1
		Carbondale:	
		Southern Illinois Normal University	1
		Chicago:	
		Academy of Sciences.....	76
		American Antiquarian	2
		Astronomical Society	1
		Board of Trade	1
		Chicago Times.....	1
		Corporation of the city of Chicago.....	2
		Dearborn Observatory	10
		Historical Society	2
		Museum of Natural History.....	2
		Natural History Society	1
		Public Library	8
		University of Chicago	1
		Galesburg:	
		Lombard University	1
		Madison:	
		American Pomological Society	6
		Normal:	
		State Laboratory of Natural History.....	6
		Rockford:	
		Rockford Scientific Society.....	1
		Rock Island:	
		Angustana College	1

Springfield :		Louisville :	
Geological Survey of Illinois.....	1	Corporation of the city.....	2
State Library	2	Historical Society of Kentucky....	2
INDIANA.		LOUISIANA.	
Evanston :		Baton Rouge :	
Northwestern University.....	1	State University.....	1
Indianapolis :		New Orleans :	
Bureau of Statistics and Geology ..	5	Academy of Sciences.....	39
Geological Survey of Indiana.....	12	Corporation of the city.....	2
State Board of Agriculture.....	1	Fiske Free Library	1
Richmond :		State Library	1
Scientific Association	1	State University.....	1
Greencastle :		MAINE.	
Indiana Asbury University.....	1	Brunswick :	
Bloomington :		Bowdoin College	3
Indiana University	1	Historical Society of Maine	14
IOWA.		Norway :	
Ames :		High School and Academy.....	1
State Agricultural College.....	1	Portland :	
Davenport :		Portland Society of Natural His-	
Academy of Natrual Sciences.....	65	tory.....	13
Decorah :		Saco :	
Norwegian Lutheran College.....	2	York Institute.....	1
Des Moines :		Waterville :	
Geological Survey of Iowa	3	Colby University.....	1
Governor of the State.....	5	MARYLAND.	
Historical Society	2	Annapolis :	
State Library	1	Saint John's College	1
Dubuque :		United States Naval Academy	3
Dubuque Observatory	1	United States Naval Academy Ob-	
Iowa Institute of Science and Arts.	1	servatory	1
Fort Dodge :		Baltimore :	
Private Observatory.....	1	American Journal of Chemistry...	3
Iowa City :		American Journal of Mathematics .	7
Iowa Weather Service	27	City Library	1
Private Observatory.....	1	Corporation of the City.....	2
University of Iowa.....	16	Johns Hopkins University	26
State Historical Society of Iowa ..	1	Maryland Academy of Sciences....	3
KANSAS.		Maryland Historical Society	9
Baldwin City :		Peabody Institute	20
Baker University.....	1	Philological Association of Johns	
Lawrence :		Hopkins University.....	1
Kansas Historical Society.....	1	MASSACHUSETTS.	
State University.....	1	Amherst :	
Topeka :		Amherst College.....	4
Kansas Academy of Sciences	7	Observatory of Amherst College...	1
Kansas Historical Society.....	4	Boston :	
KENTUCKY.		American Academy of Arts and Sci-	
Frankfort :		ences.....	185
Geological Survey of Kentucky....	3	American Gynecological Society...	4
Lexington :		American Oriental Academy	2
Kentucky University	1	American Social Science Associa-	
		tion.....	3

American Statistical Association ..	14	Worcester:	
American Unitarian Association...	1	American Antiquarian Society	11
Appalachian Mountain Club.....	1		
Archæological Institute of America.	1	MICHIGAN.	
Athenæum	3	Ann Arbor:	
Boston Hospital	1	Geological Survey of Michigan....	10
Boston Post.....	2	Observatory.....	9
Boston Public Library.....	26	Society of Agriculture	2
Boston Scientific Society.....	2	University of Michigan.....	4
Boston Society of Natural History.	226	Battle Creek:	
Bowditch Institution	1	High School Observatory	1
Bowditch Library	3	Coldwater:	
City Library.....	1	Michigan Library Association.....	2
Commonwealth of Massachusetts..	1	Detroit:	
Corporation of the city	2	Historical Society of Michigan....	1
Handel and Hayden Society.....	1	Detroit Observatory	1
Legislature of Massachusetts.....	1	Public Library	1
Massachusetts Agricultural College	1	State Agricultural Society	3
Massachusetts Historical and Genealogical Society	11	Grand Rapids:	
Massachusetts Horticultural Society.....	1	State Agricultural Society	3
Massachusetts Institute of Technology.....	5	Lansing:	
Medical and Surgical Journal.....	18	Lansing Scientific Society.....	4
New England Historical and Genealogical Society	2	State Agricultural College.....	1
Public Free Library	3	State Board of Agriculture	8
Science Observer	3	State Board of Health	22
State Board of Agriculture.....	1	State Library.....	2
State Board of Health.....	7	State Medical Society.....	5
State Library.....	16	Ypsilanti:	
Cambridge:		State Normal School Observatory..	1
American Philological Association.	1		
Atlantic Monthly.....	1	MINNESOTA.	
Etymological Club "Psyche".....	4	Duluth:	
Geological Survey of Massachusetts	1	Scandinavian City Library.....	1
Harvard College.....	48	Minneapolis:	
Harvard College Observatory.....	19	Geological Survey of Minnesota...	1
Museum of Comparative Zoology..	93	Minnesota Academy of Sciences...	7
Peabody Museum	8	University of Minnesota	4
Cambridgeport:		Northfield:	
Private Observatory.....	1	Carleton College Observatory	1
Jamaica Plain:		Saint Paul:	
Bussey Institution.....	13	Academy of Natural Sciences.....	1
Salem:		Chamber of Commerce.....	1
American Association for the Advancement of Science	50	Historical Society of Minnesota ...	8
Essex Institute.....	85	Minnesota State Library.....	1
Peabody Academy	81		
South Hadley:		MISSISSIPPI.	
Mount Holyoke Seminary Observatory.....	1	Oxford:	
Williamstown:		Observatory of the University of	
Astronomical Observatory	1	Mississippi	1
		Jackson:	
		Mississippi State Library.....	1
		MISSOURI.	
		Columbia:	
		Laws Observatory.....	2

Glasgow:		Princeton:	
Morrison Observatory.....	1	Museum of Geology and Archæology.....	1
Jefferson:		College of New Jersey.....	17
Missouri Historical and Philosophical Society	1	Halsted Observatory.....	2
State Board of Agriculture.....	1	John C. Green School of Science Observatory.....	1
State Library.....	1	Observatory of Princeton College ..	2
Kansas City:		Trenton:	
Kansas Review	1	State Board of Agriculture	1
Rolla:		State Library	1
Geological Survey of Missouri	10	NEW MEXICO.	
School of Mines.....	7	Santa Fé:	
Saint Louis:		Historical Society of New Mexico ..	1
Academy of Sciences	16	NEW YORK.	
Corporation of the city	2	Albany:	
Emigration Society	1	Albany Institute	18
Mercantile Library	10	Adirondaek Survey	5
Missouri Historical Society	7	Dudley Observatory	23
Peabody Academy	5	Mercantile Library	1
Public Library	4	New York Medical Society	5
Public School Library	6	State Agricultural Society	10
Republican.....	1	State Commissioners	1
Washington University.....	5	State Library	52
Washington University Observa- tory.....	1	State Museum	8
MONTANA.		State University.....	8
Lincoln:		Alfred Centre:	
Nebraska State Library.....	1	Alfred Observatory	1
NEBRASKA.		Brooklyn:	
Omaha:		Brooklyn Library.....	1
Nebraska Historical Society.....	1	Corporation of the city	1
NEW HAMPSHIRE.		Private Observatory	2
Concord:		Long Island Historical Society....	2
New Hampshire Historical Society..	4	Buffalo:	
Hanover:		Buffalo Historical Society.....	2
Dartmouth College	6	Buffalo Practical School	1
Shattuck Observatory	3	Buffalo Society of Natural Sci- ences.....	75
NEW JERSEY.		Private Observatory of Henry Mills.	1
Elizabeth:		Private Observatory of James W. Ward	1
Elizabeth Observatory	1	Clinton:	
Hoboken:		Litchfield Observatory of Hamilton College	7
Stevens Institute of Technology ..	9	Cornwall:	
Mount Holly:		The Cornwall Library	1
Burlington County Lyceum of His- tory and Natural Sciences	1	Fordham:	
Newark:		Private Observatory of W. Meikle- ham	1
New Jersey Historical Society.....	2	Hastings:	
New Brunswick:		Private Observatory.....	1
Geological Survey of New Jersey..	12	Ithaca:	
New Jersey Natural History So- ciety	1	Cornell University.....	18

New York:		Vassar College	3
Academy of Medicine	2	Vassar College Observatory	1
American Chemical Society	10	Riverdale:	
American Ethnographical Society	2	Private Observatory of W. Meikle-	
American Ethnological Society....	6	ham	1
American Geographical Society....	104	Rochester:	
American Institute	5	Warner Observatory	1
American Institute of Architects...	2	Schenectady:	
American Institute of Christian		Union College	6
Philosophy	2	Tarrytown:	
American Metrological Society....	6	Private Observatory of Chas H.	
American Philological Association.	2	Rockwell.....	1
American Society of Civil Engi-		Troy:	
neers.....	2	Rensselaer Polytechnic Institute ..	3
Anthropological Institute.....	1	Scientific Society	2
Astor Library	42	William Proudfit Observatory	1
Columbia College.....	7	Utica:	
Columbia College Observatory....	2	State Lunatic Asylum	1
Commissioners of Emigration....	2	West Point:	
Corporation of the City	2	United States Military Academy .	11
Cooper Institute.....	1	West Point Observatory	1
Engineering and Mining Journal..	8	Willetts Point:	
Halls, Journal of Health.....	1	Field Observatory	1
Health Department.....	2		
Historical Society of New York....	1		
Lenox Library	2		
Mayor of the city	3		
Medical Journal and Library	2		
Medical Recorder	3		
Mercantile Library Association....	2		
Metropolitan Museum of Arts.....	1		
Museum of Natural History	25		
New York Academy of Sciences....	132		
New York Handels Zeitung	2		
New York Herald.....	5		
New York Historical Society	8		
New York Literary and Philosophi-			
cal Society	2		
New York Medical Journal.....	9		
New York Medical Record	4		
New York Times.....	12		
New York Tribune.....	3		
Observatory, Central Park	10		
Popular Science Monthly	1		
Presbyterian Review	2		
Private Observatory of L. M. Ruth-			
erford	2		
Public Health Association	4		
School of Mines.....	8		
Scientific American	2		
United States Sanitary Commission.	9		
University of New York.....	8		
Phelps:			
Red House Observatory.....	1		
Ponghkeepsie:			
Society of Natural Sciences	1		
		OHIO.	
		Ashtabula:	
		Anthropological Society	8
		Cincinnati:	
		Academy of Fine Arts	1
		Astronomical Society	1
		Cincinnati Enquirer	1
		Cincinnati University	3
		Corporation of the city	1
		Historical and Philosoph'l Society.	2
		Mechanics' Institute.....	2
		Mercantile Library	1
		Observatory	24
		Public Library	9
		Society of Natural History.....	22
		Cleveland:	
		Academy of Natural Sciences.....	2
		Board of Health	2
		Kirtland Society	1
		Columbus:	
		Geological Survey of Ohio	2
		Horticultural Society.....	10
		Private Observatory.....	1
		State Board of Agriculture.....	38
		State Library	2
		Gambier:	
		Kenyon College	1
		Hudson:	
		Hudson Observatory	1
		Linwood:	
		Private Observatory.....	1

Oberlin :		Nmismatic and Antiquarian Society	3
Oberlin College	1	Observatory	1
Urbana :		Observatory of Girard College.....	4
Central Ohio Scientific Association.	1	Penn Monthly	2
Yellow Springs :		Philadelphia House of Refuge.....	2
Antioch College	1	Philadelphia Press	1
PENNSYLVANIA.			
Allegheny :		Philomathean Society	1
Allegheny Observatory	10	Polytechnic Bulletin.....	1
Bethlehem :		State Medical Society	1
Lehigh University	4	University of Pennsylvania	5
Carlisle :		Wagner Free Institute.....	13
Carlisle Society of Literature.....	1	Zoological Society	19
Easton :		Pittsburgh :	
Institute of Mining Engineers....	11	Mercantile Library	2
Lafayette College.....	3	Wilkes Barre :	
Pardee Science School	1	Wyoming Historical and Geolog- ical Society.....	1
Germantown :		RHODE ISLAND.	
Friends Free Library and Reading Room	1	Providence :	
Harrisburg :		American Naturalist.....	13
Medical Society of Pennsylvania...	1	Athenæum	2
Second Geological Survey of Pennsylvania.....	9	Brown University	4
State Agricultural Society	1	City Registrar's Office	1
State Library.....	2	Rhode Island Historical Society...	5
Haverford :		Seagrave Observatory	1
Haverford College Observatory....	3	State Registrar of Births, Marriages, and Deaths.....	1
Media :		SOUTH CAROLINA.	
Delaware County Institute of Science.....	1	Charleston :	
Philadelphia :		Literary and Philosophical Society of South Carolina.....	1
Academy of Fine Arts	3	South Carolina Historical Society	1
Academy of Natural Sciences.....	199	TENNESSEE.	
American Entomological Society..	31	Knoxville :	
American Naturalist	6	Philomathesian Society	1
American Pharmaceutical Association	11	Lebanon :	
American Philosophical Society ...	154	Cumberland University	1
Board of Health	1	Nashville :	
Board of Public Education.....	3	Private observatory	1
Board of State Charities	3	Tennessee Historical Society	1
Board of Trade	4	TEXAS.	
Central High School.....	2	Chapel Hill :	
Central High School Observatory..	2	Soulé University	1
Corporation of the city	2	VERMONT.	
Franklin Institute.....	58	Barnet :	
Geological Survey of Pennsylvania.	3	Vermont Historical and Antiquarian Society	1
Girard College.....	1	Burlington :	
Historical Society of Pennsylvania.	14	Fletcher Free Library	1
Library Company	5	University	1
Library of Pennsylvania Hospital.	3	Castleton :	
Medical Times.....	14	Orleans County Society of Natural Sciences.....	40
Mercantile Library	3		
Museum.....	1		

Montpelier:		Canadian Medical and Surgical	
State Library	2	Journal	4
VIRGINIA.			
P. O. University of Virginia:		Canadian Naturalist	3
University of Virginia	7	Entomological Society	1
Hampton:		Geographical Society	1
Hampton College	1	Government of Canada	5
Lexington:		Herald	1
Virginia Military Institute	1	L'Union Médicale de Canada	1
Richmond:		McGill College	3
Historical Society	1	Medical Association of Canada	1
Medical College	1	Natural History Society	21
Medical Society	2	Numismatic and Antiquarian Soci-	
State Library	3	ety	1
Virginia Historical and Philosophi-		Société d'Agriculture du Bas Can-	
cal Society	1	ada	1
Williamsburg:		Ottawa (Ontario):	
Eastern State Lunatic Asylum	1	Academy of Natural Sciences	2
WEST VIRGINIA.			
Wheeling:		Department of Agriculture	1
Natural History Society	2	Field Naturalists' Club	1
WISCONSIN.			
Beloit:		Geological Survey of Canada	18
Geological Survey of Wisconsin	5	Library of Parliament	3
Inmansville:		Observatories in the Dominion	1
Scandinavian Society	1	Quebec (Quebec):	
Madison:		Chronicle	1
State Agricultural Society	19	Geographical Society	3
State Historical Society	7	Historical Society	1
Washburn Observatory	13	Historical and Natural History So-	
Wisconsin Academy of Sciences	60	ciety	1
Wisconsin University	1	Laval University	2
Milwaukee:		Library of the Province of Quebec.	1
Academy of Sciences	1	Literary and Historical Society ...	10
Natural History Society	34	Literary and Philosophical Society.	3
Nenah:		Naturaliste Canadien	5
Scandinavian Library Association.	4	Observatory	1
WASHINGTON TERRITORY.			
Olympia:		Parliamentary Library	1
Territorial Library	1	Toronto (Ontario):	
WYOMING.			
Cheyenne:		Board of Agriculture of Upper Can-	
Territorial Library	1	ada	1
BRITISH AMERICA.			
Hamilton (Ontario):		Botanical Society	1
West Canada Scientific Association.	1	Canadian Entomologist	3
Kingston (Ontario):		Canadian Institute	27
Botanical Society of Canada	2	Canadian Journal	2
Kings College	1	Canadian Journal of Medical Sci-	
London (Ontario):		ence	1
Canadian Entomological Society ..	1	Canadian Naturalist	3
Montreal (Quebec):		Department of Marine and Fisher-	
Canadian Medical Record	1	ies	1
		Entomological Society	3
		Evening News	1
		Geological Commission of Canada .	1
		Library and Historical Society	2
		Magnetic Observatory	1
		Meteorological Office	3
		Meteorological Observatory	1
		Parliamentary Library	1

Public Library	3	NEWFOUNDLAND.	
The Globe	3	St. John's:	
University of Toronto.....	2	Geological Survey of Newfound-	
University College.....	1	land.....	2
		Legislative Library.....	1
		NOVA SCOTIA.	
Fredericton:		Halifax:	
University of New Brunswick	1	Nova Scotia Institute of Natural	
St. John:		Sciences	8
Natural History Society.....	1		
Life Association of Canada.....	1		

General summary.

	No. of addresses.	No. of parcels.
(a.) Societies:		
Alabama	2	2
Arkansas	1	4
California.....	21	154
Delaware	1	1
Colorado	2	3
Connecticut.....	16	25
District of Columbia	47	2,902
Florida	1	1
Georgia	2	4
Illinois	21	127
Indiana.....	7	22
Iowa.....	14	127
Kansas	5	14
Kentucky	4	8
Louisiana.....	6	45
Maine	6	33
Maryland	12	77
Massachusetts.....	50	972
Michigan	18	80
Minnesota	9	25
Mississippi	2	2
Missouri	19	227
Montana	1	1
Nebraska	1	1
New Hampshire	3	13
New Jersey	13	51
New Mexico.....	1	1
New York.....	87	754
Ohio.....	26	139
Pennsylvania	49	702
Rhode Island	7	27
South Carolina.....	2	2
Tennessee	4	4
Texas	1	1
Vermont	5	45
Virginia	9	18
West Virginia.....	1	2
Wisconsin.....	10	145
Washington Territory	1	1
Wyoming	1	1
British America	60	179
(b.) Individuals	548	7,192
	399	1,167
Total	947	8,359

The decrease as compared with 1881 in the parcels sent under domestic exchanges is due to the fact that the statistics of that year include a large number of parcels left over from 1880. At the close of the year 1881, however, all accumulations had been worked off, and not one package remained on hand, so that the figures in the present report represent the actual receipts and transmissions for this year only. The receipt of packages for 1881 was 7,890, and for the present year 8,359, thus showing an actual increase of 460 parcels, that is, a little above the average increase (400 per year) for the past ten years.

The total number of packages transmitted compares with former years as follows :

	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.
Total addresses of institutions	463	462	329	316	392	292	444	385	600	548
Total addresses of individuals	266	288	281	328	374	370	341	560	454	399
Total number of parcels to institutions	3,876	3,221	3,619	3,705	3,868	4,059	5,786	4,021	7,086	7,192
Total number of parcels to individuals	906	1,105	1,042	1,148	1,094	1,233	1,185	1,566	1,347	1,167
Total number of parcels	4,782	4,326	4,661	4,853	4,962	5,292	6,971	5,587	8,433	8,359

Recapitulation.

Total addresses of institutions	548
Total addresses of individuals	399
Total number of addresses	947
Total number of parcels to institutions	7,192
Total number of parcels to individuals	1,167
Total number of parcels	8,359

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	96	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	2,540	40	3,602	293	1,933

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.
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	345	2,368
1866.....	1,243	4,509	121	5,873	329	2,703
1867.....	1,557	3,946	328	5,831	347	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
Total	38,173	132,128	7,119	177,420	14,233	103,124

3. Government transmissions.

On the 2d day of March, 1867, the following resolution was passed by Congress, 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.”

A primary object of this movement was to secure as regularly and economically as possible all reports and other documents relative to the legislation, jurisprudence, statistics, internal economy, technology, &c., of all nations, so as to place the material at the command of the committees and members of Congress, heads of Bureaus, &c.

Distribution of Government exchanges—Continued.

	Box 10.	Box 11.	Box 12.	Box 13.	Box 14.	Box 15.	Box 16.	Box 17.	Total of boxes.
Argentine Confederation.....	1878	1878	1879	1880	1881	1881	1882	1882	17
Bavaria.....	1878	1878	1879	1880	1 81	1881	1882	1882	17
Belgium.....	1878	1878	1879	1880	1881	1881	1882	1882	17
Brazil.....	1878	1878	1879	1880	1881	1881	1882	1882	17
Buenos Ayres.....	1878	1878	1879	1880	1881	1881	1882	1882	17
Canada (Ottawa).....	1878	1878	1879	1880	1881	1881	1882	1882	17
Canada (Ontario).....	1878	1878	1879	1880	1881	1881	1882	1882	17
Chili.....	1878	1878	1879	1880	1881	1881	1882	1882	17
Colombia, United States of.....	1882	1882	1882	1882	1882	1882	1882	1882	17
Denmark.....	1870	1870	1870	1880	1881	1881	1882	1882	17
East India.....	1882	1882	1882	1882	1882	1882	1882	1882	17
France.....	1878	1878	1879	1880	1881	1881	1882	1882	17
(Second set).....	1879	1879	1879	1880	1881	1881	1882	.....	16
Germany (exclusive of specifically-named kingdoms).....	1878	1878	1879	1880	1881	1881	1882	1882	17
Great Britain.....	1878	1878	1880	1880	1881	1881	1882	1882	17
Greece.....	1878	1878	1879	1880	1881	1881	1882	1882	17
Hayti.....	1878	1878	1879	1880	1881	18 1	1882	1882	17
Hungary.....	1882	1882	1882	1882	1882	1882	1882	1882	17
Italy.....	1881	1881	1881	1881	1881	1881	1882	1882	17
Japan.....	1878	1878	1879	1880	1881	1881	1882	1882	17
Mexico.....	1878	1878	1879	1880	1881	1881	1882	1882	17
Netherlands.....	1878	1878	1879	1880	1881	1881	1882	1882	17
New South Wales.....	1878	1878	1879	1880	1881	1881	1882	1882	17
New Zealand.....	1878	1878	1879	1880	1881	1881	1882	1882	17
Norway.....	1878	1878	1879	1880	1881	1881	1882	1882	17
Portugal.....	1878	1878	1879	1880	1881	1881	1882	1882	17
Prussia.....	1878	1878	1879	1880	1881	1881	1882	1882	17
Queensland.....	1878	1878	1879	1880	1881	1881	1882	1882	17
Russia.....	1881	1881	1881	1881	1881	1881	1882	1882	17
Saxony.....	1878	1878	1879	1880	1881	1881	1882	1882	17
Scotland.....	1878	1878	1879	.....	.....	.....	.....	.....	12
South Australia.....	1878	1878	1879	1880	1881	1881	1882	1882	17
Spain.....	1878	1878	1879	1880	1881	1881	1882	1882	17
Sweden.....	1878	1878	1879	1880	1881	1881	1882	1882	17
Switzerland.....	1878	1878	1879	1880	1881	1881	1882	1882	17
Tasmania.....	1878	1878	1879	1880	1881	1881	1882	1882	17
Turkey.....	1878	1878	1879	1880	1881	1881	1882	1882	17
Venezuela.....	1878	1878	1879	1880	1881	1881	1882	1882	17
Victoria.....	1878	1878	1879	1880	1881	1881	1882	1882	17
Wurtemberg.....	1879	1879	1879	1880	1881	1881	1882	1882	17
Total of boxes.....	.....	.....	.....	.....	.....	.....	.....	.....	674

Three Governments were added to the list during the year, namely:

1. Hungary; depositing the documents with the Präsidium des König. Ungarischen Ministeriums, Budapest.
2. United States of Colombia; books to be deposited in the National Library, Bogota.
3. East Indies; deposited with the Secretary of State for India, Calcutta.

The first instalments of 16 boxes each were made to Hungary, June 10, 1882; Colombia, October 20, 1882; East India, October 20, 1882.

In 1879 the French Commission of International Exchange requested that an additional set of Government publications be sent to France, to be distributed among the various Government departments and bureaus, who in return were to furnish their publications for the use of the United States Government Bureaus, while the original set was deposited, together with its continuations, in the National Library. This practice, however, has been abandoned now, at the request of the French commission, and it has been suggested that, should the various Government

Bureaus desire an interchange of their respective publications, they should do so directly without drawing from the allowance set aside by law for the exchange among Governments.

The following tables show the Government who at present exchange their publications with the Government of the United States, together with the establishment designated for the reception of the books and the shipping agents who have charge of the transmission of the boxes to their respective distributions:

Governments in exchange with the United States Government.

Governments.	Establishments designated for the reception of Government exchanges.
Argentine Confederation	Minister of Foreign Affairs, Buenos Ayres.
Bavaria	Königliche Bibliothek, Munich.
Belgium	Bibliothèque Royale, Brussels.
Brazil	Commission of International Exchanges, Rio Janeiro.
Buenos Ayres	Government, Buenos Ayres.
Canada	Parliamentary Library, Ottawa. Legislative Library, Toronto.
Chili	Muséo Nacional, Santiago.
Colombia, United States of . .	National Library, Central Office of Exchanges, Bogota.
Denmark	Kongelige Bibliothek, Copenhagen.
East India	Secretary of State for India, Bombay.
France	Commission Française des Échanges Internationaux, Paris.
Germany	Bibliothek des Deutschen Reichstags, Berlin.
Great Britain	British Museum, London.
Greece	Bibliothèque Nationale, Athens.
Hayti	Sécétaire d'État des Relations Extérieures, Port-au-Prince.
Hungary	Präsidium des Königlich Ungarischen Ministerium, Budapest.
Italy	Biblioteca Nazionale Vittorio Emanuele, Rome.
Japan	Minister of Foreign Affairs, Tokio.
Mexico	Government, 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.
Queensland	Government, Brisbane.
Russia	Commission kusse des Échanges Internationaux, Bib- liothèque Impériale Publique, St. Petersburg.
Saxony	Königliche Bibliothek, Dresden.
South Australia	Government, Adelaide.
Spain	Government, Madrid.
Sweden	Government, Stockholm.
Switzerland	Eidgenössensche Bundes Canzlei, Berne.
Tasmania	Parliamentary Library, Hobarton.
Turkey	Government, Constantinople.
Venezuela	University Library, Caracas.
Victoria	Public Library, Melbourne.
Württemberg	Königliche Bibliothek, Stuttgart.

Shipping agents of Government exchanges.

County.	Agent.
Argentine Confederation.....	Carlos Carranza, Consul-General, New York.
Bavaria.....	North German Lloyd (Schumacher & Co., agents), Baltimore.
Belgium.....	Red Star Line (Peter Wright & Sons), New York, and White Cross Line (Funch, Edye & Co.), New York.
Brazil.....	Charles Mackall, Vice-Consul, Baltimore.
Buenos Ayres.....	Carlos Carranza, Consul-General, New York.
Canada.....	Baltimore and Ohio Express Company.
Chili.....	C. de Castro, Consul-General, New York.
Colombia, United States of.....	Pacific Mail Steamship Company, New York; Consul-General Ramon Ulloa, San Francisco, Administrator Principal de Hacienda Nacional, Panama.
Denmark.....	Henrick Braém, Consul-General, New York.
East India.....	North German Lloyd (Schumacher & Co.), Baltimore, transfer made in the office of the Secretary of State to India, London.
France.....	Compagnie Généralé Transatlantique (L. de Bébian,, New York.
Germany.....	North German Lloyd (Schumacher & Co.), Baltimore.
Great Britain.....	North German Lloyd (Schumacher & Co.), Baltimore.
Greece.....	D. W. Botassi, Consul-General, New York.
Hayti.....	Atlas Steamship Company (Pim, Forwood & Co.), New York.
Holland.....	
Hungary.....	Hensel, Bruckmann & Lorbacher, New York.
Italy.....	M. Raffo, Consul-General, New York.
Japan.....	Samro Takaki, Consul-General, New York.
Mexico.....	Juan N. Navarro, Consul-General, New York.
New South Wales.....	R. W. Cameron & Co., New York.
New Zealand.....	R. W. Cameron & Co., New York.
Norway.....	Christian Börs, Consul-General, New York.
Portugal.....	Gustav Amsink, Consul-General, New York.
Prussia.....	North German Lloyd (Schumacher & Co.), Baltimore.
Queensland.....	North German Lloyd (Schumacher & Co.), Baltimore, transfer made by the Agent-General for Queensland, Queensland Department, London, England.
Russia.....	Hamburg-American Packet Company (Oelrichs & Co.), New York, transfer made by the Imperial Russian Consul-General in Hamburg, Germany.
Saxony.....	North German Lloyd (Schumacher & Co.), 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 (Schumacher & Co.), Baltimore, transfer made by Swiss Consul-General H. von Heymann, Bremen, Germany.
Tasmania.....	North German Lloyd (Schumacher & Co.), Baltimore, transfer made by the Crown Agents for the Colonies, Colonial Office Building, Downing street, London, England.
Turkey.....	Turkish Legation, Washington, D. C.
Venezuela.....	C. G. de Garmendia, Consul-General New York.
Victoria.....	R. W. Cameron & Co., New York.
Württemberg.....	North German Lloyd (Schumacher & Co.), Baltimore

List of official publications sent to foreign governments in 1882.

AGRICULTURAL DEPARTMENT.

- Annual Report 1879. 621 p. and pl. 8°. Cloth.
- Co-operative Experimenting as a Means of Studying the Effects of Fertilizers, and the Feeding Capacities of Plants, by W. A. Atwater. 33 p. 8°. Paper.
- Special Reports of the Agricultural Department:
- No. 40. The Condition and Needs of Spring Wheat Culture in the Northwest, by Hon. C. C. Andrews, of Minnesota. 99 p. 8°. Paper.
- No. 41. Report upon the Estimated Production of Cereals in the United States for 1881. 8 p. 8°. Paper.
- No. 42. Report upon the Condition of Winter Grain, and upon Numbers and Condition of Farm Animals in the United States. April, 1882. 82 p. 8°. Paper.
- No. 43. Report upon the Condition of Winter Grain, the Progress of Cotton and Corn Planting, the Rate of Wages and Labor, and Results of Tile Draining. May, 1882. 20 p. 8°. Paper.
- No. 44. Report upon the Acreage and Condition of Cotton, the Condition of all Cereals, and the Area of Spring Grain. June, 1882. 15 p. 8°. Paper.
- No. 45. Report upon the Area and Condition of Corn, the Condition of Cotton and of Small Grains, Sorghum, Tobacco, &c. July, 1882. 33 p. 8°. Paper.
- No. 46. Report upon the Condition of Corn and Cotton, of Spring Wheat, Fruits, &c.; also Freight Rates of Transportation Companies. August, 1882. 54 p. 8°. Paper.
- No. 47. Climate, Soil, and Agricultural Capabilities of South Carolina and Georgia, by J. C. Hemphill. 65 p. 8°. Paper.
- No. 48. Silos and Ensilage: A Record of Practical Tests in several States and Canada. 70 p. 8°. Paper.
- No. 49. Report upon the Condition of Corn and Cotton, of Potatoes, Fruits, &c.; also Freight Rates of Transportation Companies. September, 1882. 8°. Paper.
- No. 50. The Dissemination of Texas Fever of Cattle and how to control it. 1882. 8°. Paper.
- No. 51. Report upon the Yield and Quantity of Small Grain, the Condition of Corn and Cotton, of Potatoes, Tobacco, &c.; also Freight Rates of Transportation Companies. 58 p. 8°. Paper.
- No. 52. Report on the Yield per Acre of Cotton, Corn, Potatoes, and other Field Crops with comparative Product of Fruits; also Local Freight Rates of Transportation Companies. Nov., 1882. 109 p. 8°. Paper.
- Florida: Its Climate, Soil, Productions, and Agricultural Capabilities, by Jas. H. Foss. 98 p. 8°. Paper.
- Proceedings of a Convention of Agriculturists held in the Department of Agriculture from January 10 to January 18, 1882. 204 p. 8°. Paper.

NATIONAL BOARD OF HEALTH.

- Annual Reports of the Board of Health for the years 1879, 1880, 1881, 1882.
- Bulletin, vol. 3, Nos. 1-52. 4°. Paper.
- vol. 4, No. 1. 4°. Paper.
- Supplement Nos. 16-19. 4°. Paper.

UNITED STATES CONGRESS.

- Congressional Directory: First Session Forty-seventh Congress. Second edition. 8°. Paper. Corrected to June 28, 1882. 176 p. 8°. Paper.
- Congressional Record: Forty-seventh Congress. Vol. 13, parts 1 to 7, and Index. (8 vols.) 4°. Half Russia.

Memorial Addresses:

- Ambrose E. Burnside, January 23, 1882. 8°. Cloth.
 Matthew H. Carpenter, January 26, 1882. 119 p. 8°. Cloth.
 Everts W. Farr, December 6, 1880. 54 p. 8°. Cloth.
 Fernando Wood, February 28, 1881. 40 p. 8°. Cloth.

House of Representatives:

Constitution, Manual, and Digest, Rules and Practice, first session Forty-seventh Congress, compiled by Henry H. Smith. 443 p. 8°. Cloth.

Executive Documents, Forty-sixth Congress:

- Foreign Relations, No. 1, Part 1. 1,093 pages. 8°. Sheep.
 Ordnance Report No. 1, Part 2. 400 pages. 8°. Sheep.
 Engineer Report. 3 vols. 8°. Sheep.
 Commissioner of Education, 1879. 8°. Sheep.
 Chief Signal Office Report, 1879. 8°. Sheep.
 Report of Secretary of Treasury. 8°. Sheep.
 Paris Universal Exposition. 5 vols. 8°. Sheep.
 Offers for carrying the mails. 8°. Sheep.
 Public Land Commission. 8°. Sheep.
 Navy Department and Post-Office Reports. 8°. Sheep.
 Reports of Commissioners of the District of Columbia, 1880. 536 p. 8°. Sheep.
 Account of the United States Treasurer, &c.
 No. 1, parts 6, 7, and 8. (Ex. Docs. Nos. 8-22, 52 to 89). 3 vols. 8°. Sheep.
 Nos. 24 to 45, except 33. 1 vol. 8°. Sheep.
 Vol. 18, Nos. 9-66, except 12, 13, 42, 47, 55. 1 vol. 8°. Sheep.

House Miscellaneous Documents: Second and third sessions Forty-sixth Congress. Vols 1. and 4. 8°. Sheep.

House Reports, Forty-sixth Congress. 3 volumes. 8°. Sheep.

United States Senate:

Paper connected with the naval appropriation bill, for the use of the Senate Committee on Appropriations. 21 p. 8°. Paper.

Senate Documents: Second session Forty-fifth Congress. Report of the United States States Coast and Geodetic Survey. 194 pages. 23 pl. 4°. Sheep.

Senate Documents: Third session Forty-fifth Congress. Report of the United States Coast Survey for the year ending June 30, 1878. 306 pages, map and appendices. 4°. Sheep.

Senate Documents: Second session Forty-sixth Congress:

Vol. 1, Nos. 1-53. 8°. Sheep.

Vol. 2, Nos. 54-104, except 59. 8°. Sheep.

Vol. 5, Nos. 181-216, except 208 and 209. 8°. Sheep.

Senate Documents: Third session Forty-sixth Congress and special session March 4, 1881.

Vols. 1 and 3. 8°. sheep.

Vol. 2, part 1 (1,105 p.), part 2 (951 p.), Private Land Claims. 8°. Sheep.

Senate Executive Documents: Second session Forty-sixth Congress.

Nos. 1-50, except 17. 8°. Sheep.

Senate Journal: First session Forty-seventh Congress and special session October 10, 1881. 1750 p. 8°. Sheep.

Senate Reports: Third session Forty-sixth Congress. Nos. 726 to 935. 2 vols. 8°. Sheep.

COURT OF CLAIMS.

Cases decided by the Court of Claims, with abstracts of decisions of the Supreme Court in Appeal Cases:

Vol. 16. 693 p. 8°. Paper.

Vol. 17. 499 p. 8°. Paper.

History, Jurisdiction and Practice of the Court of Claims of the United States, by
Win. A. Richardson, LL. D. 29 p. 8°. Paper.

INTERIOR DEPARTMENT.

List of Congressional documents from the Twentieth to the Forty-sixth Congresses,
inclusive. 63 pages. 8°. Paper.

Official Register of the United States:

Vol 1. Legislative, Executive, and Judicial. 876 pages. 4°. Cloth.

Vol 2. The Post-Office Department and Postal Service. 892 p. 4°. Cloth.

List of the additions made to the Library of the Interior Department from February
1, 1881, to September 19, 1882. 4 p. 4°. Paper.

Bureau of Education:

Circulars of Information:

No. 1. Organization of Training Schools for Nurses.

No. 2. Proceedings of the Department of Superintendence, 1882.

No. 3. The University of Bonn.

No. 4. Industrial Art in Schools.

No. 5. Maternal Schools in France.

No. 6. Technical Instruction in France.

Bulletins:

Instruction in Morals and Civil Government.

National Pedagogic Congress of Spain.

Natural Science in Secondary Schools.

High Schools for Girls in Sweden.

Annual Report for 1880.

United States Entomological Commission:

Bulletin No. 7. Insects injurious to Forest and Shade Trees, by A. S. Packard,
jr. 275 p. 8°. Paper.

United States Geological Surveys Office:

Geology of the Henry Mountains, by G. K. Gilbert. Second edition. 170 p. 4
plates. 4°. Cloth.

Regulations of the United States Geological Survey, 1882. 51 p. 8°. Paper.

Monographs of the United States Geological Survey. Vol.

The Tertiary History of the Grand Cañon District, by C. E. Dutton. 264 p. 4°. Paper.

Atlas to vol. 2.

Annual Report of the Director, 1880-81. 583 pages, 61 plates, 1 map. 8°. Paper.

Office of Indian Affairs:

Laws and Regulations regulating the Trade with Indian Tribes. January, 1,
1882. 13 p. 8°. Paper.

Annual Report for 1882.

General Land Office:

Instructions to Special Agents of the General Land Office, issued June 20, 1882.
16 p. 8°. Paper.

United States Swamp Land Laws: Regulations and Decisions thereunder. April
18, 1882. 15 p. 8°. Paper.

Coal Land Laws and Regulations thereunder. July 31, 1882. 7 p. 8°. Paper.

United States National Museum:

Bulletin 11. Bibliography of Fishes of the Pacific Coast of the United States
to the end of 1879, by Theodore Gill. 64 p. 8°. Paper.

Bulletin No. 22. Guide to the Flora of Washington and Vicinity. 264 p. 8°. Paper.

Proceedings of the United States National Museum. Vol 4. 1882.

United States Patent Office:

Decisions of the Commissioner of Patents, 1831. 537 p. 8°. Paper.

United States Patent Office—Continued.

United States Statutes concerning the Registration of Trade-marks and Labels, including the acts of March 3, 1881, August 5, 1882, and sections 3, 4, 5 of the act of June 18, 1874, with the rules of the United States Patent Office relating thereto. Edition of October 1, 1882. 16 p. 8°. Paper.

Rules of Practice in the United States Patent Office. Revised April 15, 1882. 92 p. 8°. Paper.

United States Pension Office:

Instructions to Examining Surgeons for Pensions, 1882. 16 p. 8°. Paper.

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. 272 p. 8°. Paper.

Roster of Examining Surgeons appointed under the authority of the Commissioner of Pensions. 140 p. 8°. Paper.

General Instructions to Special Examiners of the United States Pension Office, 1882. 44 p. 8°. Cloth.

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, Deputy Commissioner of Pensions. 129 p. 8°. Paper.

NAVY DEPARTMENT.

Register of the Commissioned, Warrant, and Volunteer Officers of the United States Navy, including the Officers of the Marine Corps and others. January 1, 1882. 208 p. 8°. Paper.

Register corrected to July 1, 1882. 81 p. 8°. Paper.

Reports of Officers of the Navy on Ventilating and Cooling the Executive Mansion during the Illness of President Garfield. 13 p. 8°. Paper.

Statistics relating to the Navies of the World. 16 p. 8°. Paper.

Bureau of Equipment and Recruiting :

Instructions relative to Enlistments, Discharges, &c., of the United States Navy, 1882. 72 p. 8°. Paper.

Bureau of Navigation :

Navy Scientific Papers No. 7. Turning powers of ships. 8°. Paper.

Navy Scientific Papers No. 8. Observations for dip. 8°. Paper.

Notes on Navigation, by Commander Harrington. 8°.

Treaties and Conventions between the United States and other Countries, 1873-1881. 8°.

International Code of Signals (corrected edition). 8°.

American Practical Navigator (Bowditch), revised edition. 8°.

Useful Tables (Bowditch), revised edition. 8°.

Hydrographic Office:

Hydrographic notices for 1881, Nos. 64, 66, 67-85 and index. 8°. Paper.
for 1882, Nos. 1-60. 8°. Paper.

Notices to mariners for 1881, Nos. 72, 85, 86, 87, 89, 93-108 and index. 8°. Paper.
1882, Nos. 1-106. 8°. Paper.

List of charts published during the quarter ending March 31, 1882. 8 pages. 8°. Paper.

List of charts published during the quarter ending June 30, 1882. 7 pages. 8°. Paper.

List of charts published during the quarter ending September 30, 1882. 7 pages. 8°. Paper.

Charts published during the year :

No. 347. Jamaica.

No. 349. Harbors of Jamaica.

Hydrographic Office—Continued.

Charts published during the year:

- No. 456. Gulf of Yeddo.
- No. 906. Wrangel Island.
- No. 907. Rodgers Harbor.
- No. 908. Rodgers Track.
- No. 911 *a*. Circumpolar chart.
- No. 911 *b*. Circumpolar chart.
- No. 912. Arctic Sea.
- No. 887. Amazon River, sheet 1.
- No. 307. Havana, Cuba.
- No. 888. Amazon River, sheet 2.
- No. 889. Amazon River, sheet 3.
- No. 890. Amazon River, sheet 4.
- No. 891. Amazon River, sheet 5.
- No. 892. Amazon River, sheet 6.
- No. 893. Madeira River, sheet 1.
- No. 894. Madeira River, sheet 2.
- No. 348. Port Royal, Kingston Harbor, Jamaica.
- No. 823. South Pacific Ocean, eastern sheet, lower part.
- No. 823 *a*. South Pacific Ocean, eastern sheet, upper part.
- No. 622. Coast of Mexico.
- No. 920. Port Malaga, Spain.

Nautical Almanac:

- American Nautical Almanac for 1885.
- American Nautical Almanac for 1886.
- American Ephemeris and Nautical Almanac for 1885.
- Supplement to the American Ephemeris and Nautical Almanac for 1881-1884.
- Astronomical Papers of the American Ephemeris, part 6.
- Astronomical Papers of the American Ephemeris, Vol. I.

Bureau of Steam-Engineering:

- Report of the Board on the Mallory Steering and Propelling Screw as applied to the United States torpedo-boat "Alarm."
- Report on the vedette boats constructed for British and French navies by the Herreshof Manufacturing Company.
- Annual Report for 1882.

Admiral's Office:

- Annual Report.

Bureau of Medicine and Surgery:

- Annual Report 1880.

Bureau of Provisions and Clothing:

- Pay-table of the United States Navy. New edition.

Bureau of Yards and Docks:

- Annual Report for 1882.

Naval Observatory:

- Astronomical and Meteorological Observations for 1878. 4°.
- Appendix 1, 1878: Monograph of the Central Parts of the Nebulæ of Orion. 230 p. 43 illustrations. 4°.
- Appendix 2, 1878: Longitude of the Observatory of the John C. Green School of Science, Princeton, N. J. 54 p. 4°.
- Meteorological Observations for 1878. 18 p. 4°.
- Appendix 1. V for 1879. Parallax of Δ Lyrae and 61 Cygni. 64 p. 4°.
- Instructions for observing the Transit of Venus, December 6, 1882, prepared by the commission authorized by Congress. 50 p. 4 plates. 4°.

POST-OFFICE DEPARTMENT.

Letters of the Postmaster-General transmitting to the President a letter of special counsel and the report of Post-Office Inspectors Tidball and Shallcross upon fraudulent bonds accompanying certain bids and contracts for carrying the United States Mail. 85 p. 8°. Paper.

Regulations to take effect January 1, 1883, for the guidance of postmasters in the transaction of the international money-order business between the United States on the one hand and Belgium and Tasmania respectively on the other. 8 p.

Topographer's Office :

Post Route Maps:

No. 21. Utah.

No. 23. Montana, Idaho, and Wyoming.

No. 26. Oregon and Washington.

PUBLIC PRINTER.

Annual Report for the fiscal year 1882.

STATE DEPARTMENT.

Commercial Relations of the United States.

No. 14. December, 1881.

No. 15. January, 1882.

No. 16. February, 1882.

No. 17. March, 1882.

No. 18. April, 1882.

No. 19. May, 1882.

No. 20. June, 1882.

No. 21. July, 1882.

No. 22. August, 1882.

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 in Reference to Appeals from Court of Claims. Revised and corrected. 74 p. 8°. Paper.

United States *vs.* John W. Dorsey *et al.* 152 p. 8°. Paper.

TREASURY DEPARTMENT.

Annual Report of the Secretary for 1882.

Annual Report of the Secretary for 1882, with tables.

Finance report of the Secretary for 1882.

Statement of Balances, Appropriations and Expenditures for 1881.

Combined Statement of the Receipts and Disbursements of the United States for the year ended June 30, 1881.

Digest of Appropriations for 1883.

Digest of Navy Appropriations for the year 1883.

Estimates of Deficiencies in Appropriations for 1882. (House Executive Document No. 33, Forty-seventh Congress, first session.)

Estimates of Appropriations for 1884.

Revised Estimates, Treasury Department.

Claims allowed under Balances of Exhausted Appropriations. Act June 14, 1881. (House Executive Document No. 26, Forty-seventh Congress, first session.)

Claims allowed under act of July 4, 1864. (House Executive Document No. 23, Forty-seventh Congress, first session.)

Laws relating to National Banks.

Laws and Executive Orders relating to Alaska.

Receipts and Expenditures of the United States for 1875, 1876, 1877.

Synopsis of Department Decisions, December, 1881, to November, 1882.

Report on Mineral Waters, by Special Agent Tichenor.

Report on the Tariff and Customs Laws and Administration, by Special Agent Tichenor.

Report on the Silver Profit Fund, by William Sherer.

Report on Drawback on Sugars, by Special Agent Chamberlin.

The National Loans of the United States from July 4, 1776 to June 30, 1880, by R. A. Bayley.

Comparative Rates of Wages in the United States and Foreign Countries. (Senate Executive Document No. 173, Forty-seventh Congress, first session.)

Statistical Abstract No. 4. (House Executive Document No. 133, Forty-seventh Congress, first session.)

Biographical Sketch of the life of Rear-Admiral John Rodgers, United States Navy.

Report on Pleuro-pneumonia by Treasury Cattle Commission. (Senate Executive Document No. 106, Forty-seventh Congress, first session.)

Report of Commission on the Condition of Winder's Building.

Decision of the Supreme Court of the United States on Sugar *in re Merritt vs. Welsh et al.*

Report of the United States Assay Commission.

Report on the Division of Stationery, Printing, and Blanks, Secretary's Office, by the Committee appointed by the Secretary of the Treasury.

Supervising Special Agent of the Treasury Department, Annual Report for 1882.

Supervising Architect: Annual Report for 1882.

Bureau of Engraving and Printing: Annual Report for 1882.

Bureau of the Mint: Annual Report for 1882.

Inspector-General of Steam-Vessels:

Annual Report for 1882.

Revised Rules and Regulations.

Manual of Laws and Regulations.

Laws governing the Inspection of Foreign Passenger Steam-Vessels.

Proceedings of the Thirtieth Annual Meeting of the Board of Supervising Inspectors 1882. Parts 1 and 2.

Bureau of Statistics:

Annual Report for 1882.

Annual Report for 1881, parts, 1 and 2.

Statements Nos. 1-17 of the Annual Report for 1882.

Statements Nos. 26-34 of the Annual Report for 1882.

Advanced Statement of Immigration into the United States for the fiscal year 1882.

List of Merchant Vessels of the United States for the fiscal year 1882.

Report on the imports, exports, immigration, and navigation of the United States: Second quarter, Third quarter, Fourth quarter, 1881-'82.

First quarter 1882-'83.

Preliminary Report on Foreign Commerce of the United States for the fiscal year 1882, including report for June, 1882.

Statement of the Foreign Commerce of the United States:

December, 1881. January, 1882. February, 1882. March, 1882. April, 1882.

May, 1882. July, 1882. August, 1882. September, 1882. October, 1882.

November, 1882.

Summary Statements of the Imports and Exports of the United States:

November, December, 1881. January to October, 1882.

Life-Saving Service:

Annual Report of the Superintendent for the fiscal year 1881.

Rules and Regulations of the Board on Life-Saving Appliances.

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First Comptroller of the Treasury :

Annual Report.

Second Comptroller of the Treasury :

Annual Report.

Decisions of the Second Comptroller relative to the pay of officers of the Army under act of March 2, 1867.

Commissioner of Customs :

Annual Report of the Commissioner for 1882.

List of the principal officers of the Customs Service.

Register of the Treasury : Annual Report of the Register for 1882.

First Auditor of the Treasury : Annual Report for 1882.

Second Auditor of the Treasury : Annual Report for 1882.

Third Auditor of the Treasury : Annual Report for 1882.

Fourth Auditor of the Treasury : Annual Report for 1882.

Fifth Auditor of the Treasury : Annual Report for 1882.

Sixth Auditor of the Treasury : Annual Report for 1882.

Treasurer of the United States :

Annual Report for 1882.

Annual Report on the sinking fund debt of the District of Columbia for the fiscal year 1881.

Annual Report on the sinking fund debt of the District of Columbia for the fiscal year 1882.

Assistant Treasurer of the United States :

Catalogue of blank books and blanks used in the office of the Assistant Treasurer of the United States in New York City.

Comptroller of the Currency :

Annual Report for 1882.

Annual Report for 1882, with appendix.

Internal Revenue :

Annual Report for 1882.

Annual Report, with tables.

Collection of circulars, specials, decisions, and circular letters.

Report on the condition of the Internal-Revenue Service for the fiscal year 1882.

Revenue Marine: List of officers of the Revenue Marine Service.

Light-House Board :

Annual Report of the Chairman, 1882.

Official announcement of the death of Rear-Admiral R. H. Wyman, Chairman of the Board.

Laws relating to the Light-House Establishment passed at the first session of Forty-seventh Congress.

Light-House List Atlantic, Gulf, and Pacific coasts of the United States.

Light-House List Northern Lakes and River coasts of the United States.

List of buoys, beacons, &c.: First to Twelfth Light-House District.

United States Coast and Geodetic Survey :

Summary of the Annual Report of the Superintendent for 1882.

Tide Tables Atlantic coast of the United States.

Tide Tables Pacific coast of the United States.

Marine Hospital Service :

Annual Report of the Supervising Surgeon-General for 1882.

Report on Yellow Fever in Texas.

Medical Officers and Assistant Surgeons of the Marine Hospital Service.

WAR DEPARTMENT.

Official Army Register, January, 1882. 398 pages. 8°. Paper.

Records of Officers and Soldiers Killed in Battle and Died in Service during the Florida War. 64 p. 8°. Paper.

- War of the Rebellion: Official Records of the Union and Confederate Armies. Series I. Volumes 4 and 5. 4°. Cloth.
- Alphabetical Catalogue of the War Department Library (including Law Library), Authors and Subjects, 1882. 325 p. 4°. Paper.
- Report of an inspection of the Artillery School at Fort Monroe, Virginia, May, 1882. 27 p. 8°. Paper.
- Regulations of the Army of the United States, and General Orders in force on the 17th of February, 1881, with an appendix containing all military laws in force February 17, 1881, not contained in this code. 1,385 p. 8°. Paper.
- Adjutant-General's Office:
- Report of Lieut. Gen. P. H. Sheridan of his Expedition through the Big Horn Mountains, the Yellowstone National Park, &c. 34 p. 2 maps. 8°. Paper.
- Laws, Rulings, and Decisions Governing the Military Crime of Desertion, compiled by Fred. F. Wilson, 1882. 80 p. 8°. Paper.
- Subject-index to the General Orders of the War Department from January 1, 1861, to December 31, 1880, compiled by Jeremiah C. Allen. 506 p. 8° Paper.
- General Orders:
- For 1881, Nos. 77, 78, 80, 81, 82, 84-89, 92, 93, and index.
- For 1882, Nos. 1 to 120.
- Orders for 1881, Nos. 67-70, and index. 8°. Paper.
- 1882, Nos. 1 to 66. 8°. Paper.
- Bureau of Military Justice:
- Annual Report of the Advocate-General for 1882.
- Chief Signal Office:
- Professional Papers No. 1. Solar Eclipse.
- Professional Papers No. 3. Auroas.
- Professional Papers No. 4. Tornadoes.
- Professional Papers No. 5. Time Balls.
- Instructions to Voluntary Observers of the Signal Service. 108 p. 8°. Paper.
- Daily Bulletin of Synopses, Indications, and Facts October, 1877.
- Engineer Bureau:
- Extracts from the Reports of Decisions of the Supreme Court of the United States concerning navigable waters, repaying proprietors, bridges, boundaries between States, eminent domain, title to certain lots in Washington City, contracts, compiled by John G. Parke, Lieut. Col. of Engineers, 1882. 264 p. 8°. Paper.
- Professional Papers, No. 23: Report upon Experiments and Investigations to Develop a System of Submarine Mines. 444 p. 4°. Paper.
- Decrease of Water in Springs, Creeks and Rivers, by Gustav Wex, translated by Major G. Weitzel, United States Army. 57 pages. 8°. Paper.
- Translations of Treatises on Improvements of Non-tidal Rivers, by Maj. William E. Merrill. 4°. 129 p.
- Contributions to the Theory of Blasting or Military Mining, translated by Capt. C. W. Raymond.
- Annual Report 1881. 3 vols., with maps. 8°. Cloth.
- Professional Papers No. 24: Report on the Primary Triangulation of the Lake Survey, by Lieut. Col. C. B. Comstock. 4°. Cloth.
- Laws of the United States relating to the construction of bridges over the navigable waters of the United States from March 2, 1805, to March 3, 1881, compiled under the direction of Lieut. Col. John G. Parke.
- Compilation of Opinions of Attorneys-General relative to acquisition of lands, contracts, &c., Vols. 1 to 16 inclusive, compiled under the direction of Lieut. Col. John G. Parke.
- Annual Report for 1882. 3 volumes. 8°. Cloth.

Headquarters of the Army:

Map illustrating the defense of Savannah, Ga., and the operations resulting in its capture by the Army commanded by Maj. Gen. W. T. Sherman.

Map illustrating the operations of the Army under command of Gen. W. T. Sherman, in Georgia, from May 5 to September 4, 1864.

Annual Report, 1892.

Ordnance Bureau:

Ordnance Notes 173. Machine Guns—Their status in warfare.

174. Italian 100-ton Gun.

175. Dephosphorization of Iron and Steel.

176. Vent Punch and Gimlet.

177. Friction Primers for Cannon.

178. Flank Defense.

179. Infantry Equipments.

180. Krupp's Ballistic Tables.

181. Photography—Gunpowder Analyses.

182. Field Artillery.

183. Modern Rifles.

184. The Attack on Armor-clad Vessels by Artillery.

185. Cartridges—Friction Primers.

186. The National Defenses of England.

187. Modern Ordnance.

188. Telescopic Sight.

189. Army Wagon Transportation.

190. Mechanical Motion.

191. Report of Sea-coast Artillery Practice.

192. Metrical into United States Measures.

193. The Le Bouleugé Chronograph.

194. Field Gun Carriage.

195. On the Metallurgy and Manufacture of Modern British Ordnance.

196. On the Application of Solid Steel to the Manufacture of Small-arms, Projectiles, and Ordnance.

197. Notes on the Manufacture of Small-arms, &c., at the Royal Small Arms Factory. Enfield Loch.

198. Machine-guns, and how to use them.

199. Small-arm Firing.

200. Range and Position Finding—Past and Present.

201. Report on Cranston's Safety Lighting Attachment for Lanterns for the Life-saving Service.

202. The Folger-Michelson Densimeter.

203. The Progress in Naval Artillery from 1855 to 1880.

204. Firing Investigations of the Steel Works of Frederick Krupp, made at the Meppen Firing Ground.

205. The Question of Heavy Guns.

206. Fire Upsetting Machine.

207. Torpedoes—Their disposition and radius of destructive effect.

208. Recent Experiments with a 11-inch Compound Armor Plate at Shoeburyness.

209. A proposed Armament for the Navy.

210. Type of Armored Vessel and Cruiser best suited to the needs of the United States.

211. The United States Steamer Alarm.

212. Chemical Theory of the Combustion of Gunpowder.

Ordnance Bureau—Continued.

- Ordnance Notes
213. The Development of Armor as applied to Ships.
 214. Preservation of Wood.
 215. The Employment of Torpedoes in Steam-launches against Men-of-war.
 216. The Supply of Ammunition to Infantry on the Field of Battle
 217. Wallace's Intrenching Tool.
 218. The Interior Economy of a Prussian Regiment.
 219. A Short Narrative of the Afghan Campaigns of 1879-'80-'81, from an Engineer's point of view.
 220. Magazine Rifles.
 221. Krupp Experiments.
 222. Explosives: Notes on Nitro-Glycerine.
 223. Bombardment of Alexandria by the English July 11, 1882.
 224. Rifled Howitzers and Mortars.
 225. Deviations of Small-arm Projectiles.
 226. Fortress Warfare.
 227. Training of Garrison Artillery, &c.
 228. Determination of the Value of "C." Didion's Formula.
 229. Steel for Structures.
 230. The Theory of the Gas Engine.
 231. Instructions for use of the Frankford Arsenal. Hand tools for unloading Cartridges.
 232. Some Considerations respecting Desertion in the Army.
 233. The Theoretical Rifle (El Fusil Racional).
 234. Some Thoughts about the Future of our Army.

Notes on Construction of Ordnance:

1. Resistance to Décollasement (unbreeching) in Breech-Loading Cannon.
2. Recapitulation of Experiments on Cast-steel Hoops.
3. Plan of Gun Construction; Cast Iron strengthened with Bands of cold-hammered or cold-rolled Steel.
4. Mechanical Tests on the Resistance of Metals.
5. Verification of the Hooping for Cannon in the Italian Service.
6. The resistance of Hollow Cylinders and of Cannon; new studies.
7. The resistance of Hollow Cylinders and Cannon; new studies.
8. Trials of Expanding Sabots for Projectiles; Rifle Muzzle-loading Mortars.
9. Resistance of Metallic Tubes, Simple and Compound, with application to the Construction of Cannon.
10. Resistance of Simple and Compound Metallic Tubes with application to the Construction of Cannon.
11. Special Elasticity; Experiments to determine its Value and Deductions concerning its application for increasing the Advantages derived from the Use of Hoops in Gun Construction.
12. Treatment of Steel.
13. Fabrication of Cannon in France.
14. Experiments on Hooping 9" .45 guns.
15. Physical Properties of Metals.

Pay Department: Annual Report for 1882.

Quartermaster-General's Office:

Fuel for the Army, 1882.

Uniform for the Army, 1882.

Specifications for means of transportation of paulins, stoves, ranges, lamps, and fixtures for use in the United States Army in 1882.

Annual Report for 1882.

Subsistence Department:

Notes on bread making, permanent and field ovens and bake houses, prepared by direction of the Commissary-General of Subsistence, by Maj. George Bell, C. S., U. S. A., with extracts from notes on flour by the same officer. 143. p. 8°. Paper.

Annual Report, 1882.

Army Ration: Issue and conversion tables.

Surgeon-General's Office: Index Catalogue of the Library. Vol. 3. 4°. Cloth.

United States Geographical Surveys West of the One Hundredth Meridian:

Final Report Vol. 3, Supplement: Report upon Geological Examination in Southern Colorado and Northern New Mexico. 420 p. 36 p. appendix. 4°. Cloth.

REPORT OF THE ASSISTANT DIRECTOR OF THE UNITED STATES NATIONAL MUSEUM FOR 1882.

Prof. SPENCER F. BAIRD,

Director of the United States National Museum:

SIR: I have the honor to submit herewith a report upon the work of the Museum for the year 1882, in which are included certain suggestions relative to the administration of the Museum, which may at some future time, either in their present form or with modifications, be recommended for adoption.

Very respectfully,

G. BROWN GOODE,
Assistant Director.

U. S. NATIONAL MUSEUM, *January 1, 1883.*

With the beginning of the year 1882 systematic work in the reorganization and installation of the collections may be said to have been fairly commenced. Although something had been accomplished in the three or four months prior to the above date, the work was, for the most part, experimental. The year 1882 may, therefore, be regarded as the first year of the occupation of the new building.

On January 1, 1882, was issued Circular No. 1, containing a plan of organization and regulations. This pamphlet contains 58 pages, and in it are defined the limits of each department of work, the duties of every officer, and the routine to be followed in each kind of administrative work.*

This code of regulations has been systematically enforced during the year with consequent important improvement in the efficiency of each department.

Cases.—Much thought and time have been expended in making experiments for the purpose of ascertaining what forms of cases are most suitable for the exhibition of our collections. Old patterns have been modified and new ones invented. A detailed account of these experiments, and their results, will be submitted at some future time. Four thousand five hundred and eighty-six cases and boxes of various patterns have been received, as specified in the accompanying schedule. They have

* See Appendix to Proceedings United States National Museum, Vol. IV, following page 534.

been, as a rule, constructed by contract after the specifications had been submitted for competition to a number of reliable firms in Washington, Baltimore, and Philadelphia. The glass has been imported free of duty, the locks and other hardware purchased of manufacturers, and the finishing of the wood-work, the setting of the glass, and the fitting up of the interiors with shelves, and otherwise preparing them for the reception of specimens, have been done by a force of men working in the Museum building, paid by the day or job, as was found in each particular instance to be more economical and satisfactory.

The adoption of a peculiar style of case, known as the "unit-box," for the exhibition of many classes of objects, has rendered it necessary to employ a number of mechanics in mounting the specimens for display. In this work several women have been employed, who have proved to be industrious and skillful.

The following is a list of cases in use in the Museum and for the most part received during the year :

Case A (3. 3). Pier uprights, 8' 6" × 3' 3" × 9'.....	28
B (4. 4). Floor uprights, 8' 6" × 4' 4" × 7'.....	11
B (3. 3). Floor uprights, 8' 6" × 3' 3" × 7'.....	30
C (1. 3). Door screens 8' 6" × 1' 3" × 7'.....	25
C (2. 2). Door screens, 8' 6" × 2' 2" × 7'.....	28
D (1. 3). Sliding screens, 8' 6" × 1' 3" × 7'.....	55
D (2. 2). Sliding screens, 8' 6" × 2' 2" × 7'.....	11
E. Flat screens.....	53
F (1. 2). Fold screens, half pillar.....	11
G. Slope screens.....	1
H. Table uprights.....	21
I. Unit tables.....	91
J J ₂ J ₄ . Unit drawers.....	2,490
K. Unit boxes.....	1,606
L. Wall uprights.....	4
N. Gothic alcoves.....	18
O. Basement drawer-storage.....	6
P. Sectional library cases.....	14
Q. Standard shelf-stacks.....	29
R. Standard pigeon-hole stacks.....	30
S. Quarter tables.....	22
Trophy cases.....	1
Costume cases.....	1

4,586

Labels.—Similar experiments have been made in regard to labels, many different styles of type and colors of paper and methods of arrangement having been tried. It has been found necessary to employ

a printer to operate the presses belonging to the Museum, and his services have been particularly valuable in this work of experimenting. One of the chief obstacles to the labeling of the collections has been the uncertainty as to what form of label should be used, while another difficulty, equally embarrassing, has been experienced in endeavoring to decide exactly how much descriptive matter might properly and effectively be printed on a given label. Nearly 1,200 objects have, however, been finally labeled, and this work is rapidly advancing.

Fitting up Laboratories.—Several of the curators' laboratories have been fitted up with storage cases and furniture, and are now better supplied with conveniences for work than ever before. Among these may be specially mentioned those in the departments of birds, fishes, mollusks, insects, invertebrate fossils and fossil plants; and the increased facilities for work thus afforded to the several curators cannot fail to be productive of great general advantage to the Museum.

Monthly Reports.—During the year each curator and chief of department has submitted to the Director a monthly report of the operations of his department.

Storage and Archives.—The Registrar, Mr. S. C. Brown, has had in charge the Department of Registry and Storage, his duties being the keeping of the registry books, the reception and assignment of packages, the packing and unpacking of boxes, and the acknowledgment of donations. He has also had in charge the department of archives. The storage rooms have been entirely rearranged and a card-catalogue of their contents prepared, and the records of the year have been carefully kept, in accordance with the requirements of the new code of regulations, besides which considerable progress has been made in the work of arranging in a similar manner the accumulations of past years. The rules for the administration of collections, as specified upon pages 25 and 26 of the "Plan of Organization," already referred to, have been faithfully put upon trial by the Registrar, and have been found thoroughly practicable and much to the advantage of the general service of the Museum.

Library.—The Librarian, Mr. Frederick W. True, has successfully carried out the regulations and specifications issued in the "Plan of Organization," on pages 37 and 38. The establishment of the central and sectional libraries has been perfected, and a complete card catalogue prepared.

The Library is now estimated to contain 5,800 books and 5,500 pamphlets.

The Library room has been remodeled and enlarged during the year, and will now accommodate conveniently at least 10,000 volumes. Fuller details may be found in the report of the Librarian.

Publications.—Volume IV of the "Proceedings of the National Museum" for 1881, has been published, under the editorship of Dr. T. H. Bean. It is a book containing 534 pages, with an appendix consisting

of eighteen circulars (in all 142 pages), explanatory of the work proposed for the Museum. A list of these circulars is here appended.

	Pages.
No. 1. Plan of organization and regulations	58
No. 2. Circular addressed to friends of the Museum	2
No. 3. Circular in reference to petroleum collections	2
No. 4. Circular concerning the department of insects	1
No. 5. Establishment and officers	2
No. 6. Classification and arrangement of the materia medica collections. By James M. Flint, surgeon, United States Navy	2
No. 7. A classification of the forms in which drugs and medicines appear and are administered. By James M. Flint, surgeon, United States Navy	7
No. 8. Memoranda of collectors of drugs for the materia medica section of the National Museum. By James M. Flint, surgeon, United States Navy	2
No. 9. Circular in reference to the building-stone collection	9
No. 10. Two letters on the work of the National Museum. By Barnet Phillips	10
No. 11. A provisional classification of the food collections. By G. Brown Goode	18
No. 12. Classification of the collection to illustrate the art of taxidermy	2
No. 13. Outline of a scheme of Museum classification. By G. Brown Goode	4
No. 14. Circular requesting material for the Library	3
No. 15. The organization and objects of the National Museum	4
No. 16. Plans for the installation of collections	2
No. 17. Contributions and their acknowledgment	1
No. 18. List of publications of the United States National Museum	12

Bulletin 19 of the Museum, consisting of Mr. Samuel H. Scudder's "Nomenclator Zoologicus," has been published during the year; also Bulletin 11, consisting of Prof. Theodore Gill's "Bibliography of the Fishes of the Pacific Coast;" Bulletin 22, consisting of Mr. Lester F. Ward's "Guide to the Flora of Washington and Vicinity;" and Bulletin 24, consisting of Dr. H. C. Yarrow's "Check-List of North American Reptilia and Batrachia," complete the list of those published in 1882. Bulletin 23 has been sent to press. Bulletins 16 and 20 have been passing through the press during the year, but have not yet been issued.

Dr. Bean has prepared a list of the publications of the Museum, with indexes. This has been printed in Circular 18, and is of great aid in the consultation of the matter which has been published by the Museum during the last seven years. It has not yet been found practicable to issue, from time to time, as provided for in Section C of the "Plan of Organization," the list of accessions to the Museum, although the desirability of such a publication as this is growing constantly more apparent.

Duplicates and Exchanges.—During the year 1882 there were only

three of the departments of the Museum that attempted any regular distribution of specimens, viz:

		Specimens.
Department of birds	32 packages, 597 species	892
Department of invertebrates ..	30 packages.....	9,986
Department of minerals	30 packages, 793 species	995
A total of	92 packages.....	11,873
There were also sent from the Museum to individuals and collectors in the field 312 packages, consisting of single specimens, small lots, and collecting materials, aggregating 518 specimens		
		518
Making in all		12,391

During the year, 102 applications for specimens were received from museums, schools, and individuals; and of these and previous applications on file, 98 have been supplied in whole or in part.

The total number of specimens distributed prior to the close of 1882 is about 435,000.

Property and Supplies.—Operations in this department have been greatly facilitated during the year by the introduction of two important measures.

There is now only one order-book, which is kept in the office of the Assistant Director, and no supplies, however small, can be obtained without the filing of a formal requisition specifying the probable cost of the articles required. The requisitions approved are numbered to correspond with the serial numbers in the order-book, and are filed away for reference. Every expenditure is thus placed on record, and the sum total of the prices entered on the order-book, together with the amount of the regular pay-roll, will, at the end of any month, indicate exactly the amount of liabilities for the month. A requisition for the hire of a laborer for half a day is treated in the same manner as that for a large order of goods.

In addition to this, a property clerk has been appointed to take the charge of unpacking and cataloguing every article of furniture or supply received, of issuing the same upon "house requisitions," and of preparing a semi-annual report, thereby relieving the Superintendent of the labor and responsibility of this work.

Mr. C. W. Schuermann was appointed property clerk on July 1, 1882, and has been efficient in his work. He has submitted perfect 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.

The property clerk has also been charged with the duty of inspecting and reporting upon each article of furniture and all supplies purchased for the Museum.

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.

Buildings and Labor.—Under the administration of Mr. Henry Horan, superintendent of the buildings, the watchmen, mechanics, and the laborers have rendered exceedingly efficient service. The published regulations * have been put into effect, and found not only practicable, but of great advantage in promoting the efficiency of all departments.

There are now upon the permanent roll in this department one superintendent of buildings, two assistant superintendents of buildings, one engineer, one assistant engineer, three firemen, three carpenters, two painters, one mason, twelve watchmen, four janitors, twenty laborers, four messengers, and two cleaners.

In addition to the permanent force, several mechanics, chiefly carpenters, have been working, under the direction of the superintendents, on the construction and fitting up of cases. It has been found more economical and satisfactory to build cases in this way than to put them out by contract, but lack of room has rendered it impossible to do this except in a few instances. The regular employees of the Museum have, as in former years, been required to wear a simple uniform. The cleanliness of the building and its preservation in good repair, as also the general public-comfort service, have been efficiently attended to.

The safety of the collections has been more carefully guarded during this year than hitherto. The numerous private doors in the old building have been closed, and a watchman is now stationed at every entrance. No persons, except officers of the Museum, are allowed to carry packages out of the buildings without a written pass, and no one is allowed to carry umbrellas or canes into the exhibition halls. These rules have caused considerable dissatisfaction, both among employees and visitors; but in my opinion strict custody is absolutely necessary for the safety of the collections. Even now it is impossible to keep people from handling and disfiguring objects which are not covered with glass; and on Saturdays and other holidays it is necessary to employ a considerable portion of the laboring force in guarding uncovered objects in order to prevent visitors from carrying them away piecemeal. One of the worst annoyances with which we have to contend is the mania of the "relic-hunter," who, devoid of all conscience, does not hesitate to break off and carry away with him pieces of any objects that may come within his grasp, especially such as are the more interesting on account of historical associations. The more precious the objects, the greater is his greed for the possession of fragments.

The number of persons employed in guarding and caring for the building seems, at first sight, unnecessarily large, and it certainly is a

* "Plan of Organization and Regulations," Article CXL (on requisitions), Appendix No. 1 to Proceedings of United States National Museum, Vol. IV.

cause of great regret that it should be necessary to expend so much of the appropriation in this manner; but experiments, made with a view to reducing the number of this body, have forced me to the conclusion that it should be increased rather than decreased.

Electric Service.—The electrical service is being slowly perfected, under the supervision of Mr. W. J. Green, electrician. Extensive systems of telephones in the several buildings, as well as at the residences of three or four of the chief executive officers, have aided in facilitating business, and have enabled us to dispense almost entirely with messenger boys.

I here present a description of the electrical service as at present arranged. In the electrical room of the National Museum are the following articles of apparatus:

One 50-drop telephone switch-board, with 34 connections, 14 of which are in the National Museum, 9 in the Smithsonian building, and 11 outside. There are 5 ordinary electric lamps, and 2 electric lamps for photographic purposes, with dynamo-electric machine and resistance-box. There is also a 100-drop annunciator, to which are connected 300 windows and 85 doors throughout the Museum building; 1 large watch-clock for recording on paper dials the time signals which the watchman turns in from the 12 clock stations throughout the building as he makes his patrol; and one alarm box of the district Telegraph Company. In the Smithsonian building there are 9 clock stations, controlled in the same manner as those in the Museum building, and also a special telephone connection with the city.

Preparation of Specimens.—The work of the preparators has been extensive and important. Mr. Joseph Palmer, chief modeller, has been engaged during a large part of the year in mounting the skeleton and cast of a humpback whale, 32 feet in length, which now stands in the south main hall. This is the largest cast of an animal that has yet been made, and is unique in conception. Viewed from the left side, the visitor sees the cast of a whale in the attitude of swimming through the water. Standing on the right he sees the concavity and inner outline of the half cast, in which against a suitable background is mounted the articulated skeleton of the animal. Mr. Palmer has also made during the year a number of casts of smaller whales and of fishes, and his assistant, William Palmer, has devoted several months to making a papier-maché cast of the model of the town of Zuñi, which was prepared by Mr. Mindeloff under the direction of the Bureau of Ethnology. Mr. Wm. T. Hornaday was appointed chief taxidermist on March 16, 1882. Among the important objects mounted by him during the year are a young African elephant, a polar bear, and a cinnamon bear. Mr. Henry Marshall, taxidermist in the department of birds, has mounted about 450 specimens in a very satisfactory manner. Mr. A. Zeno Shindler, artist, has been employed almost entirely in repainting the collection of fish casts.

Mr. J. Hendley has devoted much time to repairing broken speci-

mens, and during the past five months has been employed in making dummies for the display of various costumes in the possession of the Museum.

Accessions.—The number of packages received by the Registrar during the year was 10,045, of which 5,401 were cases and parts of cases paid for from the "furniture and fixtures" appropriation, while 1,287 were received through Mr. Thomas Donaldson from the permanent exhibition on the Centennial grounds at Philadelphia, having been transported hither in December in seventeen freight-cars. The remaining 3,357 were packages received in the ordinary course of administration.

Number of Visitors.—Since the 8th of February the janitors at the doors of both buildings have registered the number of visitors by means of a tally machine, and it has been ascertained that the average daily number of visitors to the Museum building has been 535, and to the Smithsonian building, 488. The total number of visitors for the year, calculated upon this basis, has been, for the Museum, 167,455; for the Smithsonian building, 152,744.

Lectures.—During the year the Biological Society has held its meetings regularly in the lecture-room of the Museum, and two courses of lectures have been delivered in the same apartment.

The first of these, the Saturday lectures, under the direction of a committee of the Biological and Anthropological Societies, were given on Saturday afternoons in March and April. These lectures, eight in number, were attended by audiences of 500 to 900 people. In December a course of "young folks'" lectures, under the same auspices, was begun, and twelve lectures were delivered. These were attended chiefly by teachers and advanced scholars of the public schools and seminaries of the city. Many of these lectures were illustrated by specimens from the Museum, or have had a definite bearing upon its work, and it is hoped that they have increased its popularity and efficiency.

The first lectures were delivered in the northwest range, which was fitted up with considerable care as a lecture-room; but it was soon discovered that this was not large enough to accommodate the audiences in attendance, and accordingly the west-north range, which is 26 feet longer, was fitted up, and the old lecture-room abandoned.

The Extent of the Museum.—An attempt has been made by the curators of the several departments to estimate the total number of specimens in the Museum. This estimate is at present only a partial one, but it may not be amiss to quote its results for the departments which are sufficiently organized to permit it.

	Specimens.
Department of antiquities.....	35,512
Department of mammals.....	8,265
Department of birds.....	44,354
Department of reptiles.....	26,258
Department of fishes.....	50,000
Department of mollusks (catalogue entries, it being impossible to estimate the number of specimens).....	33,375

	Specimens.
Department of insects.....	about 1,000
Professor Riley's private collection	150,000
Department of marine invertebrates.....	Impossible at present to estimate.
Department of fossil invertebrates	Impossible at present to estimate.
Department of minerals	Impossible at present to estimate.
Department of rocks and building-stones; in reserve series.....	9,075
Department of metallurgy and economic geology.....	Impossible to estimate.

DEPARTMENT OF ANTIQUITIES.

The arrangement of the collections in the department of antiquities, under the administration of Dr. Charles Rau, is, as it has been for some years past, more perfect than in any other in the Museum. To this department will eventually be devoted all of the upper exhibition hall in the older Museum. At present the upright floor-cases and more than half of the wall cases are filled with specimens belonging to the department of arts and industries, the implements and manufactures of partly civilized races of the present day. These are being removed as rapidly as possible to the new Museum.

The unexpected delay in transferring the ethnological and industrial materials to the new Museum has retarded Dr. Rau's contemplated re-arrangement of portions of this collection in the upright floor-cases. A few, however, have been emptied, and in these, special mound collections have been placed, with excellent effect.

During the coming year (without question) an additional number of these cases will be emptied, thereby providing space for a much more striking presentation of the relics of prehistoric man than at present.

Embarrassment has also been caused by the fact that prehistoric objects and modern ethnological and industrial material have hitherto been entered indiscriminately in the same register, and that, with the expansion of the scope of the Museum and the separation of modern and ancient material in the two buildings, these combined catalogues are very inconvenient. The work of making a duplicate copy of the catalogue has already been begun.

Dr. Rau reports the following as the number of specimens at present under his charge: Total, 35,512, of which 21,217 are on exhibition, 7,748 are in the reserve series, and 6,547 are duplicates.

The total number of accessions has been 3,569, of which 2,554 were acquired by gift, 353 by exchange and purchase, 511 from explorers employed by the Smithsonian Institution, and 141 by deposit. Two lots of duplicates, containing, respectively, 27 and 171 specimens, have been distributed.

Four papers have been published by the curator of this department during the year, and in the "Proceedings" of the Museum, volume IV, was printed a list of his publications relating to anthropology which appeared between 1859 and 1882—fifty-two titles in all.

Dr. Rau has been engaged during the year in the preparation of an

extensive illustrated work upon prehistoric fishing in Europe and North America.

DEPARTMENT OF ARTS AND INDUSTRIES.

When, in 1857, the Smithsonian Institution assumed the custody of the collection of the United States Exploring Expedition, together with the miscellaneous material which had gathered around this nucleus, a great quantity of material was transferred to the Smithsonian building which has not to this day been classified and placed upon exhibition. The rapid growth, especially during the past decade, of the collections illustrating the ethnology of North American Indians, and especially of prehistoric objects from this continent, has absorbed the attention of all who were interested in this department of the Museum. A year ago the majority of the foreign ethnological objects were, on account of lack of room, packed up or crowded together in a too limited amount of case-room. At the close of the Centennial Exhibition the Museum received from foreign Governments great quantities of material exhibited at Philadelphia, which, while possessing an undoubted ethnological interest, could not in many instances be displayed in the manner usually adopted in ethnological museums.

The material received from Philadelphia in 1876 was for several years stored in the Armory building. On completion of the present Museum building, and before the collections could be transferred to it, it became necessary to decide by what method the stored material (other than zoological, botanical, geological, or mineralogical) could be most effectively classified for purposes of study and exhibition.

After a careful consideration of the methods of the large museums of Europe, the officers of the Museum agreed that the ordinary classification by races or tribes would in this case be less satisfactory than a classification based upon function.

In the report of the Smithsonian Institution for 1881, pages 117-122, and also in circular No. 13, of the National Museum, the Assistant Director presented a provisional outline of a plan of classification for the Museum. This classification, while its purpose was to embrace every kind of object which could possibly be exhibited in the Museum, was especially full in those parts which related to the arts and industries, forty-nine out of the sixty-four primary classes relating to this group of museum material. The general idea of the classification, as there explained, is that the collections should constitute a museum of anthropology, the word "anthropology" being applied in its most comprehensive sense. It should exhibit the physical characteristics, the history, the manners past and present of all races civilized and savage, and should also illustrate human culture and industry in all their phases; the earth, its physical structure, and its products are to be exhibited with special reference to their adaptation for use by man. The so-called "natural history" collections are grouped in separate series, which are to be

arranged in accordance with the well-tried methods prevailing in natural-history museums, and which would, of course, occupy a very large portion of the space and the attention of a majority of the staff, as at present constituted, but which, at the same time, should illustrate and supplement the collections in industrial and economic natural history.

Some experiments have already been made with reference to the feasibility of this plan of arranging the exhibition series, but I am not yet prepared to recommend its final acceptance.

The adoption of this plan would necessitate the grouping together, in continuous series, of objects which had never before been placed side by side in any museum. If the evolution of any given industry or class of objects is to be shown, the series should begin with the simplest types and close with the most perfect and elaborate objects of the same class which human effort has produced.

In the textile industry, for instance, at one extreme is shown the simple whorl of stone or terra cotta, used by savage or semi-civilized man, together with the archaic representative of the same, surviving among rural members of the most highly civilized races; these being supplemented by the threads and the simple woven fabrics produced by them; on the other hand, the steam spinning apparatus and the power and Jacquard looms.

Much attention has been devoted during the year to experiments for determining the manner in which the idea of this classification can best be carried into effect. It is not possible within the limits of this report to describe what has been done. In fact a full account of them at present would be premature. The practicability of the scheme can best be judged of by an examination of the one or two groups, such as the materia medica collection, the collection of musical instruments, and the portion of the costume collection, which are already partly installed.

The department of arts and industries with the growth of the Museum will naturally be divided into a number of independent sections, each under the charge of a curator. In its present partially organized condition it is under the special charge of the Assistant Director. The section of materia medica has, however, been entirely under the control of Dr. James M. Flint, U. S. N., detailed for this service by the Surgeon-General of the Navy. Mr. J. King Goodrich has since the first of November been acting as assistant, devoting particular attention to the arrangement of the musical instruments and the costumes, while Mr. A. Howard Clark has been engaged in the reorganization of the section of fisheries. The section of building-stones and stone-working has recently been assigned to Mr. George P. Merrill.

This department at present occupies nearly all of the northern half of the Museum building. No assignment of space has been made to special subjects. The extremely flexible system of cases which has been adopted permits us to arrange the collections in very small subdivisions.

The unit of bulk is a glass-covered box 24 by 30 inches. When sixteen of these boxes are filled with specimens and labelled, they are grouped together by sliding them into place in a specially prepared frame. When several of these groups have been arranged, if a different order of sequence seems preferable, the work of re-arrangement can easily be accomplished by giving a few words of instruction to a mechanic, who changes the position of the unit boxes in the screens. We thus have an immense advantage over those museums which have fixed cases of large dimension, and which must needs, therefore, assign from the first a definite amount of space to each class of objects. Our policy has been to mount objects in the unit boxes as rapidly as small groups could be brought together, the only limitation being that objects derived from different races or nations should not be mingled in the same box. By this means, if at any time a rearrangement by race criteria seems desirable for any special purpose, it can be effected without difficulty. For instance, let us suppose that all the objects in the department of arts and industries had been arranged according to function—all the pipes together, all the weapons together, all the foods together and all the games and amusements together. If the Eskimo or Japanese objects are to be studied or lectured upon, it is simply necessary to go through the halls, and to mark upon the glass front of each small unit case with French chalk, to withdraw these unit boxes from the screens, and to close up the gaps by sliding the unit boxes closer together and removing the screens, which are thus thrown out of use.

It is, of course, impracticable to arrange everything in the unit boxes. Many other similarly flexible systems of installation are employed which will be described in a future report.

In the above remarks I have attempted simply to explain the principle of our methods.

At the end of the year about 500 unit boxes had been filled, and about 500 labels had been printed. The work of preparing descriptive labels is very laborious, and the subject of labels has received almost as much study during the year as that of cases.

It is impossible at present to form any estimate whatever of the extent of the collections in this department. There are over 60,000 entries in the ethnological catalogues. A large number of these relate to pre-historic objects which are not assigned to the department of arts and industries, while great quantities of objects still remain unentered. A great quantity of others properly belonging to this department are entered in the catalogues of the department of mineralogy and other departments of the Museum.

The number of entries during the year in the catalogue, exclusive of archæological specimens, has been 7,875. At the close of another year the curator hopes to present a careful estimate of the condition and capabilities of the department.

DEPARTMENT OF MAMMALS.

Mr. Frederick W. True, assistant curator, has been acting as curator of this department since January 20, 1882, at the same time performing the duties of librarian.

The south main hall of the new Museum has been fitted with exhibition cases for the reception of the mounted mammals, and also with a considerable number of storage cases of the unit-table pattern for the reserve series of skins. The room at the west end of the south balcony is used as a laboratory for this department, and the room on the third floor above it has been assigned for the storage of the alcoholic series. These rooms are very small, and it has been found necessary to make use of a part of the south balcony in addition.

Since the mammal hall has been ready for occupation, the entire time of the curator and one or two assistants has been devoted to transferring the collections from the old Museum and to their rearrangement. Little attention having been paid to the mammal collections since 1876, it has been found necessary to devote much time to bringing up arrearages of work, and to inspecting and relabeling almost every specimen. This work has been very efficiently inaugurated by Mr. True, who has also nearly completed a preliminary card-catalogue of the collection arranged alphabetically under genera.

A very effective preliminary display of the mounted mammals has been made, and studies have been prosecuted and experiments made in preparation for a system of full descriptive labels.

The osteological section of the mammal collection still remains in the east gallery of the lower hall of the old Museum.

The cast of a humpback whale, elsewhere referred to, has within the past month been finally placed at the south end of the mammal hall.

The number of specimens is estimated by the curator to be 8,265, 4,660 being skins, of which 689 are mounted and on exhibition, 3,535 in the osteological series, and 70 in the anatomical series.

On page 130 of last year's report may be found the census of the collection of mounted mammals. The number of entries for the past year in the mammal catalogue has been 293; in the osteological catalogue, 139.

One paper based upon the material of this department has been published by its curator, who has, however, also printed several contributions to other departments of science.

DEPARTMENT OF BIRDS.

There has been great activity in the department of birds, notwithstanding the fact that it has been impossible for the curator, Mr. Ridgway, to make any changes in the appearance of the exhibition series. The mounted birds are now displayed on the main floor of the lower hall of the old Museum and in a part of its western gallery, but the

cases are crowded so fully that no effective display can be made until the cases in the eastern gallery are emptied of the osteological collection which they now contain. The cases in this hall are all old and somewhat unsuitable, and it is hoped that before long they may be reconstructed. The number of mounted specimens is so great that their rearrangement is an undertaking of great magnitude, especially since it involves the transfer of a large proportion of them from the old fashioned white perches, to which they are now fastened, to the improved pattern recently adopted. It also involved the rewriting and reprinting of a majority of the exhibition labels, changes in ornithological nomenclature having of late years been very considerable. Rearrangement, therefore, means an immense amount of work, and Mr. Ridgway has refrained from undertaking it until the whole of the hall assigned to ornithology shall be at his disposal. The birds in the exhibition cases are, however, arranged in systematic order, with the exception of those in one case. Much has been done also in the way of weeding out from the exhibition series surplus specimens and those which are faded or badly mounted, the latter being replaced by newly-mounted specimens of excellent workmanship. It is but fair to say that the curator of birds would have accomplished much more in this department of his work, had not the fitting up of the new Museum absorbed so much of the time of our force of mechanics and preparators.

His time has been no less usefully spent in the rearrangement of the study series, which is nearly eight times as large as that upon exhibition. This series is arranged in "Salvin" cabinets and other receptacles in the southern half of the west basement and in the two upper rooms of the south tower, the lower of which has since 1870 been used by the curator of birds for a laboratory. The necessary inspection of the collections occupies much time, since they fill 347 drawers, in which they are often arranged in small trays, three or more layers deep. An important improvement introduced into this department has been to line the drawers containing the birds with heavy carbolized paper, as protection against insects. This same carbolized paper of thinner texture has been used to great advantage in wrapping and packing skins sent in by collectors from remote localities, especially when part of the transportation has been by sea.

The collection of eggs which, as is well known, is, so far as North American species are concerned, the most complete in the world, is stored in various receptacles in the west basement and in the drawers of table cases in the ornithological hall. Plans are being made for new cabinets, in which this great collection shall be arranged.

Mr. Ridgway makes the following report upon the present condition and general needs of the collection :

Number of specimens.—The collections belonging to the department of birds are at present divided into nine separate lots or series as follows :

1. The reserve series of smaller North American birds, including the orders Passeres

(except larger Corvidæ), Macrochires (except Humming-birds), and Picariæ (except genera *Campephilus* and *Hylotomus*). These are stored in walnut cabinets in the upper room of the south tower.

2. The reserve collection of smaller Neotropical birds, including the order Passeres (except Corvidæ and larger Cotingidæ), the Humming-birds (with which are included also the North American species), and smaller Picidæ (Woodpeckers). These are temporarily packed in tin herbarium cases in the main upper room of the south tower.

3. The reserve series of smaller old world land-birds, arranged in a walnut cabinet in the top room of the south tower.

4. The reserve series of larger birds, arranged systematically, and including chiefly Gallinaceous birds, water-birds, and birds of prey, but also the larger Corvidæ and Cotingidæ, the genera *Campephilus* and *Hylotomus*, and all of the Neotropical as well as old world Picariæ (except Picidæ) and Parrots. This, the most bulky portion of the collection, is stored in twelve large cabinets of the "Salvin" model (measuring 8 feet in length by 4 feet in breadth and height), and seventeen large chests, and other cases, in the west basement.

5. The exhibition series in the museum cases.

6. Mounted specimens intended for the exhibition series, but not yet put on stands

7. The duplicate series, stored chiefly in the west basement.

8. The collection of alcoholic specimens, intended for anatomical investigation, also in west basement.

9. Collections in storage, not yet acted upon.

A summary of the number of specimens contained in these separate series, as determined by a careful inventory concluded December 30, 1882, is as follows: *

	Specimens.
1. North American reserve series.....	8, 839
2. Neotropical reserve series.....	8, 733
3. Old World reserve series.....	1, 294
4. Reserve series of larger birds.....	8, 259
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Total reserve skin series.....	27, 185
5 and 6. Exhibition series (including 161 specimens not yet put on stands)..	5, 779
8. Alcoholic series.....	1, 524
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Total reserve series.....	34, 488
7. Duplicate series.....	9, 356
9. Unassorted collection (in storage).....	510
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Total number of specimens in the collection.....	44, 354

Storage.—The bird collections of the Museum are stored as follows:

The *North American reserve collection of smaller birds* in ten walnut cases, fitted with open drawers and loose-fitting sash doors; two of these cabinets measuring 53 inches long, 26 inches wide, and 38½ inches high; the others measuring 37½, 26, and 36½ inches, respectively.

The *Old World reserve collection of smaller birds* in one case similar to the larger sized ones containing the North American collection.

The *Neotropical reserve collection of smaller birds* (except Humming-birds), in eighty-one old Japanned-tin herbarium cases, 19 inches long, 13 inches wide, and 6 inches thick.

* The discrepancy between this statement of the extent of the bird-collections and that contained in the Assistant Director's report for 1881, is explained by the fact that the latter was based merely upon a rough estimate, it being impracticable at the time to make an actual inventory.

The reserve Humming-bird collection, in a galvanized-iron chest, 30½ inches long, 21 inches wide, and 20½ inches high.

The reserve collection of larger birds (not classified geographically) in twelve large "Salvin" cabinets, each 8 feet long, 4 feet wide, and 4 feet high, with closed, interchangeable drawers; and in seventeen large chests measuring 46½ inches long, 29½ inches wide, and 21½ inches high.

The duplicate collection in various drawers, chests, and boxes, or wherever room can be found.

Desiderata.—It having been the policy of the Museum to make a specialty of American ornithology, the chief desiderata are in consequence principally among foreign birds. The collections of the Museum embrace, however, tolerably good collections from Europe, New South Wales, New Caledonia, Polynesia, and Kerguelen Island. But from Africa, Asia (except Japan and parts of Eastern China), New Guinea, the East India Islands, Philippines, Tasmania, Madagascar, and the various islands of the Indian, South Atlantic, and Antarctic Oceans, the Museum possesses little or nothing; while the birds of New Zealand, Western and Northern Australia, the Sandwich Islands, and Japan, are very incompletely represented. The most desirable Old World birds are of course those of the eastern portion of the Palæartic region (Siberia, Kamtschatka, Japan, etc.), the close zoölogical relationship between that region and North America requiring a careful and complete comparison of specimens from the two regions, not only in the case of species common to the two (circumpolar species), but also of representative species and genera.

There are also still many important desiderata among Neotropical birds, which it is highly desirable should be secured as soon as practicable. A full list of these desiderata has been published in the "Proceedings" of the National Museum (vol. 4, pp. 165-203). The total number of Neotropical species of birds known to date, is about 3,800, exclusive of North American species found within Neotropical limits. Of this number the National Museum possesses no less than 2,225 species, among them being not a few which are unrepresented in other museums. The national collection is especially rich in West Indian birds, containing as it does nearly all the known species of that interesting portion of the world, and is by far the most complete extant.

The aggregate number of specimens of Neotropical birds in the collection is not known; but the reserve skin series of Passeres, Trochilidæ, and Pici (exclusive of the genera *Campophilus* and *Hylotomus*) alone contains nearly 9,000 specimens.

In volume 4 of the "Proceedings" of the National Museum (1881, pp. 165-203), there was published a "List of species of Middle and South American birds, not contained in the United States National Museum," the object of the list being to acquaint museums and individuals with the desiderata of the collection. Copies of this list were judiciously distributed, the direct result being the addition of nearly 100 species to the collection, and the promise of several hundred more.

Among North American birds there still remain a few important desiderata. Principal among these are, of course, species of which the Museum possesses no specimens whatever, as Cuvier's Kinglet (*Regulus curieri*), Lawrence's Warbler (*Helminthophaga lawrencei*), the White-throated Warbler (*H. leucobronchialis*), the Cincinnati Warbler (*H. cincinmatiensis*), the Carbonated Warbler (*Perisoglossa? carbonata*), the Blue Mountain Warbler (*Dendroca? montana*), Small-headed Flycatcher (*Myiodiodes? minutus*), Grinnell's Water Thrush (*Sialurus navius notabilis*), Large-billed Shrike (*Lanius ludoricianus robustus*), Brewster's Linnet (*Ægiothus brewsteri*), Thick-billed Parrot (*Rhynchopsitta pachyrhyncha*), Arctic Horned Owl (*Bubo virginianus arcticus*), Krider's Hawk (*Buteo borealis krideri*), Pallas's Cormorant (*Phalacrocorax perspicillatus*), Siberian Gull (*Larus affinis*), Hornby's Petrel (*Oceanodroma hornbyi*), Large-billed Puffin (*Fratercula arctica glacialis*), Short-winged Guillemot (*Brachyrhamphus brachypterus*), and Sooty Guillemot (*Uria carbo*). The first, fifth, sixth, and seventh of the above named species, it may be remarked, do not exist, so far as known, in any collection. The Museum is also particularly desirous of obtaining good specimens of the Califor-

nian Vulture or Condor (*Pseudogryphus californianus*), and of the American Flamingo (*Phænicopterus ruber*), for the exhibition collection.

A complete list of the desiderata of the Museum among North American birds has also been published in the "Proceedings" (vol. iv, pp. 207-223).

The number of entries in the bird register during the year has been 3,761, and of eggs 300. In the latter case, however, the figures afford no indication of the actual number of specimens catalogued. The number of packages sent out was 57, twelve being distributed in exchange, 38 lent for examination, (of which 28 have been returned,) and seven miscellaneous, the total number of specimens distributed having been 892 of skins, representing 597 species, and 123 lots of eggs, representing 90 species.

Forty-four papers founded upon this collection, have been published by eleven persons as follows: Robert Ridgway, 18; William Brewster, 13; Dr. L. Stejneger, 3; Mr. George N. Lawrence, 2; Mr. N. C. Brown, 2, and one each by Dr. T. H. Bean, Mr. E. P. Bicknell, Mr. J. H. Gurney, Mr. C. C. Nutting, Dr. R. W. Shufeldt, and Mr. L. M. Turner.

The curator has also devoted much time to the revision of the final volumes of the "History of North American Birds."

A full bibliographical list, as well as an account of the many valuable accessions to this department will be found in another part of this report.

Bird Skeletons.—The care of the collection of bird skeletons was voluntarily assumed by Dr. R. W. Shufeldt, U. S. A.. During the early part of the year the unassorted material was inspected and re-arranged, and was made by Dr. Shufeldt the basis of several publications. In 1882 Dr. Shufeldt was ordered to New Orleans, and the collection now stands in the bird compartment of the west basement of the Smithsonian building.

DEPARTMENT OF REPTILES AND BATRACHIANS.

Dr. Henry C. Yarrow, U. S. A., has continued to act as curator of this department. His services have been voluntary as heretofore, and and he therefore stands upon the list of officers as an honorary curator. His duties in connection with another department of the Government service have rendered it impossible for him to devote very much time to the Museum except in his vacation, though two assistants have been working steadily upon the collections during the entire year. This collection is now established in the easternmost of the small rooms south of the corridor leading to the west basement of the Smithsonian building. This can be regarded solely as a storage room and the collection as being provisionally in storage, though the specimens are arranged in a systematic order unsurpassed in any other department. Nothing is on exhibition except the collection of casts of snakes and turtles in the north hall of the new building. Much of the material, lent many

years ago to Prof. E. D. Cope for investigation, has been returned and incorporated with the remainder of the collection.

One of the most important tasks accomplished during the year has been the preparation of a complete catalogue of the North American species in which every specimen, with its locality and the name of its collector, is given, the duplicates being specially designated. This is the first of the systematic catalogues of the National Museum and forms Bulletin 24, prefaced by a new check-list of the reptiles and batrachians of North America.

Much has already been accomplished by the curator of this department in the identification and final arrangement of the exotic reptiles, a task which, like that of rearranging those of North America, has been especially laborious, for the reason that the original labels in many instances were destroyed in the fire of 1865, and have never been replaced.

The number of entries in the record books for the year is 230, representing about 920 specimens. The following census of the collection is presented by the curator:

Reserve series.....	7,972
General series.....	2,686
Temporary exhibit.....	600
Duplicates.....	2,000(?)
Identified.....	5,000(?)
Total, about.....	18,000

This census relates to the North American reptiles. In addition there are estimated to be about 8,000 foreign reptiles. A number of living reptiles have been placed on permanent exhibition in the new building.

DEPARTMENT OF FISHES.

The west range of the Smithsonian building has been assigned to the department of fishes for exhibition purposes, and has been redecorated and fitted with new cases. The fish laboratories in the north end of the west basement on the first story, in the basement north of the corridor leading to the west basement, in the east end of the cloister north of the west range, and in the temporary second story of the same cloister, have been re-arranged and made more convenient by building a private stair-case in the tower at the northwest corner of the main building, and by the construction of new stories in book-cases.

A large number of fishes were placed on exhibition, but have been withdrawn for the purpose of making a revision of the entire collection. This task, which is still in progress, is one of great magnitude, the number of duplicates being large, and the history of many of the specimens having been recovered since the fire. It is now being carried on with great rapidity by Dr. Bean, who has been assisted by Messrs.

R. H. Miner and H. G. Dresel, U. S. N., Mr. Peter Parker, and Mr. Barton A. Bean.

The extent of the task may be estimated from the fact that between the time of the beginning of this work, in October, and the first of January over 10,000 catalogue cards were written, each containing the name of the species and of the donor, the catalogue number, the locality, and the size of the jar in which the specimens were contained. In connection with this work every specimen is inspected and every receptacle supplied, when necessary, with fresh alcohol.

Specimens frequently have to be transferred from old tanks and bottles to better vessels. Another laborious task is that of stamping the catalogue number on a strip of block tin and attaching it permanently to each specimen in the reserve series, a work which has been going on during the entire year with the hope of having every specimen in the Museum before long permanently identified by having attached to it an indestructible label.

Dr. Bean presents the accompanying census of this collection, based upon estimate:

In reserve series	20,000
On exhibition.....	20,000
Duplicates.....	10,000
	<hr/>
Total.....	50,000

And remarks as follows upon its condition and his present methods of administration:

I am confident that this estimate is below rather than above the real figures. More than 10,000 catalogue cards have already been written for the specimens in bottles, and the work is not more than two-thirds completed. There will be certainly 15,000 cards for the identified species, exclusive of large faunal collections, such as those of Alaska, Japan, China, Southern United States, Bermuda, West Indies, and deep sea off the New England coast, all of which are set aside for special reports from officers of the Museum now employed in their investigation when opportunity can be had. The tank collection is also very large, and will bring up the total number to the figures given above, and probably far beyond.

As a matter of course, where so many fishes are to be cared for, some of which are received in bad condition, part of the material is poorly preserved and some is fit only to be thrown away. Difficult as it is to keep a collection of fishes in good order, and remembering the length of time during which some portions of it have been in this Museum, subjected to the ordinary causes of decay as well as to the wear and tear involved in such examination of specimens as has always been permitted here, it is not to be wondered at that we have some mutilated and decayed fishes. Until a thorough overhauling, which is now in progress, is completed, the collection will contain some things which are neither pleasing nor useful.

The bad element, however, is comparatively small and is rapidly decreasing. With the exception of the salmonoids and allied families proverbially hard to preserve, the bottled fishes are mostly in good condition. Many of the tanks used for holding large fishes are leaky and their tin lining is worn off, so that copper stains are frequent on specimens so kept. We have transferred such lots to newly-tinned tanks, recently received, whenever their condition was noted.

The fish skins, as might be expected from the nature of such preparations, are gen-

erally in a pitiable condition. Dust-incumbered, moth-eaten, rigid and brittle from age, gnawed by rats and mice, they are a solemn warning against the attempt to illustrate species by such means. I have only too gladly obeyed my instructions to destroy all such material unless, for some reason or other, it is necessary to keep it in the collection. Hereafter nothing but types or examples from localities of especial interest will tax our efforts to preserve them, and, whenever possible, these skins will be put in glass jars.

During the first ten months of the year Mr. H. L. Todd executed 93 drawings of fishes under the direction of the curator. These are in continuation of the series of drawings of the fishes of North America begun five years ago, the number of which has now extended to 665. These drawings are prepared especially for reproduction by the photo-relief process, and are exceedingly fine, thorough scientific accuracy of detail having been secured through the supervision of Dr. Bean, who has devoted much time to the examination, measurement, and criticism of each drawing.

During the year 88 papers, written by 22 persons, as shown in the following list, were prepared with special reference to specimens in this department.

Baird, Prof. S. F.....	1	Jordan & Gilbert.....	22
Bean, Dr. T. H.....	12	McDonald, Col. M.....	5
Editor of Belfast (Me.) Journal ...	1	Mather, Fred.....	7
Collins, Capt. J. W.....	2	Phillips, Barnet.....	1
Forbes, Prof. S. A.....	1	Rathbun, Richard.....	1
Gilbert, Charles H.....	1	Robertson, R. R.....	1
Gill, Prof. T. N.....	3	Ryder, John A.....	6
Goode, G. Brown.....	6	Smith, Rosa.....	1
Goode & Bean.....	3	Smith & Swain.....	1
Goode & Collins.....	1	Swain, Joseph.....	2
Hay, Prof. O. P.....	1	Swan, James G.....	1
Ingersoll, Ernest.....	1	Tanner, Lieut. Z. L.....	1
Jordan, David S.....	5	True, Frederick W.....	1

There are only two persons who have made much use of the collections besides the Museum officers. Professors Jordan and Gilbert, by reason of their contributions of fishes from the west coast of the United States, Central America, the Gulf of Mexico, Charleston, and other regions, have performed much labor upon the elaboration of these collections and other Museum material previously sent here from the same places. By reference to the bibliography immediately following this chapter, it will be seen that nearly twenty papers have been written by these gentlemen, principally upon material recently contributed by one or both of them. These studies were made principally upon fishes of Lower California, Mazatlan, Panama, Gulf of Mexico, and Charleston.

Professor Hay studied and reported upon the 64 species taken by him in Mississippi, Tennessee, and other Southern States before they were forwarded to the Museum.

Miss Rosa Smith and Mr. Joseph Swain reported upon a collection

of fishes made at Johnston's Island, Pacific Ocean, and Mr. Swain prepared papers on *Syngnathine* and *Stolephorus*.

As in years past, the curator of this department has acted as editor of the "Proceedings" and "Bulletins" of the United States National Museum, also performed the duties of editor of the Fish Commission Bulletins until April 1882, at which date this work was transferred to Mr. C. W. Smiley, of the Fish Commission.

DEPARTMENT OF MOLLUSKS.

Mr. William H. Dall, of the United States Coast Survey, has continued his voluntary supervision of this department. No assistants, however, having been assigned to him this year, and his own time having been largely occupied by his official duties elsewhere, including an investigation of the deep-sea mollusks collected by Mr. Alexander Agassiz on the *Blake*, little has been done on the general collections, which are in the main stored in the drawers of the table cases in the main Smithsonian hall and its galleries. The mollusk laboratory on the fourth floor of the main central tower of the Smithsonian building has, however, been entirely refitted and refurnished, and is now the most completely equipped of all the special laboratories. A great quantity of material belonging to this department, including the Binney collection, the collection of fresh-water shells identified and labeled by Mr. James Lewis, and that portion of the collection labeled by Mr. Robert E. C. Stearns, which has already been received, together with many other valuable lots, is stored in packing-boxes in the general storage room in the central basement of the Smithsonian building. During the year the boxes containing mollusks have been separated from the others in storage and have been included in the card catalogue of the storage rooms prepared by the registrar. Our collection of mollusks is exceedingly rich, and it is hoped that during the present year steps may be taken toward its final arrangement. Mr. R. E. C. Stearns, of Berkeley, Cal., who had been expected to assume the curatorship, has hitherto been prevented by ill health. Mr. Dall in his report for the year presents a history of the department and suggestions for its administration, which it seems desirable to place on record:

The collection of the mollusca has suffered many vicissitudes in the past. It is about eighteen years since I first became interested in the mollusk collection of the Institution. It is about fourteen years since I first took charge of it, and my connection with the duties of the position has been (except during about fourteen months in 1870-71) that of a volunteer worker, struggling to keep from deterioration a valuable typical collection, without clerical assistance, without any of the mechanical aids to labor employed in all museums of equal importance, without any regular allowance whatever for the needs of the department, with a building and cases which rendered the work of preservation more than ordinarily difficult, and with the necessity of supporting myself by other work which occupied nearly all the ordinary working-hours of the day. It is obvious that under such circumstances the curator who succeeded in making any impression on the material which was added from

time to time by gift or exchange, in addition to keeping order among that originally on hand, might reckon himself fortunate.

The original collection was mounted with cement on glass plates by the late Dr. Philip P. Carpenter. Twice the writer replaced the twelve or fifteen thousand specimens upon their tablets, from which the extremes of winter cold and summer heat had detached them. When the third winter passed and the effect of the temperature was again apparent, I spent a month experimenting with cements, found none reliable, and proceeded to relabel and place in paper trays the entire collection.

From July, 1871, to January, 1875, I was detailed on field work in Alaska by the United States Coast Survey, and again in 1880. During these periods the curatorship remained practically vacant. While engaged in the above-mentioned field work, dredgings were carried on over nearly the whole coast of Alaska, and of invertebrates alone, from 1871 to 1875, not less than 100,000 specimens were forwarded to the Museum. On my return in 1875, the question of representation at the Centennial Exhibition was mooted, and the curator of mollusks devoted, with the exception of his Sundays, every spare hour of his time for six months in preparing a collection of economic invertebrates for that occasion.

The funds available for this purpose indirectly benefited the collection by the duplicates which came in with specimens collected for exhibition and which were administered upon simultaneously.

At this time the valuable services of Mr. F. G. Sanborn were temporarily obtained, and by hard and constant work the general collection of the Museum was labeled, cleaned, and systematically arranged. The policy of the curator from that time forward has been simple.

Specimens of a general character coming in are carefully registered and boxed and put in store. A collection prepared by the late Dr. James Lewis, for the Centennial, of the land and fresh-water shells of the United States, carefully labeled, catalogued, and packed, has been retained in its original boxes. Everything of value or not administered upon has been put away, packed and secluded, safe from harm at least, until better times for the collection should arrive. In this way only could the progress made be held good. Until skilled assistance and a constant guardianship are available, it would be very unwise to expose to the inevitable injuries of dust, accident, or carelessness, collections whose value could not be estimated in money. Meanwhile the curator has bent his energies and employed his leisure in putting into shape for future reference special groups, one by one. In this way something has been accomplished. This has been done especially with the brachiopods, limpets, and chitons, but unfortunately, owing to defects of the only cases available, mice and dust have since made such effectual inroads upon the chitonidæ that the labor of months has been lost and that part of the collection practically ruined. -

The immense collection of Alaskan mollusks, however, has been registered and systematically arranged, compared, and studied in a preliminary way, and has suffered from nothing worse than dust. The administration upon some thirty or forty thousand specimens has taken several years, and has been carried on wholly out of ordinary office hours.

During the last year the curator has been engaged during spare moments in reporting upon the very interesting mollusks of the deep sea obtained by various United States vessels, especially the party on the Coast Survey steamer *Blake*, under the supervision of Prof. A. Agassiz; and the mollusks of the northwest coast have been temporarily laid aside, to be returned to hereafter. The latter are in a forward state and will take comparatively little labor to prepare a proper monograph and catalogue of them for publication.

The present state of the collection may be summarized as follows:

1. Labeled in order and accessible for reference, the general collection of mollusks prepared by Dr. Carpenter, and of which part was originally mounted on glass, except two boxes as hereafter mentioned.

2. In order and accessible for reference, but requiring new labels, the West American collection prepared by Dr. Carpenter and originally mounted on glass, containing many of his types. Also the types of Dr. Gould's descriptions of North Pacific mollusks, from the Rodgers exploring expedition, so far as they are in the possession of the Institution. The majority of the types of Dr. Gould, however, though the property of the United States, have never reached the National Museum, and are believed to be in private hands.

3. In order, labeled, catalogued, and inaccessible (*i. e.*, packed up), the collection of North American land and fresh-water shells prepared by Dr. James Lewis for the Centennial exhibit of the National Museum.

4. Identified and labeled with rough labels, to be replaced by the standard Museum label before exhibition, catalogued, but not unpacked, two boxes of the original Carpenter collection of miscellaneous shells.

5. Identified and labeled as above by the donors, packed up safely, but never yet placed on the Museum catalogues or registers, the Binney collection of typical American land shells; a large number of shells (between 2,000 and 3,000 species) given to the Museum by W. H. Dall, being his own private accumulations by purchase, collection, or exchange, when not connected with the Museum; numbers of small donations from many friends of the Institution, received from time to time; typical land and fresh-water shells received from Dr. Isaac Lea, of Philadelphia, &c.

6. Unidentified virgin material received from definite localities, packed safely, but not administered upon in detail, an immense stock from the United States, and divers valuable lots of exotics.

7. Separated, labeled with preliminary labels, registered, and in process of being worked up, generally dusty, but in good order, the general Alaskan and northwest coast collection contributed by W. H. Dall, his associates and friends, from original field researches; a smaller but still valuable Californian collection from the same sources; a North European collection of recent and Tertiary fossil species obtained by purchase and exchange for special comparison with and identification of the preceding; also many Arctic species gathered with the same end in view.

8. Injured and worthless specimens; though notwithstanding the great mass of the material belonging to the Institution, it is probable that there is unusually little trash in it.

9. Alcoholics, in good order, partly labeled. There is a large collection of alcoholics, much of which is labeled and, thanks to the care and energy of Mr. Rathbun, in excellent order. It may be worth while to remark that, all earlier alcoholics having been removed by Dr. Stimpson to Chicago and subsequently burned in the historic conflagration, when the curator returned to Washington, in January, 1875, there was no alcoholic collection except that made by himself in Alaska and California. (The Fish Commission collection, not having reached Washington, is not included among the assets of the Museum, though eventually to become so.) Special attention has been given to this class of specimens; and by a wide correspondence and the generosity of the never-failing friends of the Smithsonian Institution, a good representation of most types of mollusks may now be found in the room devoted to invertebrates in alcohol. A few species have lately been received from the collections of the Fish Commission, and a larger number from Dr. R. E. C. Stearns, collected on the Pacific coast.

Having thus briefly reviewed the treasures of the National Museum in the present curator's department, a few words as to facilities obtained during the year and required for the future are in order.

Until the present year, the conchological department of the Museum has not been provided with cases suitable for receiving and preserving shells free from dust, mice, and sudden concussions from ill-fitting drawers.

During the present summer the laboratory has been partly fitted up in excellent shape. The middle and chief working room of the range of three in use for the

shells has been fitted with good and dust-proof cases, a new gallery, and accommodation in the shape of universal drawers for a large number of specimens. It is hoped and believed that to these will be added suitable cases for the Museum Hall, in which finally perfected work may be placed permanently for reference or exhibition, without fear of deterioration. Steps have already been taken to replace the inflammable partitions of the east and west laboratory rooms by brick walls, and to refurnish with suitable shelving and cases this part of the work-shop.

Means for making sections of shells are desirable, but the necessary lathe might economically and easily be made a part of the taxidermist's equipment, where it would be equally and more frequently useful, while still accessible when needed.

It is the writer's opinion that an extensive exhibition of the shells as mere *objets de regard* is not desirable. He believes that, first, a thoroughly illustrated series of a few typical forms from embryo to adult, with enlarged models and dissections of the soft parts; secondly, an economical series, with illustrations of their economic application, as in cameo shells, pearl shells, &c.; thirdly, a good local series of the mollusks of the District; and, lastly, a case or two of prominent characteristic forms of the different orders, recent and fossil, side by side, would be more instructive, more interesting, and more desirable than the large series of every attainable species common to most museums, and which produces, except for the specialist, only a confused and even wearying impression upon the visitor's mind.

DEPARTMENT OF INSECTS.

As was stated in my last report, the department of entomology is one which has been very little cultivated in the National Museum, although in past years the Smithsonian Institution has published many valuable works on insects, and through its various collectors gathered much material for investigation.

The material thus obtained by special collectors, by the various Government surveys, as well as that sent in by correspondents, has always been distributed for study to the several entomologists who have been serving as collaborators of the Smithsonian Institution, much of the material having passed into the hands of the entomologists of the Department of Agriculture, it always having been the understanding that all material, after being reported upon, should be returned to the Department of Agriculture for preservation in its cabinets. The custody and entire responsibility of the national collection of insects was in this way transferred to the Department of Agriculture; but the lack of a permanent museum organization and the constant changes in the heads of the Department resulted very unfavorably for the collection, and the remnants of the same, which have recently been transferred to the National Museum by the present Commissioner, are of very slight importance. Prof. C. V. Riley, the entomologist of the Department of Agriculture, has, from the time of his accession to that position, urged the transfer which has recently been made, and has from the beginning insisted that the systematic collection should be preserved under the permanent organization of the National Museum. Following out this idea, Professor Riley accepted, in 1881, the position of honorary curator, performing voluntarily such duties connected with this division of the Museum as are at present necessary.

Professor Riley has deposited his own private collection of insects, which comprises about 30,000 species of all orders, mostly from North America, arranged in some 350 double folding boxes, and in two cabinets with eight glass-covered drawers, the specimens being all in good condition and classified so far as determined. In addition to this collection, Professor Riley has deposited a large amount of material preserved in alcohol, mounted on microscopic slides, or blown and mounted dry, illustrating the life, history, and economy of more than 3,000 species. This collection is illustrated by a large quantity of notes and descriptions, in large part still unpublished.

The Riley collection now on deposit represents about all that is valuable in this department of the Museum.

Mr. Albert Koebble was assigned as an aid to the curator during a portion of the year. The actual work has consisted chiefly in the answering of inquiries made regarding insects, from correspondents of the Museum and the Smithsonian Institution, and in taking care of and mounting the material received. The collection has been constantly used in the work of the Department of Agriculture by specialists who have found occasion to refer to it. All investigations in entomology made by the curator during the year were for the Department of Agriculture, and a statement of the various lines of investigation pursued will be found in his annual report for that Department. A list of papers by him printed during the year is also given in the bibliography appended.

The following suggestions are extracted from the curator's report:

Repeatedly during the year collections have been offered but necessarily declined, because there was no fund for their purchase. I would strongly recommend, therefore, that provision be made, 1st, for the purchase of such collections as are of sufficient value and which may be from time to time offered or obtainable; 2d, that a competent assistant be permanently engaged in the general work of the Department and in the preparation of the exhibit collection.

Hitherto no attempt has been made to preserve and keep together the entomological material that has been gathered and brought to Washington by officers of the Government. Such material has generally been turned over to the Department of Agriculture and either distributed among specialists or neglected and lost sight of. While my present work as curator is a labor of love, and very little can be accomplished without means, yet I shall strive to at least properly care for the specimens that accumulate from various sources until such time as their importance shall warrant more means and labor being devoted to them.

DEPARTMENT OF MARINE INVERTEBRATES.

The collection of marine invertebrates under the direction of the curator, Mr. Richard Rathbun, is rapidly being reduced to order; the arrears of many years fast being made up. This has been a task of considerable magnitude, from the fact that in the decade ending 1880 very little attention had been paid to this department, and that the best part of the material was destroyed in the burning of the Chicago Academy of Sciences. The amount of space assigned to this department is very small, consisting of the western work-room south of the corridor

leading to the west basement, the laboratory in the western end of the cloister north of the west range, and the west range of the Smithsonian building. The west hall has been assigned to this department for its exhibition purposes, but is still to some extent filled with other material eventually to be moved to the new museum. Very little, therefore, has been done in the development of the exhibition series, and the chief activity has been in the store-rooms, but the results are not so apparent now as they will be when room can be found for the proper installation of the collections. The coral collection, as well as part of the echinoderms and sponges, have been mounted on ebonized tablets, and the experiments which have been made in arranging these in cases with maroon backgrounds indicate that the west hall when arranged will be one of the most beautiful and attractive in the Museum.

Mr. Rathbun has been assisted during the year by Messrs. J. B. Blish and W. E. Safford, midshipmen, U. S. N., and by Messrs. R. S. Tarr and George F. Weld; the latter a volunteer.

The number of entries in the catalogue during the year have been 2,630. The card-catalogue begun last year is now nearly complete, containing between 8,000 and 9,000 cards. This card-catalogue indicates which of the specimens are in the reserve and which in the duplicate series.

During the summer the curator was attached to the party of the United States Fish Commissioner at Wood's Holl, and under Professor Verrill had charge of the dredging operations on the steamer *Fish Hawk*. Mr. Rathbun paid special attention to the use of the tow-nets at different depths in collecting free-swimming copepods, on which he is preparing a special report; and he has also been engaged in preparing for the Fishery Report, now in progress of publication under the joint direction of the Commissioner of Fisheries and the Superintendent of the Census, a chapter descriptive of the natural history, of all known species of economic American marine invertebrates, and of the methods and results of this particular fishery. These reports, which are now in the hands of the printer, set forth the practical features of this department of the Museum, which are of no small consequence, as they embrace the lobsters, crabs, shrimps, and sponges, the annual fisheries for which amount to over \$1,200,000. This is the first attempt made to report upon this class of fisheries in this country from accurate data. Fourteen papers relating to this department have been published during the year, five by the curator, six by Prof. A. E. Verrill, one by Mr. Sidney I. Smith, one by Dr. T. Hale Streets, and one by Mr. John A. Ryder. The collection of fresh-water crayfish has been lent to Mr. Walter Anderson, of the Museum of Comparative Zoology, for study and publication.

Mr. Rathbun has submitted the following special statement upon the distribution of duplicate specimens:

The condition of the collections in this department of the Museum can now be considered as exceptionally good, considering the restricted quarters in which they are contained. It was the first care of the curator, when he entered upon his duties, in the fall of 1880, to examine every part of the collection with reference to its safe keeping, and every new accession has been unpacked as soon as it was received, in order that no destruction might result from long storage. The dry specimens have all been removed from the basement rooms, which are too damp for the preservation of such materials, and the entire alcoholic collection has been examined at least once a year, for the purpose of replacing alcohol lost by evaporation or the cracking of jars. It is impossible to state the number of specimens or species now belonging to this department, as large portions of the collection are still uncatalogued and larger portions un-identified. The reserve series is very extensive and contains much unique material. The dry reserve specimens of corals and sponges have been mostly mounted and placed on exhibition, as have also representatives of all the groups of echinoderms and a few of the crustaceans. The exhibition series, thus far prepared, contains the following number of specimens:

Corals, 734. Sponges, 235. Echinoderms, 510. Crustacea, 47.

The National Museum suffered severely by the Chicago fire of 1871, which destroyed almost all of the alcoholic reserve series of crustaceans and radiates, as already explained. The reserve series as now constituted has been derived from innumerable sources, of which the following are the most prominent, either from the size or value of the collections furnished:

From the United States Exploring Expedition: About 50 types of Dana's species of crustaceans, partly dry and partly alcoholic, have been left to the Museum, and are still in good condition for examination. A large number of the corals obtained by the same expedition and named by Dana are also intact, and, although they have suffered much from rough handling, they still form the most important feature of the exhibition series of corals. A few of the United States Exploring Expedition sponges were also saved.

From the North Pacific Exploring Expedition: A small number of Stimpson's types of crustaceans and many dry echinoderms were retained at Washington, and thereby escaped destruction.

From the United States Fish Commission: As elsewhere stated, the Fish Commission collections constitute the bulk of the materials in nearly all the branches of this department. These collections are especially complete for the New England coast as to the decapod crustaceans, pycnogonids, worms, echinoderms, and anthozoa, and include large quantities of unidentified crustaceans and radiates from the South Atlantic coast, collected by Messrs. Earl and MacDonald; from the Gulf coast, by Mr. Silas Stearns, and from the Pacific coast, by Prof. D. S. Jordan.

From the Bermuda Centennial Commission: A fine collection of Bermuda corals.

From the Museu Nacional de Rio de Janeiro: A complete collection of Brazilian corals.

From Mr. John Xantus: An old collection of corals and other specimens from Southern California.

From various naval expeditions, including the Transit of Venus Expedition, the Palos Expedition, and the Alliance Arctic Expedition: Numerous collections of radiates, crustaceans, and worms.

From Dr. T. H. Streets, U. S. N., and Dr. William H. Jones, U. S. N.: Similar collections from several sources.

From the United States Coast Survey: Alaskan collections of crustaceans, worms, radiates, and sponges, collected by Mr. William H. Dall.

From the United States Signal Service parties in Alaska, including Mr. E. W. Nelson.

From Mr. L. Turner and the party at Point Barrow: Miscellaneous collections.

From the United States Coast Survey steamer *Blake*: Crustaceans, crinoids, anthozoa, and sponges, received from Prof. Alexander Agassiz.

From Prof. J. M. Langston: Corals from Hayti, W. I.

From Mr. J. M. Bowers: Corals from the Society Islands.

From the Germany Fishery Commission, through Prof. Karl Möbius: Miscellaneous collections from the North Sea.

From Professor Lindström: Similar collections from the Baltic Sea.

From Prof. Charles Lütken: Eighty-five species of European annelids.

From Dr. Gustav Eisen: A collection of European and Californian earth-worms.

From Mr. Winifred Stearns: Miscellaneous collection from the Coast of Labrador.

From Wesleyan University, Middletown, Conn., and Dr. George Hawes: Similar collections from Bermuda.

From Col. N. Pike: Corals, echinoderms, and crustaceans from the Mauritius Islands.

From Messrs. Henry Hemphill and L. Belding: Similar collections from the coast of California.

From Captain Dow: Similar collections from Panama.

From Messrs. McResson and Robbins: A large collection of Florida commercial sponges.

By purchase: A large and fine series of the commercial sponges of the world, exhibited at the Centennial Exposition and identified by Prof. Alpheus Hyatt.

From Prof. H. L. Smith: 1,275 microscopic slides of foraminifera, from many sources.

It would be quite impossible to enumerate further the constituent parts of the reserve series without going beyond the proper limits of this report.

The duplicates still on hand and available for distribution are as follows: Number of species: Crustaceans, 43; worms, 19; mollusks, 48; bryozoans and tunicates, 30; radiates, 42; sponges, 5; total, 187. Number of specimens: Crustaceans, 24,000; worms, 4,000; mollusks, 24,000; bryozoans and tunicates, 6,000; radiates, 16,000; sponges, 250; total, 74,250.

The *reserve series* of specimens is still in quite an unfinished state, which makes a report upon it very unsatisfactory. So much material has been received during the past year, and other administrative work, including the distribution of duplicates, has interfered to such an extent, that in many cases it has been only possible to enter the specimens in the record books and store them for future examination. In reality, more time has been spent upon the reserve series than upon any other collections. The different groups are arranged separately in the storage cases and any specimens desired can be readily found. A portion of the reserve series of alcoholic crustaceans and echinoderms has been stored temporarily in the wall-cases of the main hall of the Smithsonian building; but the bulk of the alcoholics still remain in the east and west basements of the same building.

In this connection it may be proper to refer to the work now being carried on at New Haven by Prof. A. E. Verrill and Prof. S. I. Smith, on the marine invertebrates collected by the United States Fish Commission on and off the New England coast. The curator is not kept informed as to the progress of this work, excepting as reports are handed in for publication and finished collections are received for the Museum. An account of the materials so far received from Professors Verrill and Smith has already been given, and a bibliography of their reports published this year will be found below.

The exhibition series.—The work thus far accomplished in the preparation of the exhibition series of invertebrates has been extremely satisfactory, and gives promise that the display of marine invertebrates will be second to no other in the Museum in attractiveness. In the fall of 1881 the west hall of the Smithsonian building, which had been previously occupied by the mineral exhibit and a portion of the pottery received from the Centennial Exposition, was assigned to this department, but as yet only a part of the wall space has been made available for use. This hall, which has a length of 90 feet and a width of 40 feet, is admirably fitted for the exhibition of specimens, and is well lighted. Suitable cases of black walnut cover the walls, to a height of 7½ feet, on three sides of the room, the east, south, and west. The empty

floor space remaining after the large objects of pottery shall have been removed will be sufficiently great to accommodate five or six separate upright cases, and the semi-circular space at the north end can also be utilized for smaller cases. Only the cases on the east and south sides have thus far been emptied of the old collections, and these are now filled with marine invertebrates. Considerable time was spent in preparing this exhibit, in studying the effect of different-colored tablets and backgrounds upon the specimens, ebonized tablets and a maroon background to the cases being finally adopted as the most desirable and attractive. The collections first selected for exhibition were those which could be the most readily prepared and which were in greatest need of proper storage—the dry corals, sponges, and echinoderms—and these naturally constitute the most showy portions of the marine invertebrate collections. Mr. E. H. Hawley, who had been very successful in the preparation of the exhibition series of marine invertebrates at the Peabody Museum, of Yale College, and at the American Museum, New York, was employed for this task, which he has executed in a very superior manner, producing a more attractive display than probably exists in any other similar museum in the country. Mr. Hawley continued his work upon this collection during most of 1881, and until March, 1882, when his services were required in another department of the Museum, and the mounting of marine invertebrates was temporarily discontinued. He had, however, finished all the specimens that had been prepared for mounting up to that time.

As the cases prepared for this purpose were inadequate to hold the entire mounted display collection, it has been impossible to arrange it in proper order, but, nevertheless, the temporary arrangement has been duly appreciated by the public, judging from the many favorable criticisms passed upon it. The showy corals now form the bulk of the display collection, and, considering that a majority of the corals are types from the United States Exploring Expedition, their value is very great. Other features of this display are the centennial collection of Bermuda corals; a complete series of all the known species and varieties of commercial sponges, identified by good authority; a large series of Alaskan sponges; and a great variety of echinoderms, from many sources. The proposed additions to the exhibition series will be discussed further on. The Museum printing office having been fully occupied with preparing labels for other departments, the exhibition collection in this department is still unlabelled, but this deficiency will be remedied during the coming year.

Distribution of duplicates.—The extensive explorations of the United States Fish Commission, along the eastern coast of the United States, during the past twelve years, have brought together a large mass of duplicate materials, in the line of marine invertebrates, which is being distributed as rapidly as possible to institutions of learning throughout this country, and to a few foreign ones. No returns have been demanded for the duplicates disposed of in the United States, but those sent to foreign countries are generally in exchange for collections of equal value for the Museum. Three general series of duplicate sets have already been prepared and two distributed. The first series, consisting of 50 sets, with 118 species each, and over 18,000 specimens in all, was sent out, in 1879, to many of the higher schools of learning in this country, and to a few foreign institutions. Series II, also containing 50 sets of 189 species each, and a total of over 50,000 specimens, is now very nearly ready for distribution, and will be sent out the coming January or February. Series III, or the educational series of 50 sets, with 98 species each, and a total of over 15,000 specimens, was finished and distributed in June, 1882. Enough material stills remains for making up a second educational series of 200 sets, with about 125 species each, and the work of preparing this series will be begun in January, 1883.

As a part of Series II, ten additional sets, containing the same species and many others, is now being prepared, for sending to the London Fishery Exhibition of 1883, to be disposed of in Europe, by exchange, for collections for the Museum. This Museum is greatly in need of authentic foreign collections of marine animals for the purposes of comparison, and much valuable material of this character can undoubtedly be obtained by such a system of exchange.

The disposal of such a quantity of duplicate material as is now being sent out, of no further value to the Museum, will be of benefit to the institution in more than one way. In addition to increasing its sphere of usefulness, and bringing back to it some returns in the way of exchanges, it will also relieve the Museum of much care and expense, necessary to the preservation of such an extensive collection, and enable the workers in this department to devote their entire time to the reserve and undetermined materials.

From the many resources of the National Museum, it is natural to suppose that this department will, in the course of time, assume greater proportions than the same department of any other museum in the country. The accessions for the past three years, or since the renewal of activity in this line, have been so great that the department has outgrown the space assigned to it, and, unless more room is made available at an early date, the safety of the collections will be more or less imperiled. It is very gratifying to the curator to be able to note such rapid progress in a department which has lain dormant for so long a time.

Among the many plans proposed for the coming year, it is intended to make considerable advancement in the preparation of the exhibition series, in order that the more instructive specimens, of which many are still packed away, may all be made serviceable to the general public at once. Another reason for rapidly perfecting the exhibition series is one now generally recognized by all museums, that, as a rule, less damage happens to specimens when they are open to constant inspection than when they are stored away out of sight. The pottery now filling the cases on the west side of the marine invertebrate hall is to be soon removed, when these cases will be altered to correspond with those now containing the invertebrate collections. Enough specimens of corals and sponges are now mounted or prepared for mounting to nearly fill these new cases, so that with little exertion a very extensive display can be made.

The scheme for the exhibition of specimens in this department, as at present worked out, comprises two features—the general display collection, which we have been discussing, and the synoptical collection, which has not yet been begun. The former will illustrate the several groups of marine invertebrates, with reference to external form, by a massing together of all the members of the groups, which it is possible to obtain or to exhibit to advantage in the cases. The synoptical collection will be of a more educational character, and will represent the external and internal anatomy, and embryology of typical members of each group by means of careful preparations, dissections, and diagrams. The latter scheme will necessitate a much greater outlay of labor than the former, and will require a number of years for its accomplishment. This portion of the exhibition collection will have to be accommodated in new upright cases, to occupy the center floor space, after the present incumbrances are removed. The general display collection will also soon outgrow the wall cases allotted to it, and require additional space on the floor.

In the present scheme no account has been taken of the large reserve series of alcoholic specimens, excepting where such may be used in the synoptical collection. The general display collection now contains only dried specimens, which are the most suitable for display. The ordinary cylindrical jars of thick glass distort their contents, and it is generally impossible to keep the alcohol so clear that the specimens can be readily distinguished from the outside. Nevertheless, there are in this department large quantities of showy specimens, of which dry preparations cannot be made, and which it is desirable to display. Square jars have been suggested, and would certainly be preferable to the round ones. A matter of greater importance, however, is the safe keeping of the entire reserve series of specimens in alcohol, which is now mainly stored in dark rooms and passageways in the basement, where it is very difficult to give it the proper attention. A portion of these specimens, which have been determined and properly labelled, have been arranged in the wall cases on the south side of the main Smithsonian hall, and if no objection is made the curator proposes to fill as many of these cases as are not now used for other purposes. There is no doubt but that the

safety of the collections will be greatly improved by keeping them open to daily inspection.

A great desideratum in this department is a supply of authentic foreign collection for the purposes of comparison in making identifications, and an attempt will be made this spring to remedy this deficiency in part by soliciting exchanges from several European authorities. For this purpose, ten very superior sets of duplicates of Fish-Commission specimens have been prepared and will be sent to the London Fishery Exhibition, where they can probably be disposed of to the best advantage of the Museum.

DEPARTMENT OF FOSSIL INVERTEBRATES.

The department of fossil invertebrates has been under the charge of Dr. C. A. White, who during part of the year was directly in the employ of the Museum, and who now, having accepted the position of paleontologist of the United States Geological Survey, continues his work in the Museum as honorary curator. Unlike most of the honorary curators, however, his whole time, except when in the field with the survey, in summer, is devoted to administrative work and investigation upon the collections, and his office is in the laboratory of the department. This department is now installed in the west-south range of the new Museum, being deposited in the drawers of thirteen unit table-cases, the laboratory being in the two adjoining rooms at the west side of the south entrance. No part of this collection is on exhibition, and considerable portions of it are still in the storage rooms. The most valuable specimens, particularly those which have been studied and have served as types for the publication of the late Prof. Fielding B. Meek, have been cleansed of the accumulated dust of long storage and put in excellent order.

Dr. White's own specialty is in the study of the invertebrates of the Mesozoic and Cenozoic periods, and Mr. C. B. Wolcott, also of the Geological Survey, has been assigned by its director to work in this department, and is acting as assistant curator, under the direction of Dr. White, having special charge of the Paleozoic fossils. His work in the field extends over more than half the year, and work upon this section of the collection is not so far advanced. Mr. L. M. Garrett, U. S. N., has acted as assistant in this department and accompanied the curator to the field upon the work of the United States Geological Survey from July to October. Dr. White has already devoted much time during the year to duties as chief of the Artesian Wells Commission.

Of this department of the Museum it can be said that its material is in excellent order for scientific investigation, and that it is being extensively used for that purpose.

I quote from Dr. White the following statements and recommendations:

The present state of the collection is that of only partial arrangement, and therefore the number of specimens cannot be given, even approximately. Their condition, however, is favorable to their complete arrangement and division into series as soon as I shall get time and suitable assistance to do the work. A few years ago a

considerable quantity of duplicate specimens was set aside for exchange. Subsequent investigation has shown the desirability of retaining a large part of these in the Museum, and it is therefore necessary to review them again before any are sent out.

Since even an extensive collection of fossil invertebrates may be presumed to be less attractive to the public than much of the material of other departments, my plans have contemplated mainly such a classification and arrangement of the Museum collection as will make it conveniently available to students for scientific purposes. The fact that so large a part of these specimens are those upon which official reports and other scientific writings have been based, makes it especially desirable that they shall be made accessible to students of paleontology as early as practicable.

DEPARTMENT OF FOSSIL PLANTS.

This department, like that of fossil invertebrates, is under the honorary curatorship of an officer of the United States Geological Survey, Prof. Lester F. Ward. The collection is installed in the drawers of a number of unit-table cases in the west south range and upon the south balcony, contiguous to which at its east end is the laboratory of the curator. This laboratory has during the year been filled up with cases, and a large amount of preliminary work has been done by the curator, who since October has been assisted by Mr. E. E. Hayden, midshipman of the United States Navy. This collection, like many others, has been in a quiescent state for many years, and a large amount of work has been found necessary, preliminary to its final arrangement in proper shape for study. No effort has as yet been made to provide exhibition space for it. Its present condition is well shown by the following extracts from Professor Ward's report:

The extensive collection which had been received from Mr. Leo Lesquereux, of Columbus, Ohio, who had previously employed it in the preparation of his printed reports, and had catalogued and numbered it according to your instructions, was merely unpacked during the last months of 1881, and remained at the beginning of the year in a wholly unorganized condition. The bulk of the work done in the department has therefore been that of systematically classifying and arranging this material. This work was delayed by the necessity of having appropriate cases erected in the laboratory rooms to receive it, as also by the lack of assistance and the performance of duties in connection with the Geological Survey.

The deficiencies of a merely chronological catalogue rendered necessary the preparation of a much more complete and convenient slip catalogue, which could be systematically arranged and serve as an efficient aid in the progress of the work.

The catalogued material has been arranged in three series according to horizon, viz, the Cretaceous (chiefly from the Dakota Group), the Tertiary (including for convenience the Laramie Group, which Mr. Lesquereux considers to be Eocene), and the Carboniferous and lower formations (there being a few from the Old Red Sandstone of Ireland, and a few from the Silurian of New York).

The system of classification adopted is, in so far as this was practicable, that of Schimper, as given in his "*Traité de Paléontologie Végétale*," the most comprehensive work on the subject.

As the greater part of the undetermined material in the department belongs to the later formations, and as my field work for a great while will probably be chiefly confined to these horizons, I have found it necessary to reserve, for the present at least, the whole of the Cretaceous and Tertiary collection and retain it in the laboratory as a basis for comparison and investigation. For the same reason I have not thought

best to select a reserve series of the Carboniferous plants, and have prepared the whole collection for exhibition in the cases below. It still remains on the balcony waiting the completion of the necessary cases.

Very little was done during the year in the way of original research or towards the elaboration of new material, owing to the time required in making these preparations.

Fifty-nine specimens of Alaskan fossils were sent in September by your instructions to Mr. Lesquereux to be figured. These have been returned. One specimen (No. 556) was sent, August 15, to Dr. J. S. Newberry, to be used in connection with a report to be published by the Geological Survey.

The following is a summary exhibit of the state of the collection so far as regards specimens which have been specifically determined :

	Genera.	Species.	Specimens.
Carboniferous	53	177	1,550
Cretaceous	65	142	549
Tertiary	121	351	1,821
Total	239	670	3,920

The undetermined material consists chiefly of the thirty-one boxes collected by myself in 1881, and seven boxes collected by Captain Bendire.

DEPARTMENT OF MINERALS.

The classification of the departments of the Museum provides for three departments in the division of geology: (xvi) physical geology, in which branch no work has as yet been attempted; (xvii) minerals and rocks; and (xviii) metallurgy and economic geology. The two latter were for nearly two years under the charge of Dr. George W. Hawes, whose death on the 22d of June has been in many ways an irreparable loss to the Museum.* Mr. William S. Yeates, aid in the staff of the Museum, has during the year had special charge of the department of minerals, and with the assistance of Messrs. E. E. Hayden, Henry S. Chase, and E. Wilkinson, midshipmen in the United States Navy, has been pressing forward the work of unpacking and cataloguing the accumulated mass of material. The number of entries on the Museum register has been 2,528, representing 3,437 specimens; of these 1,370, have been assigned to the exhibition and reserve series, and 417 to the duplicate series; 155 have been rejected, and the remainder assigned, according to their nature, either to the collection of rocks or ores and metallurgical products. The card catalogue in the duplicate series has been increased during the year by 1,261 cards. Mr. Yeates reports that such work as has been done is that of putting in order the specimens in the old collection, a large number of which have never been entered on the register. The

* A short biographical notice of Dr. Hawes is given at the close of this report, together with a list of his scientific publications; and also an account of the work planned and commenced by him in relation to the collection of building-stones.

work of entering these and putting the catalogue number on each specimen has been for some time, and is now, in progress. Numbers have been painted on 2,894 specimens, and nearly 2,000 labels have been written. A preliminary classification has been begun, and twenty-three sets of duplicate specimens have been distributed; some of them as exchanges, but the majority to institutions of learning. Mr. Yeates reports, upon the present state of the collection, that it contains 6,939 specimens in the combined reserve and exhibition series, while in the duplicate series there are about about 7,000 specimens, making an approximate total of 14,000 specimens. During the past year 413 specimens were added to the reserve and exhibition series, and 1,261 to the duplicate series.

The mineral collection is disposed in drawers of unit cases in the west hall of the new Museum, while a great mass of material, unsorted and in process of classification, is still in the temporary work-room in the southwest court.

The department of building-stones, which in the preliminary classification was associated with that of mineralogy, has already been reported upon as one section of the department of arts and industries.

DEPARTMENT OF METALLURGY AND ECONOMIC GEOLOGY.

This department, like the preceding, has been without a head for the greater part of the year. In July, 1882, Mr. F. P. Dewey, previously employed as chemical assistant to Dr. Hawes in his investigations upon the building stones for the Tenth Census, was given temporary charge of the department of the collection, and made some preliminary studies and inspections. On December 1, Mr. Dewey was appointed to the curatorship of the department. Active work in the department is, therefore, hardly begun, and all that can be said concerning it is in the way of anticipation. To this department is assigned a very large portion of the material given to our Government by the various foreign Governments and other exhibitors at the close of the Centennial Exhibition, which from 1876 to 1882, was stored in the basement of the Armory Building, and which has in part been removed to the new museum, together with the material recently received from the permanent exhibition in Philadelphia and stored in the temporary building adjoining the Armory. The curator of metallurgy and economic geology also necessarily acts as curator of the section of metallurgy and metal-working in the department of arts and industries, which is already in possession of great quantities of heavy and bulky material, and which may be expected rapidly to grow in extent and importance. This department is one of the most difficult the Museum to manage; the material which it includes is always heavy in and unwieldy and often of great bulk. Unlike many other departments, it must place on public exhibition almost everything which it contains; in fact, it has a greater share than any other department of material

which is chiefly useful on account of its educational value, which for purposes of investigations might perhaps better be examined in the place in which it was collected. Its proper arrangement, therefore, must be the work of several years; and, on account of the number of laborers required to handle it, the work must be comparatively very costly.

The original intention, to the carrying out of which the Museum is in a certain way pledged, was that the mineral resources of each particular State should be shown separately; and, to accomplish this, it will be necessary to secure extensive additions to the collection from almost every State in the Union; extensive not only in number, but also in bulk, weight, and cost of transportation.

Another difficulty in the management of this department is the uncertainty as to its final location. At present the southwestern quarter of the building, including the west hall, the southwest court, and the two adjoining ranges, are assigned to the division of geology, to metallurgy and metal-working. A portion of this space is at present occupied by paleontological collections, but even when these are removed the space will probably be inadequate for the accommodation even of the material already on hand. Should a new building be erected for the Museum, these collections will naturally be the first to be transferred, and consequently much bulky material will require to be moved. It cannot be doubted, however, that this department will be of greater importance to the country in an industrial way, and will interest and benefit a larger number of the visitors to the Museum, than any other; especially when it is so arranged as to show concisely and impressively the character of the mineral resources of each State and the methods by which the various products of the metal-working industries are produced.

Mr. Dewey reports that in the catalogue of the collection there have been made 3,851 entries, representing 4,772 specimens; of these 4,420 were specimens previously received from Centennial sources, and of which no entry had been made, and 281 were specimens entered from the old Smithsonian collection. Almost all the work done has been upon the reserve series, especially upon the Centennial material, about 150 boxes having been unpacked and specimens identified as far as possible, and all information in regard to them put in a permanent form for preservation. This was a work of considerable magnitude, since much care and time were necessary in unpacking the specimens and tracing up their records.

The southwest range is at present assigned to this department, and in it quite a number of specimens are to be seen, although nothing can properly be said to be on exhibition. The collection of ores from Nevada is the only special collection which has been thoroughly examined; the records in regard to this are perfect and its condition satisfactory.

The curator has presented the following estimate of the present condition and possible future of the department:

As to the number of specimens it is not possible to give it exactly, as many specimens are still packed in the boxes in which they came from Philadelphia, and with the exception of 360 they are all as yet in the reserve series; after a careful estimate I would place the number at about 20,000.

In general, the condition of the specimens is perhaps fair, although many of the more showy specimens have suffered from want of proper care and attention aside from the necessary deterioration by decomposition, generally confined to the surface, but in some cases extending to the interior, in which case serious disintegration has been the result. Decomposition is the chief source of deterioration of metallurgical specimens, and while there are various devices for its prevention, no feasible plan has yet been proposed to completely arrest its action.

A matter of the first importance in this department is a collection for the study of the science of metallurgy, which need not be large, as it will contain little or no duplicate material, and will be designed to show the following points in the production of the metals: the natural occurrence of the various ores of each metal, together with the prominent associated material; the natural occurrence of such materials as are necessary in the refining of the ores; the various processes for the extraction of the natural occurring material showing the plans and methods of exploration and working principally by means of models and drawings, and, where practicable, by the exhibition of specimens of the tools actually used; the various steps in the treatment of the ores from the time they leave the mines until they are converted into the commercial metals, with specimens of the various intermediate products and plans and models of the machines, furnaces, &c., brought into requisition during the processes; (this is perhaps the least satisfactory part of the present collections in the Museum, and one that should be increased as rapidly as possible;) and, finally, the various forms in which the different metals are produced and placed upon the market, together with the incidental products, especially such as can be utilized.

By far the greatest portion of the collection, however, should be arranged upon a geographical basis, whereby the ores and products of certain regions would be grouped together, and, when possible, the connection between the various regions should be clearly indicated. In the arrangement of this collection a somewhat different plan should be followed from that adopted in the scientific collection, as in this case there will be of necessity considerable duplication of specimens, and prominence should be given to peculiarities in occurrences and composition of the ores, and the modifications thereby necessitated in the usual course of treatment. This collection will require constant care and attention to keep it abreast of the progress of development, which is very rapid in this country where many new regions are being explored and developed every year, and where the varying conditions found in isolated regions lead to interesting and important modifications in processes, which should be examined and made available to the rest of the world. It is also very desirable to have suites of specimens showing the changes occurring in the composition and character of ores from the surface to the greatest depth attained, but these cannot be obtained after a mine has been in operation a few years. At the same time, as regions decline in importance, and processes become antiquated and pass out of use, a judicious culling out of unimportant material could be made with advantage. There is one field which the department could with propriety occupy, namely, the collection of the literature of American metallurgy, which is at present very restricted, a condition readily explained by the fact that metallurgical knowledge has a high commercial value which its possessors desire to retain, from purely selfish motives. Such books as there are upon metallurgical subjects are mainly of European origin, and their ignorance and silence upon developments in metallurgy made in this country are so great as to make them valueless for application here except so far as broad general principles are concerned. There

have been many and great advances in metallurgy made in this country, and a complete record of their development would be a valuable contribution to knowledge. It is but just to say that, as a rule, American metallurgists have written and published far more than their European brethren, but there is still room for improvement. The majority of papers by American writers are scattered through various society-journals and other periodicals, so that the student is obliged to waste a great deal of time in tiresome search through a large amount of (to him) valueless matter.

DEPARTMENT OF EXPLORATION AND FIELD WORK.

The explorations which have been made, especially in the interest of the National Museum have been, as hitherto, under the immediate direction of the Smithsonian Institution, from whose funds the expenses have been for the most part defrayed. The details are given at length in the report of the Secretary of the Smithsonian Institution. Various officers of the Museum have been attached, especially during the summer months, to the service of the United States Fish Commission, the Geological Survey, and the Bureau of Ethnology of the Smithsonian Institution, while others, more or less affiliated with the Museum, have been engaged in field work incidentally in connection with their duties as employees of the Coast Survey and the Signal Service of the Army.

DEPARTMENT OF CHEMISTRY.

The chemical laboratory occupies the two upper stories of the southwest pavilion, and the chemist, Mr. Frederick W. Taylor, has been engaged in the solution of many questions in chemistry and economic geology, proposed by the other departments of the Museum or by outside departments of the Government. The chemist reports that, in answer to letters received from the Director, he has made 119 reports, 15 being letters in response to queries submitted to the Smithsonian Institution; 70 being reports of qualitative analyses of specimens received by the Institution, and identifying 93 specimens of minerals, rocks, and ores. Thirty-four reports have been made representing 65 quantitative analyses, and involving 274 determinations.

One of the most interesting of the investigations was made for the chairman of the House Committee on Ways and Means for the purpose of determining the possibility of extracting the methylic alcohol from the ethyl alcohol contained in English methylated spirit. Another was the analysis of eight samples of zinc-covered or galvanized-iron telegraph wire for the Signal Office of the War Department, the object being to find some explanation of the different degrees of resistance to an electric current exerted by the different wires.

The main work of the laboratory has, however, been the examination of questions in economic geology, involving the analyses of numerous specimens of iron ore, coke, gold and silver ore, of natural brines, and of soda incrustations from Nevada, the latter for the United States Geological Survey.

The chemist makes the following statements upon the present condition of the laboratory:

The present condition of the chemical laboratory is, with very few exceptions, most promising. In the balance-room we have three No. 7 analytical balances, one large analytical balance to carry one kilogramme, one assay button balance, one small so-called prescription scale, one pulp scale for assay charges, and one Jolly's balance for specific gravity determinations.

Ample facilities for the preparation of samples for analysis are provided, the laboratory being provided with a small Blake crusher for reducing samples to small fragments, a "buck plate" for assay samples, and a number of valuable agate mortars for preparing samples of silicates, rocks, &c., where iron cannot be used.

The facilities for assaying are good, there being three furnaces for that purpose, one for crucibles, and two for scarification and cupellation. The stock of glassware is good, as also the porcelain. The main feature of the laboratory, however, is the fine stock of platinum ware in the form of dishes and crucibles, the laboratory possessing 19 platinum dishes holding from 50 cubic centimeters to nearly half a liter, and 25 platinum crucibles. In addition to the 2,070 grammes spoken of, the Institution has purchased at different times about 700 grammes of platinum, this being purchased before we had received the addition from Newport, making in all about 2,770 grammes of metal, representing a money value of over eleven hundred dollars.

In regard to the general arrangements of the rooms of the laboratory a full description will be found in the report of the Institution for 1881. The main room is fitted with white-pine desks, one running across the entire width of the room against the south wall, the other being placed against the third wall, besides which there are cases for chemicals and apparatus, and a fume chamber. The balance room is handsomely fitted up with cases of black walnut and contains a heavy black walnut table for the balances. The third floor of the building has also been fitted up during the year with a substantial double desk. During the past year the supply of water has been entirely insufficient, or rather the pressure has been insufficient, causing much annoyance, the flow often ceasing for the greater part of the day; and should the engineer desire to fill his boilers no water can be had on the laboratory floor during the process. Frequently the operation of distilling water for use in making analysis had been suspended for lack of water to cool the condenser. To remedy this evil, the chemist would suggest that a tank be placed on the roof of the building and connected with the feed pump for the boilers in the engine room by a suitable arrangement of valves; this could be so arranged as to supply the upper or third floor continuously, being used on the second floor only when the ordinary supply should fail.

DEPARTMENT OF EXPERIMENTAL PHYSIOLOGY.

Mr. John A. Ryder, embryologist of the United States Fish Commission, has occupied during the year a laboratory fitted up for microscopic work, and especially for embryological investigations, in the Armory building, and has carried on several important investigations upon the embryology of fishes and oysters. The laboratory has been filled up with considerable completeness, chiefly at the expense of the Fish Commission.

A list of Mr. Ryder's publications will be found in the appended bibliography.

The Museum has furnished a considerable amount of material to Dr. S. Weir Mitchell, of Philadelphia, who is engaged in investigating the venom of the rattlesnake, and also a number of specimens to Dr. John J. Mason, of Philadelphia, for his studies upon the brain.

In connection with the Fish Commission work some very important experiments have been made by Colonel MacDonald and Mr. Ryder upon the retardation of the development of the eggs of shad and other fishes.

Involuntary experiments have been made in this department during the year by Dr. R. W. Shufeldt and Mr. A. Z. Shindler, of the Museum, the former having been bitten by a *Heloderma suspectum*, and having described his experience in the "American Naturalist," November, 1882, Vol. XVI, No. 11, the latter having suffered a like mishap while handling a specimen of *Elaps fulvius*, as described by Mr. F. W. True in the "American Naturalist," 1882, Vol. — page —.

DEPARTMENT OF VIVARIA.

A number of living animals are on exhibition in the rotunda of the new building and seem to afford much amusement and instruction to visitors. This department, while of but little service in the general disposition of the collection, is well suited for the exhibition of a few cases of living animals; and I am inclined to believe that fifteen or twenty characteristic forms might be obtained and maintained here at trifling expense, while serving an excellent purpose in illustrating and supplementing the preparations in the Museum cases.

At present, the following mammals are thus exhibited:

A Red-footed Douroucouli, or Owl Monkey (*Nyctipithecus rufipes*, Sclater), from Costa Rica; two Pinches, or White-tufted Marmosets (*Edipus titi*, Lesson), from Chiriqui, Colombia; a young Mexican Deer (*Cariacus mexicanus*, Gmelin), from Chiriqui, Colombia. All these specimens were presented to the Museum by Capt. John M. Dow.

In the same room is also a large case in which at various times throughout the year many species of American snakes have been shown. Upon these the curator of herpetology has made the following report:

The vivarium for reptiles continues to prove of the greatest interest to visitors, and it is hoped a sufficient number of living specimens may be sent to render it still more popular. In connection with it, a most instructive and interesting event occurred early in the summer, namely, the birth of 109 young snakes (*Tropidonotus sipedon*). The act of parturition was carefully observed, and it is the intention of the curator to publish a paper upon the subject.

There is little trouble in keeping the harmless reptiles alive in captivity for an indefinite length of time, provided proper food can be obtained; but with regard to the *Crotalus* and *Ancistrodon*, as yet our efforts have failed to induce them to feed.

It has been noticed, also, that quite a number of our specimens die from necrosis of the jaw, an experience which has, it is believed, been shared by nearly every museum and zoological garden in the world.

Early this year a very fine and extremely large rattlesnake (*Crotalus adamanteus*) was received from Florida, and shortly after an equally large kingsnake (*Ophibolus getulus*), and it was determined to test the popular belief as to the antagonism existing between the two species. They were accordingly placed in a large case, the bottom of which was covered with sand, and allowed to remain together for some time. No hostilities took place, and it was noticed that neither species appeared to fear the other. Perhaps under more natural surroundings the case may be different.

It has been found necessary to keep king-snakes apart from the others, as their cannibalistic tendencies are well developed.

In the months of September and October copulation was noticed between some fine examples of the indigo snake (*Spilotes erebennus*) in the vivarium, and it is hoped young specimens may be secured as a result.

In the basin of the fountain in the rotunda are kept living fishes of the following species:

1. *Cyprinus carpio* (Linné). *a* scale carp; *b* leather carp.
2. *Carassius auratus* (L.) Bleeker. Goldfish; *a* common form; *b* triple-tail form.
3. Hybrid between Nos. 1 and 2. 4. *Idus melanotus* (Hæckel).

In a tank in the same room are shown two specimens of albino axolotls (*Siredon pisciformis*), which were bred by M. Carbonnier in Paris, France, from other albinos which were the progeny of a pair of black axolotls.

Nearly all the living species of North American *Testudinata* are kept in confinement in one of the smaller inclosures on the carp ponds on Monument lot, where they remain for purposes of acclimation.

Fishes of the following species are cultivated in the carp ponds:

1. *Cyprinus carpio* (Linné). *a* scale carp; *b* mirror carp; *c* leather carp.
2. *Idus melanotus* (Hæckel). *Leuciscus idus* (Gthr.). Nerfling; Orfe; Golden Tench; Ide. 3. *Tinca vulgaris* (Cuv.). Tench.

These ponds are under the control of the Director of the Museum, and the details of their management are described in his report as Commissioner of Fisheries. Many American species of fish have also during a part of the year been kept in aquarium tanks in the Armory Building, where during the spring months extensive operations in connection with the hatching of fish have been carried on, which have been witnessed by large numbers of visitors.

OBITUARY NOTICE OF DR. G. W. HAWES.

GEORGE WESSON HAWES was born December 31, 1848, in Marion, Ind., and died of quick consumption June 22, 1882, in Manitou Springs, Colo., whither he had gone in the hope of benefit to his health. Both his parents were natives of Massachusetts; and both died while he was very young. His father was the Rev. Alfred Hawes, a missionary of the American Home Missionary Society, stationed at Marion, Ind. His early days passed under the care of a lady in Worcester, Mass., a friend of his parents whom he regarded as his foster-mother.

His taste for scientific studies was early manifest, and, having been for some years a student in the High School, Worcester, at the age of seventeen he entered the Sheffield Scientific School at New Haven, to which with some intermissions he was attached for fifteen years in the capacities of student, laboratory assistant, and instructor. From 1867

to 1871, he was engaged in business pursuits in Boston, but returned to graduate with the class of 1872, *four* years later than would otherwise have been the case. The first year after his graduation he was private assistant to Prof. S. W. Johnson in the chemical laboratory, subsequently until 1880 assistant and instructor in mineralogy and blow-pipe analysis in the Sheffield Scientific School. The summer of 1878 he devoted to the study of microscopic lithology in Breslau, under Prof. A. Lasaulx, and from March, 1879, to June, 1880, was studying mineralogy and crystallography at Bonn with Professor vom Rath, and lithology with Professor Rosenbusch at Heidelberg. He received the degree of doctor of philosophy from the University of Heidelberg in 1880.

In the fall of 1880, he accepted the position of curator of the Department of Economic Geology in the National Museum, and about the same time was appointed special agent of the Tenth Census in charge of the building-stone investigation. His strength was too heavily taxed by close study in the hot summer of 1881, and in the fall he found himself unable to continue his work. A month at the Warm Springs in Virginia failed to restore his vigor, and on his return it was ascertained that incipient lung trouble existed. He decided to spend the winter in the Bermudas, hoping that the mild air of a southern ocean would restore him to health. On his return in May it was evident to us all that his days of life were few, and as we bade him good-bye, when he set forth for Colorado, we could scarcely hope to see him again.

In the early part of his student life he paid much attention to biological studies, and in the summer of 1872 was one of the party accompanying the United States Fish Commission at its summer station at Eastport, Me. Later he became an enthusiastic botanist and published a most admirable work upon the flora of New Haven and vicinity. After finally selecting a specialty he devoted himself to it with untiring zeal, and at the time of his death had placed himself in the front rank of American mineralogists and lithologists. His future was rich in promise. He regarded his life work as just begun, and his chief regret, as he often expressed it to me, was that he had to leave a task which he had for so many years been laying out and preparing himself for. "His death," remarks Dr. Rosenbusch in the *Neues Jahrbuch für Mineralogie*, "has deprived science of an enthusiastic and unusually gifted servant." He was possessed of unusual executive ability, and his associates in the Museum often wondered at the ease with which he organized and conducted his own department. He had published twenty or more memoirs upon mineralogical and lithological topics, prominent among which are his studies upon contact zones in the Albany granites, and the Mesozoic diabase of Connecticut. His largest work was the Mineralogy and Lithology of New Hampshire, constituting volume IV of the Reports of the State Geologist. He regarded the investigation of the building stones of the United States, which he had just taken in hand, as the great work of his life, and had laid out an extremely

comprehensive scheme for its prosecution. The report upon this subject, soon to be published by the Census Bureau, his in conception and chiefly the product of his labors, will undoubtedly be the finest of its kind ever prepared. The National Museum contains an imperishable monument to his memory in the magnificent collection of building stones which he gathered—a collection far surpassing any other in the world.

Hawes was a man of upright and noble character—a character shaped by a reverent faith in the teachings of the Christian religion. Like many men trained in the methods of scientific thought, he felt unable to agree with the doctrines of any sect, but in our conversations he asserted his belief in the Christian revelation, and all who know him must feel that his life was shaped by this belief.

LIST OF PAPERS BY DR. G. W. HAWES.*

[Experiments on the use of potassium dichromate.] Published in an article by Prof. S. W. Johnson on the use of potassium dichromate in ultimate organic analyses.

(American Journal of Science, 1874, VII, p. 466.)

On a feldspar from Bamle, in Norway.

(Am. Journal of Science, 1874, VII, p. 579.)

Gives the results of chemical analyses of a feldspar identical with or closely allied to oligoclase.

On the chemical composition of the wood of aerogens.

(Am. Jour. of Science, 1874, VII, p. 585.)

Gives the results of twelve chemical analyses as made by the author upon aerogens of the following species: *Lycopodium dendroideum*, *L. complanatum*, *Equisetum hyemale*, *Aspidium marginale*, *Cyathea canaliculata*.

[Analysis of a serpentine pseudomorph, and examination of brucite.] In J. D. Dana's "Serpentine pseudomorphs from the Tilly Foster mine."

(Am. Jour. of Science, 1874, VIII, pp. 451-453.)

[Analysis of chondrodite from the Tilly Foster mine.] In Prof. E. S. Dana's memoir on chondrodite.

(Transactions of the Connecticut Academy of Arts and Sciences, 1875, III, p. 86.)

The trap rocks of the Connecticut Valley.

(Am. Jour. of Science, 1875, IX, pp. 185-192.)

Gives the results of several chemical analyses of the dolerites and diabases of the Connecticut Valley.

On diabantite, a chlorite occurring in the trap of the Connecticut Valley.

(Am. Jour. of Science, 1875, IX, pp. 454-457.)

Gives the analysis of a variety of chlorite found in the trap of the Connecticut Valley.

* This bibliography was prepared by George P. Merrill.

On zonochlorite and chlorastrolite.

(Am. Jour. of Science, 1875, x, pp. 24-26.)

Concludes from chemical and microscopic examination that these are not true mineral species, but rather impure varieties of phrenite. Reviewed by Rosenbusch in the Neues Jahrbuch for 1875, p. 750.

[Analysis of durangite.] In Prof. G. J. Brush's article on "The chemical composition of durangite."

(Am. Jour. of Science, 1876, xi, p. 464.)

The rocks of the "Chloritic formation" on the western border of the New Haven region.

(Am. Jour. of Science, 1876, xi, pp. 122-126.)

Gives the results of microscopic and chemical examinations of certain metamorphic rocks in the vicinity of New Haven, Conn. Concludes that they are true dolerites, diabases, and metaphyres, and distinguishes them from similar eruptive rocks by the prefix *meta*.

On a lithia-bearing variety of biotite.

(Am. Jour. of Science, 1876, xi, pp. 431-432.)

Finds that the black biotite from the feldspar quarries of Portland, Conn., contains some 0.95 per cent. of lithia, which replaces a part of the potash.

On the greenstones of New Hampshire and their organic remains.

(Am. Jour. of Science, 1876, xii, pp. 129-137, 1 plate.)

Gives the result of numerous chemical and microscopic examinations of the so-called greenstones of New Hampshire, and also describes and figures certain forms contained in them, which appear to be of organic origin. These forms, which excited considerable interest at the time, proved, on further examination, to be but the peculiar skeleton-like forms left by decomposing titanite iron.

On grains of metallic iron in dolerites from New Hampshire.

(Am. Jour. of Science, 1877, xiii, pp. 33-35.)

Mineralogy and lithology of New Hampshire, by George W. Hawes, instructor in mineralogy in the Sheffield Scientific School of Yale College. Part IV, of the third volume of the Geology of New Hampshire, 262 pp., royal 8vo, with 12 plates. Concord, N. H., 1878.

This, the most important work of the author's life, gives the results or extensive research upon the chemical and microscopic properties of what may be regarded as typical rocks and minerals of New Hampshire. It also contains extensive notes upon the external characters, economic value, and general distribution of the rocks over the State, together with a short treatise upon the method of study with the microscope.

The rocks of the "Chloritic formation" on the western border of the New Haven region.

(Am. Jour. of Science, 1878, xv, p. 219.)

A note on the previous paper published in this journal, xi, 1876, p. 122. The author finds on further examination that a certain mineral, supposed at first to be a pyroxene, is hornblende, and that the rock belongs therefore to the diorite group.

H. Mis. 26—11

On liquid carbonic acid in syenite.

(Am. Jour. of Science, 1878, xvi, p. 234.)

A short note taken from the author's "Report on the mineralogy and lithology of New Hampshire."

On leucoxene in the New Hampshire diorites.

(Am. Jour. of Science, 1878, xvi, p. 396.)

A short note taken from the author's "Report on the mineralogy and lithology of New Hampshire."

On the association of pyroxene and hornblende.

(Am. Jour. of Science, 1878, xvi, p. 397.)

A short note taken from the author's "Report on the mineralogy and lithology of New Hampshire."

On a group of dissimilar eruptive rocks in Campton, N. H.

(Am. Jour. of Science, 1879, xvii, pp. 147-151.)

Describes five closely adjoining dikes cutting a mica schist in Campton, N. H., which, upon examination, prove to be composed of diabase, olivene diabase, diorite, and syenite. Gives chemical analyses.

An account of recent progress in geology, for the years 1879 and 1880.

(Smithsonian Report, 1880, pp. 221-234.)

Also published separate in pamphlet form.

An account of recent progress in mineralogy, for the years 1879 and 1880.

(Smithsonian Report, 1880, pp. 229-312.)

Also published separate in pamphlet form.

The Albany granite, New Hampshire, and its contact phenomena.

(Am. Jour. of Science, 1881, xxi, pp. 21-32.)

Describes the chemical and structural change produced in the eruptive Albany granite, and the adjoining argillitic mica schist at their point of contact. The rocks were studied both chemically and microscopically.

An abstract of this paper by H. Rosenbusch was afterward given in the Neues Jahrbuch für Mineralogie, &c., 1882, i. Band, i. Heft, pp. 464-465.

On liquid carbon dioxide in smoky quartz.

(Am. Jour. of Science, 1881, xxi, pp. 203-209.)

The author finds the smoky quartz of Branchville, Conn., to be particularly rich in cavities, containing carbonic acid in both the liquid and gaseous state. Considers that the motion of these included bubbles is due to changes in external temperature. The paper is supplemented by a communication by Mr. A. W. Wright, giving the results of chemical examinations of the gases and liquids contained in these cavities.

On the mineralogical composition of the normal Mesozoic diabases upon the Atlantic border.

(Proc. U. S. Nat. Mus., 1881, iv, pp. 129-134.)

This paper gives the results of several chemical and microscopic examinations of the rocks, showing that their composition is somewhat more complex than is generally supposed; that two varieties of plagioclase are generally present. The paper was reviewed by Prof. J. D. Dana, in American Jour. of Science, xxii, 3d series, 1881, p. 230. Also reviewed by H. Rosenbusch in Neues Jahrbuch für Mineralogie und Geologie, 1882, i, iii, p. 414.

On the determination of feldspars in thin sections of rocks.

(Proc. Nat. Mus., 1881, iv, pp. 134-136.)

The author gives as the result of his experience that grave errors are liable to arise through relying altogether upon optical methods for determining feldspars in thin sections, since, owing to the uncertain angle at which the crystals are cut, it is not only not possible at all times to distinguish with certainty between the different varieties of plagioclase, but at times they can with great difficulty be distinguished from orthoclase.

On a phosphatic sandstone from Hawthorne, Fla.

(Proc. U. S. Nat. Mus., 1882, v, pp. 46-48.)

Gives the results of microscopic and chemical analysis of a phosphatic sandstone from Hawthorne. The stone was found to contain some 16 per cent. of phosphoric acid.

Brief abstracts and reviews of papers by American authors, published by Dr. Hawes in the Neues Jahrbuch für Mineralogie, Geologie, und Paläontologie.

B. J. Harrington. Notes on chrome-garnet, phyrhotite, and titaniferous iron ore. Proc. Canadian Natural History Society, May, 1880.—H. B. Cornwall. Gallium in American blende. Am. Chem. Jour., April 1880, p. .—Peter Collier. Analysis of a mineral resembling thorite. Jour. Amer. Chem. Soc., xi, ii, p. 73.—F. W. Clark and M. E. Owens. On a new variety of tetrahedrite. Am. Chem. Jour., June, 1880, p. 173.

(Neues Jahrbuch, 1881, xi, ii pp. 174-175.)

George J. Brush. On American sulpho-selenides of mercury with analysis of onofrite from Utah, by W. G. Comstock. Am. Jour. Science, xvi, April, 1881.—F. A. Genth and W. C. Kerr. The minerals and mineral localities of North Carolina, being Chapter I of Vol. II of the Geology of North Carolina, p. 122. Raleigh, 1881.—Henry C. Lewis. On Philadelphite, a new mineral species. Proc. Phil. Acad. Nat. Sciences, December 22, 1879.—Wm. P. Blake. Occurrence of realgar and orpiment (auripigment) in Utah Territory. Am. Jour. Science, March, 1881, p. 219.—W. E. Hidden. On the Whitfield County, Georgia, meteoric iron. Am. Jour. Science, April, 1881, p. 287

(Neues Jahrbuch, 1881, xi, iii, pp. 337-343.)

A. R. C. Selwyn. Geological survey of Canada; report of progress for 1878-'79.—D. Honeyman. Geological waifs from the Magdalen Islands.—D. Honeyman, D. C. L. Nova Scotia geology. Notes on a new geological map of Pictou County. Proceedings and Transactions of the Nova Scotia Institute of Natural Sciences, Halifax, 1880, Vol. v, pp. 119, 136, 192.—Eugene A. Smith. On the geology of Florida. Am. Jour. Science, April, 1881, p. 292.—Geo. M. Wheeler. Annual Report upon the Geographical Survey of the Territory of the United States west of the 100th meridian. Appendix OO of the Annual

Report of the Chief of Engineers for 1879. 338 pages. An atlas of six maps; also several large maps with the text.—Warren Upham. The geology of Central and Western Minnesota. A preliminary report. Saint Paul, Minn. 33 pp.—Edward Orton. Review of stratigraphical geology in Eastern Ohio, from the annual report of the secretary of state, 1879. Columbus, Ohio, 1880. pp. 33.—C. G. Rockwood, jr. Notices of recent American earthquakes. *Am. Jour. Science*, March, 1881, p. 183.

(*Neues Jahrbuch*, 1881, xi, iii, pp. 373-376.)

R. P. Whitefield. Notice of the occurrence of rocks representing the Marcellas shales of New York in Central Ohio. *Proc. Am. Assoc.*, Saratoga meeting, August, 1879, p. 297.—H. M. Chance. The millstone grit in England and Pennsylvania. *Am. Jour. Science*, February 1881, xxi, p. 137.—Andrew S. McCreath. Second report of progress in the laboratory of the second geological survey of Pennsylvania. J. P. Lesley, State geologist. Containing communications by Professor Frazier, F. Platt, and J. P. Lesley. 438 pp.—Persifer Frazer. The geology of Lancaster County, second geological survey of Pennsylvania.—M. E. Wadsworth. Notes on the geology of the iron and copper districts of Lake Superior. *Bulletin of the Museum of Comparative Zoology at Harvard College*, geological series, 1, July, 1880. 157 pp.—Geology of Wisconsin. Vol. III, survey of 1873-'79. T. C. Chamberlin, State geologist. 763 pp.—Geological survey of Alabama; report of progress for 1877-'78. Eugene A. Smith, State geologist, 138 pp.—C. E. Dutton. Report on the geology of the high plateaus of Utah, 1880.—Alexis A. Julien. On the geological action of the humus acids. *Proc. Am. Association*, August, 1879, pp. 311-411.—W. C. Kerr. The mica veins of North Carolina. *Transactions Am. Inst.—Mining Engineers*, Feb., 1880.—J. S. Diller. The felsites and their associated rocks north of Boston.—*Proc. Boston Soc. of Nat. Hist.*, Jan. 21, 1880, p. 385.—J. Peter Lesley. Second geological survey of Pennsylvania. Reports from 1874 to 1880.

(*Neues Jahrbuch*, 1881, xi, iii, pp. 380-390.)

Dr. Hawes assisted in the preparation of the following works, which should be added in order that the list may be complete:

A catalogue of the flowering plants and higher cryptogams growing without cultivation within thirty miles of Yale College. Published by the Berzelius Society, New Haven, 1878.

A manual of determinative mineralogy, with an introduction on blow-pipe-analysis, by George J. Brush, professor of mineralogy in the Sheffield Scientific School of Yale College.

THE COLLECTION OF BUILDING STONES.

About the time that Dr. Hawes entered upon his duties as a curator at the National Museum he also assumed charge of that branch of the Tenth Census relating to the quarrying industries of the United States. His plan was to make a complete census of all the quarries of stone worked in the country, to ascertain the amount and value of their productions, the number of men employed, and all the facts usually included in census reports; in addition to which it was hoped to gain a large amount of information of more strictly scientific interest. In order to carry out his plans, special agents or collectors were employed, in all cases in which it was possible, men of scientific attainments, whose education and training had especially fitted them for the work, who were to visit the quarries in person and gather all necessary facts of economic importance relative to the industry, besides which they were instructed to collect all additional facts possible of scientific importance but perhaps of less practical value. Among the printed questions to be answered relative to each quarry were the following: "Kind of rock quarried?" "Geological age of formation?" "Structure of natural blocks as regards stratification and jointing?" "How large a block can be obtained?" "Principal uses for which it is employed?" &c.; or, if the stone was used for ornamental purposes only, there were added such questions as, "What are the qualities that render this stone desirable for ornamental purposes?" and, "Is it suitable for ornaments exposed to the weather?"

From each quarry two specimens, or more if the character of the rock seemed to require it in order to represent it in all its varieties, of sufficient size to be dressed into four-inch cubes, were forwarded by mail to the Museum for further examination. Here a corps of aids and assistants was employed to work up the material as it came in. Each specimen on its arrival, after being catalogued, was placed in the hands of stone-cutters who dressed them into four-inch cubes the different faces of the cubes being finished as follows: Polished in front, drafted and pointed on the left side; drafted rock face upon the right side; rock face behind, and smooth sanded or chiseled upon the top and bottom. This preparation was modified to suit individual cases; for example, sandstones which do not polish, had the front face simply rubbed smooth. The specimens thus prepared were placed in suitable exhibition cases and properly labelled, where they might be examined by all who wished.

The chips made in the process of dressing were carefully saved to be utilized in chemical and microscopic analyses. Also specimens from each quarry, so far as practicable, were to be submitted to proper tests, to ascertain their powers of resistance to pressure. Special tests were also to be made to learn the absorptive properties of the various kinds of stone; their specific gravity and weight per cubic foot; their powers of resistance to the effect of heat and frost, together with the effect of

certain included minerals upon their weathering properties. Preparations were made for extensive chemical analyses, and several hundred thin sections prepared for microscopic study.

The final report was to be published in quarto form and to contain, in addition to extensive articles upon the subjects already mentioned, chapters on the history of the quarrying industry of the United States, and upon rock weathering and decomposition as illustrated in the stone buildings of the principal cities of the country. It was also to contain numerous plates showing the rocks both as they appear to the naked eye and as seen in thin sections under the microscope. Also illustrations of some of the principal quarries and of special machinery used in quarrying and dressing stone.

When it became evident that Dr. Hawes could no longer continue his work it was placed in other hands for continuation, but the long delay already caused by his illness rendered its full completion impossible within the limits of time prescribed by the census, and it was therefore greatly abbreviated. Had he been able to carry out his plans as originally intended, this would, beyond all doubt, have been the most important work upon the subject of building stones ever produced in this or any other country.

APPENDIX A.—LIST OF OFFICERS, JANUARY 1, 1883.

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- SPENCER F. BAIRD.....*Secretary of the Smithsonian Institution; Director.*
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- G. BROWN GOODE.....*Assistant Director; Curator, Dep't of Art and Industry.*
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- TARLETON H. BEAN.....*Curator, Dep't Ichthyology, and Editor of "Proceedings."*
 WILLIAM H. DALL.....*Honorary Curator, Department of Mollusks.*
 FREDERICK P. DEWEY..*Assistant Curator, in charge of Department of Metallurgy.*
 JAMES M. FLINT.....*Honorary Curator, Section of Materia Medica.*
 EDWARD FOREMAN.....*Assistant, Department of Ethnography.*
 GEORGE P. MERRILL....*Assistant, Section of Building Stones.*
 RICHARD RATHBUN.....*Assistant Curator, in charge Dep't of Marine Invertebrates.*
 CHARLES RAU.....*Curator, Department of Archaeology.*
 ROBERT RIDGWAY.....*Curator, Department of Birds.*
 CHARLES V. RILEY.....*Honorary Curator, Department of Insects.*
 FREDERICK W. TAYLOR..*Chemist.*
 FREDERICK W. TRUE.....*Librarian; Acting Curator, Department of Mammals.*
 CHARLES D. WALCOTT..*Honorary Ass't Curator, Dep't of Invertebrate Fossils.*
 LESTER F. WARD.....*Honorary Curator, Department of Fossil Plants.*
 CHARLES A. WHITE.....*Curator, Department of Invertebrate Fossils.*
 HENRY C. YARROW.....*Honorary Curator, Department of Herpetology.*
 WILLIAM S. YEATES.....*Acting Curator, Department of Minerals.*
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APPENDIX B.—BIBLIOGRAPHY OF PUBLICATIONS OF THE MUSEUM FOR 1882.

I.—PAPERS BY OFFICERS OF THE MUSEUM.

- BEAN, TARLETON H. A partial bibliography of the fishes of the Pacific coast of the United States and of Alaska, for the year 1880.
 (Proc. U. S. Nat. Mus., 1881, iv, pp. 312-317.)
- Notes on fishes collected by Capt. Chas. Bendire, U. S. A., in Washington Territory and Oregon, May to October, 1881.
 (Proc. U. S. Nat. Mus., 1882, v, pp. 89-93.)
- Note on the occurrence of a Silvery Lamprey (*Ichthyomyzon castaneus* Girard) in Louisiana.
 (Proc. U. S. Nat. Mus., 1882, v, pp. 117-119.)
- Notes on birds collected in Alaska and Eastern Siberia during the summer of 1880.
 (Proc. U. S. Nat. Mus. 1882, v, pp. 144-173.)

- BEAN, TARLETON H. Translation of note on the habits and the rearing of the Axolotl (*Amblystoma mexicanum*), by M. Carbonnier.
(Proc. U. S. Nat. Mus., 1882, v, pp. 221-222.)
- Notes on a collection of fishes made by Capt. Henry E. Nichols, U. S. N., in British Columbia and Southern Alaska, with descriptions of new species and a new genus (*Delolepis*).
(Proc. U. S. Nat. Mus., 1882, v, pp. 463-474.)
- List of publications of the United States National Museum.
(Bull. U. S. Nat. Mus., No. 18, pp. 1-12.)
- Notes on a shipment, by the United States Fish Commission of California salmon (*Oncorhynchus chouicha*) to Tanner's Creek, Indiana, in 1876.
(Bull. U. S. Fish Com., 1882, I, pp. 204-205.)
- Account of a shipment, by the United States Fish Commission, of California salmon-fry (*Oncorhynchus chouicha*) to Southern Louisiana, with a note on some collections made at Tickfaw.
(Bull. U. S. F. C., 1882, I, pp. 205-206.)
- (J. W. Collins.) An inquiry as to the capture of young codfish in Chesapeake Bay.
(Bull. U. S. F. C., 1882, I, pp. 401-402.)
- Directions for collecting and preserving fish.
(Forest and Stream, No. 25, Jan. 19, 1882, xvii, p. 492.)
A reprint from Proc. U. S. Nat. Mus., 1881, iv, pp. 235-238.
- Rainbow and other Pacific trout.
(Forest and Stream, June 15, 1882, xviii, pp. 389-390.)
See also GOODE and BEAN.
- DALL, WILLIAM H. On the genera of Chitons.
(Proc. U. S. Nat. Mus. 1881, iv, pp. 279-291.)
- The currents and temperatures of Bering Sea and the adjacent waters.
(Report U. S. Coast Survey for 1880, App. No. 16.)
Separate 4to, p. 46, maps and section, March, 1882.
- On certain Limpets and Chitons from the deep waters off the Eastern coast of the United States.
(Proc. U. S. Nat. Mus. 1881, iv, pp. 400-414.)
Reprinted in Ann. and Mag. Nat. Hist., London, x (1882), 11-26.
- List of papers by William Healey Dall, assistant, U. S. Coast Survey, honorary curator, U. S. National Museum. 1866-1882. Washington: Judd & Detweiler, printers, 8vo, pp. 11.
- Notes on Alaska Tertiary deposits.
(Amer. Journ. Sci., July, 1882, xxiv, pp. 67, 68.)
- Biographical sketch. [Charles Darwin.]
(Proc. Biol. Soc. Wash., 1882, I, pp. 56-59.)
Read before the society May 12, 1882, on the occasion of the Darwin memorial meeting.

DALL, WILLIAM H. Address by William H. Dall, vice-president, section F, before the section of Biology, American Association for the Advancement of Science, Montreal meeting, August 23, 1882. Salem, printed at the Salem Press, 1882, 8vo, pp. 16.

- Species in Buccinum.
(Nachricht. d. dents. malakozool. Gesells., Aug.-Sept., 1882, pp. 118-121.)
- Zum Kapitel der "Natural Selection."
(Nachricht. d. dents. malakozool. Gesells., Oct., pp. 145-149.)
- Dall über das Klima von Alaska.
(Zeitsch. d. österreichis. Gesells. f. Meteo., Nov., 1882, xvii, pp. 443-444.)
- Note on *Gadinia excentrica* Tiberi.
(Amer. Nat., Sept., 1882, p. 737.)
- Der Golfstrom nach den neuesten Forschungen.
(Petermanns geogr. Mittheilungen, 1883, i, pp. 19-21.)
- GOODE, G. BROWN. The eel question.
(Forest and Stream, xviii, 1882, March 2, pp. 91-93; March 9, pp. 111-113; March 16, pp. 132-133.)
- Materials for a history of the Swordfish.
(Forest and Stream, xviii, 1882, June 22, p. 410; July 20, p. 492; xix, 1882, Aug. 17, p. 52; Aug. 24, p. 70; Aug. 31, pp. 91, 92; Sept. 7, pp. 111, 112; Sept. 14, pp. 132, 133; Sept. 21, pp. 149, 150; Oct. 5, p. 193; Oct. 19, pp. 231, 232.)
Also in Trans. Amer. Fish Cult. Assoc., 1882, pp. 84-150.
- The taxonomic relations and geographical distribution of the members of the swordfish family (*Xiphiidae*).
(Proc. U. S. Nat. Mus., 1881, iv, pp. 415-433.)
- The fisheries of the world.
(Cyclopædia of Political Economy, Chicago, ii, pp. 211-231.)
- Benthodesmus, a new genus of deep-sea fishes, allied to *Lepidopus*.
(Proc. U. S. Nat. Mus., 1881, iv, pp. 379-383.)
- The Mackerel.
(Proc. Biol. Soc. Wash., i, 1882, p. 32.)
- The fishermen of the United States. [Abstract.]
(Trans. Anthrop. Soc. Wash., i, pp. 62-66.)
See GOODE and BEAN; also, GOODE and COLLINS.
- GOODE, G. BROWN, and TARLETON H. BEAN. Benthodesmus, a new genus of deep-sea fishes, allied to *Lepidopus*.
(Proc. U. S. Nat. Mus., 1881, iv, pp. 379-383.)
- A list of the species of fishes recorded as occurring in the Gulf of Mexico.
(Proc. U. S. Nat. Mus., 1882, v, pp. 234-240.)

GOODE, G. BROWN, and TARLETON H. BEAN. Descriptions of twenty-five new species of fish from the Southern United States, and three new genera *Letharchus*, *Ioglossus*, and *Chriodorus*.

(Proc. U. S. Nat. Mus., 1882, v, pp. 412-437.)

GOODE, G. BROWN, and Capt. J. W. COLLINS. The winter haddock fishery of New England.

(Bull. U. S. F. C., 1882, I, pp. 226-235.)

——— The winter haddock fishery of New England.

(Forest and Stream, May 18, 1882, xviii, pp. 311-312; also in Trans. Amer. Fish Cult. Assoc., 1882, pp. 48-65.)

RATHBUN, RICHARD. Dredging stations of the U. S. Fish Commission steamer, Fish Hawk, Lieut. Z. L. Tanner, U. S. N., commanding, for 1880, 1881, and 1882, with temperature and other observations.

(Bull. U. S. Fish Comm., Nov. 1882, II, pp. 119-131.)

——— List of marine invertebrates, mainly from the New England coast, distributed by the United States National Museum. Series II.

(Proc. U. S. Nat. Mus., 1881, IV, pp. 298-303.)

——— List of marine invertebrates from the New England coast, distributed by the U. S. National Museum. Series III. Educational series.

(Proc. U. S. Nat. Mus., 1881, IV, pp. 304-307. Feb'y., 1882.)

——— Notes on the shrimp and prawn fisheries of the United States.

(Bulletin U. S. Fish Comm., II, pp. 139-152. Nov., 1882.)

See also SMITH and RATHBUN.

RAU, CHARLES. Articles on anthropological subjects contributed to the annual report of the Smithsonian Institution, from 1863 to 1877, by Charles Rau. Washington. Published by the Smithsonian Institution, 1882, 8vo, pp. x, 1-169.

——— The Mount Pisgah (U. S.) stone carvings.

(Nature, July 13, 1882, p. 243.)

——— Die Jadeitgegenstände des National-Museums zu Washington.

(Archiv für Anthropologie, 1882, XIV, pp. 157-163.)

——— List of anthropological publications, 1859-1882.

(Proc. U. S. Nat. Mus., 1881, IV, pp. 455-458.)

——— Review of "Ancient Scottish lake-dwellings or crannogs, with a supplementary chapter on lake-dwellings in England," by Robert Monro, M. A., M. D., F. S. A. Scot. Edinburgh, 1882.

(The Nation, October 26, 1882, p. 363, anonymous.)

RIDGWAY, ROBERT. Catalogue of Old World birds in the United States National Museum.

(Proc. U. S. Nat. Mus., 1881, iv, pp. 317-333.)

The object of this catalogue, as expressed in the preface, "is to render apparent the desiderata of the National Museum in the way of Old World birds, so that museums or individuals desiring to make exchanges (or donations) may know what species are wanted." The total number of species enumerated is 1,339, to which there have been many additions* during the year, the result chiefly of a judicious distribution of the catalogue. It is proposed to publish annually a supplement to this list, giving the names of all the species added to the collection during the year, for the information of those from whom accessions to the collection may be expected.

Notes on some Costa Rican birds.

(Proc. U. S. Nat. Mus., 1881, iv, pp. 333-337.)

This paper is based upon a small but very interesting collection of birds presented by Sr. Don José C. Zeledon, of San José, Costa Rica, and mostly obtained upon the volcanic peak of Irazú. This elevated peak, like many others of a similar character throughout tropical America, possesses a number of entirely peculiar species, increased by two in the collection upon which this paper is based, viz, a very pretty wren (*Troglodytes ochraceus*), and a remarkable, as well as totally new form of dendrocolaptine bird (*Acanthidops bairdi*), the genus as well as the species being new.

Description of a new flycatcher and a supposed new petrel from the Sandwich Islands.

(Proc. U. S. Nat. Mus., 1881, iv, pp. 337-338.)

The birds described in this paper are new and very distinct species (*Chasiempis sclateri* and *Cymochorea cryptoleucura*) from the island of Waimea Kauai. The ornithology of the Sandwich Islands, notwithstanding their accessibility, being very imperfectly known, every addition to our knowledge of the birds of these islands possesses peculiar interest.

Description of a new owl from Porto Rieo.

(Proc. U. S. Nat. Mus., 1881, iv, pp. 366-371.)

In addition to the description of a new species (*Asio portoricensis*), this paper treats critically of the nearly cosmopolitan *Asio accipitrinus*, or short-eared owl, and its allies.

Descriptions of two new thrushes from the United States.

(Proc. U. S. Nat. Mus., 1881, iv, pp. 374-379.)

The birds herein described are *Hylcoichla fuscescens salicicola*, or willow thrush, from the Rocky Mountains, and *H. alieix bicknelli*, from the Catskill Mountains, New York. The latter is of particular interest, as being a local or geographical race of a species which breeds abundantly along the Arctic coast of North America, and which was supposed to be specially limited to that district during the breeding season. Nevertheless, Mr. Eugene P. Bicknell, of Riverdale, N. Y., found a smaller and darker colored form, unquestionably referable to the same species, breeding upon the Catskill Mountains, at an elevation of about 4,000 feet.

On two recent additions to the North American bird-fauna, by L. Belding.

(Proc. U. S. Nat. Mus., 1881, iv, pp. 414-511.)

During the winter of 1881-'82, Mr. L. Belding, of Stockton, Cal., made an

*The subsequent additions of identified species number 104, making a total of 1,443 species now in the collection.

RIDGWAY, ROBERT—Continued.

exploration of the western coast and southern extremity of Lower California, in the interests of the National Museum, a considerable portion of his time being spent at La Paz, on the eastern side of the peninsula. Among the birds obtained at this locality was a single example of Swinhoe's wagtail (*Motacilla ocularis*), a species belonging to eastern Asia, so that the individual in question must in all probability have crossed the Pacific Ocean, perhaps aided by some vessel bound toward our shores. The other, a Mexican species, the chestnut-headed yellow warbler, (*Dendroica bryanti*), first described in 1874, Mr. Belding found to be a common inhabitant of the mangrove thickets skirting the Gulf shore.

— Description of several new races of American birds.

(Proc. U. S. Nat. Mus., 1882, v, pp. 9-15.)

The new birds described in this article are (1) *Methriopterus curvirostris occidentalis*, from western Mexico; (2) *Mimus gilvus lawrencei*, from southern Mexico; (3) *Merula flavirostris graysoni*, from the Tres Marias Islands; (4) *Sialia sialis guatemalæ*, from Guatemala; (5) *Chamaea fasciata henshawi*, from the interior of California; and (6) *Perisoreus canadensis nigricapillus*, from Labrador.

— On the genera *Harporhynchus*, Cabanis, and *Methriopterus* Reichenbach, with a description of a new genus of *Mimina*.

(Proc. U. S. Nat. Mus., 1882, v, pp. 43-46.)

The purport of this paper is the definition of characters distinguishing two genera which had been previously confounded. A new allied genus (*Mimodes*), also related to *Mimus*, is instituted for the *Harporhynchus graysoni* Baird.

— Critical remarks on the tree creepers (*Certhia*) of Europe and North America.

(Proc. U. S. Nat. Mus., 1882, v, pp. 111-116.)

This paper, based upon extensive material in the National Museum, defines the distinctive characters of several Palearctic and North American races of *Certhia familiaris*, among which the following are described for the first time: (1) *C. familiaris britannica*, from the British Islands; (2) *C. familiaris montana*, from the Rocky Mountains; and (3) *C. familiaris occidentalis*, from the Pacific coast of North America.

— Description of some new North American birds.

(Proc. U. S. Nat. Mus., 1882, v, pp. 343-346.)

The species described are *Catherpes mexicanus punctulatus*, California; *Lophophanes inornatus griseus*, Middle Province of United States; *Geothlypis beldingi*, San José del Cabo, Lower California; *Rallus beldingi*, Espiritu Santo Islands, Lower California, of which the types are all in National Museum collection.

— On an apparently new heron from Florida.

(Bull. Nutt. Orn. Club, 1, 1882, vii, pp. 1-6.)

This article embodies a review of the question of dichromatism in *Ardea occidentalis* (first hinted at by the author in the Bulletin of the U. S. Geol. and Geog. Survey of the Terr., 1, 1873, iv, pp. 2-236), and also brings to notice an allied dichromatic species, or race, from western Florida, named *Ardea wardi*, in honor of its discoverer, Mr. C. W. Ward, of Pontiac, Mich., who generously furnished the facts and specimen upon which the new species was based.

RIDGWAY, ROBERT. Notes on some of the birds observed near Wheatland, Knox County, Indiana, in the spring of 1881.

(Bull. Nutt. Orn. Club, 1, 1882, VII, pp., 15-23.)

This paper presents the chief results of a collecting trip to the locality in question, in the interest of the National Museum.

— On the generic name *Helminthophaga*.

(Bull. Nutt. Orn. Club, 1, 1882, VII, pp. 53-54.)

This paper calls attention to the necessity (if the rules of nomenclature be strictly adhered to) of suppressing this name as used for a North American genus of warblers, it having been applied forty-seven years previously to an entirely dissimilar European group, including the nightingale and redbreast. In order to render the change as slight as possible, the name *Helminthophila* is proposed.

— The great black-backed gull (*Larus marinus*), from a new locality.

(Bull. Nutt. Orn. Club, 1, 1882, VII, p. 60.)

The known range of this species has been greatly extended by specimens from Herald Island, in the Arctic Ocean, north of Bering Strait, and Port Clarence, on the Atlantic side of the same strait, collected by Captain Hooper, U. S. Cutter "Corwin," and Dr. T. H. Bean, curator Department of Fishes, U. S. National Museum. The nearest previously recorded locality was Japan.

— Additions to the catalogue of North American birds.

(Bull. Nutt. Orn. Club, 1, 1882, VII, p. 61.)

The additions (to the catalogue published by the National Museum in 1881) are Nos. 440*, *Buteo fuliginosus* Scf. (little black hawk); 440**, *B. brachyurus* Vieill. (short-tailed hawk, white-fronted Hawk); 708, *Puffinus borealis* Cory (northern shearwater); and 717*, *Estrelata gularis* Peale (Peale's petrel). The numbers prefixed indicate their position as interpolated in the catalogue in question.

— Distribution of the fish crow (*Corvus ossifragus*).

(Bull. Nutt. Orn. Club, 4, 1882, VII, p. 250.)

This supposed strictly littoral species found among the mountains of Virginia, at least sixty miles from the nearest tide-water.

— Birds new to or rare in the District of Columbia.

(Bull. Nutt. Orn. Club, 4, 1882, VII, p. 253.)

The species given, verified by specimens in the National Museum collection, are the following: † Bewick's wren (*Thryomanens bewicki*); yellow-throated warbler (*Dendroica dominica*); loggerhead shrike (*Lanius ludovicianus*); and sharp-tailed finch (*Ammodromus caudacutus*).

— List of additions to the catalogue of North American birds.

(Bull. Nutt. Orn. Club, 4, 1882, VII, pp. 257, 258.)

This list is supplementary to that published in the January number of the same journal (No. 15), and includes subsequent additions, given "for the benefit of those who, for various reasons, are not able to keep the run of all the new discoveries." There are twenty-two species, as follows: 2a, *Hylocichla fuscescens salioicola* Ridgw. (Willow thrush) 3a. *H. alicia bicknelli* Ridgw. (Bicknell's thrush). 35a, *Chamaea fasciata henshawi* Ridgw. (Pallid ground. tit). 38a, *Lophophanes inornatus griseus* Ridgw. (Gray titmouse). 55b, *Certhia familaris montana* Ridgw. (Rocky Mountain creeper). 59b, *Catherpes mexicanus punctu-*

RIDGWAY, ROBERT—Continued.

latus Ridgw. (Punctulated wren). 69*, *Motacilla ocularis* Swinh. (Swinhoe's wagtail). 93*, *Dendroica vielloti bryanti* Ridgw. (Chestnut-headed yellow warbler). 122*, *Geothlypis beldingi* Ridgw. (Belding's yellow-throat). 144a, *Vireo huttoni stephensi* Brewst. (Stephens' vireo). 230b, *Peucea ruficeps eremæca* Brown. (Rock sparrow). 297c, *Perisoreus canadensis nigricapillus* Ridgw. (Labrador jay). 311a, *Myiarchus mexicanus cooperi* Baird (Cooper's flycatcher). 354a, *Caprimulgus vociferus arizonæ* Brewst. (Stephens' whippoorwill). 402e, *Scops asio bendirei* Brewst. (California mottled owl). 452*, *Gyparchus papa* Linn. (King vulture). 475a, *Lagopus mutus reinhardti* Brehm. (Greenland ptarmigan). 475b, *L. mutus atkensis* Turner (Atkhan ptarmigan). 486*, *Ardea wardi* Ridgw. (Ward's heron). 569*, *Rallus beldingi* Ridgw. (Belding's rail). 701*, *Diomedea melanophrys* Temm. (Spectacled albatross).

RILEY, CHARLES V. [United States] *Department of Agriculture*. Special report No. 11. The Silk-worm; being a brief manual of instructions for the production of silk. Second edition. Prepared by direction of the Commissioner of Agriculture, by C. V. Riley, M. A., Ph. D., entomologist, Washington, 1882, 37 p., ill.

Urges practicability and desirability of the culture of *Sericaria mori* in the United States; gives estimates of the profits of silk-culture; a brief natural history of *S. mori*, with its enemies, diseases, and food-plants; directions for the culture of the insects and the reeling of silk, and a glossary of terms used in silk-culture. Corrects errors in the estimates given in the first edition, makes other minor changes, and adds introduction on the requisites of successful silk-culture.

On the oviposition of *Prodoxus decipiens*.

(Amer. Nat., Jan., 1882, v, pp. 62-63.)

An abstract of a paper read at the Cincinnati meeting of the A. A. A. S. on the time and manner of oviposition of *Prodoxus decipiens* in stem of *Yucca filamentosa*.

Horn's classification of the *Carabidæ*.

(Amer. Nat., Jan., 1882, xvi, pp. 63-64.)

A notice of G. H. Horn's "On the genera of *Carabidæ*, with special reference to the fauna of boreal America" (Trans. Amer. Entom. Soc., July-Oct., 1881, ix, pp. 91-196, pl. 3-10); shows necessity for broad view in the performance of classificatory work.

New insects injurious to agriculture.

(Amer. Nat., Feb., 1882, xvi, pp. 151-152.)

An abstract of a paper read at the Cincinnati meeting of the A. A. A. S.; states that the occurrence of previously unnoticed noxious insects is due sometimes to the introduction of species from abroad, sometimes to previously-existing unnoticed species, and at other times to the acquisition of new habits by previously-known innocuous species. In the last case the acquisition of new habits may be accompanied by the acquisition of new descriptive characters, constituting of the insect a new species. New species may thus become developed within brief periods of time.

Locust probabilities for 1882.

(Amer. Nat., Feb., 1882, xv, p. 153.)

Gives the itinerary of Lawrence Bruner in Utah, Idaho, Montana, and Wash-

RILEY, CHARLES V.—Continued.

ington Territory, and reports favorable prospects of immunity from ravages of *Caloptenus spretus* in 1882.

——— A new depredator infesting wheat stalks.

(Amer. Nat., Mar., 1882, xvi, pp. 247-248, fig. 1.)

This insect was described as a new wheat pest, under the name of *Isosoma allynii*, by G. H. French, in *Prairie Farmer*, 31 Dec., 1881; and in his "Two new species of *Isosoma*" (*Can. Entom.*, Jan., 1882, xiv, pp. 9-10), is a species of *Eupelmus*, doubtless parasitic on some of the wheat-stalk feeders and probably on some species of *Chlorops*; habits and figures of larva are also given and descriptions of female imago of *Isosoma tritici* n. sp. (previously characterized by author in *Rural New Yorker*, March 4, 1882), which is injurious to wheat; gives comparison between *I. tritica* and *I. hordei*; states doubt concerning the habits of *I. lineare* of Europe, and the relative conspicuousness of the "humeral spot" in European, American, and Australian species of *Isosoma*.

——— Further notes on the imported clover-leaf weevil, *Phytonomus punctatus*.

(Amer. Nat., Mar., 1882, xvi, pp. 248-249.)

Specimens of a variety of *Phytonomus punctatus*, supposed to have been collected in Canada in 1853, and in Pennsylvania, described by LeConte as *P. opimus*, in 1876; citations of other instances in which injurious insects have been overlooked for a long time, or scantily collected; probability that plant-feeding coleoptera imported from Europe will not spread far from the Atlantic coast; some such species, injurious in Europe, are thus far innocuous in this country; hibernation of and means against *P. punctatus*.

——— Possible food-plants for the cotton-worm.

(Amer. Nat., April, 1882, xvi, pp. 327-329.)

Aletia argillacea is, so far as known, strictly confined to *Gossypium* as a food-plant; locality list of the Malvaceæ of northeastern United States, upon some of which plants the larva of the *Aletia* will probably be found; physical characters and geographical distribution of *Urena lobato*, on which larvæ of *Anomis erosa* occur; egg and larva of the *Anomis* and the *Aletia*.

——— Lichtenstein's theory as to dimorphic, asexual females.

(Amer. Nat., May, 1882, xvi, p. 409.)

Criticises J. Lichtenstein's theory that "winged female" Aphides and "asexual female" Cynipids are larvæ and their eggs pupæ; corrects errors in the comparison of these forms with the hypermetamorphic stages of *Meloidæ*.

——— Injurious insects in California.

(Amer. Nat., May, 1882, xvi, p. 410.)

Notice of Matthew Cooke's "A treatise on the insects injurious to fruit and fruit-trees of the State of California, 1881," with indication of a few errors in specific determination.

The cotton-worm. How its ravages may be prevented and the insect destroyed. What an eminent entomologist has to say on the subject.

——— Some facts of interest to planters in the flooded district.

(N. O. Times-Democrat, May 7, 1882.)

States probability of unusual injury to the cotton crop in the Mississippi

RILEY, CHARLES V.—Continued.

River flats by *Aletia argillacea* in 1882, owing to the belatement of the crop by floods; want of suitable machines for destroying these insects; describes the machines for this purpose invented during the investigations of the U. S. Entomological Commission; mentions poisons available for use; states advantages of early application of poisons, and describes methods for the preparation and application of these poisons.

———— Habits of *Cybocephalus*.

(Amer. Nat., June, 1882, xvi, p. 514.)

Cybocephalus nigrifolius feeds on the scale-insect *Chionaspis pinifoliae*, on *Pinus elliottii* in South Carolina, and *C. californicus* on a Coccid on apple trees in California.

———— The triungulin of *Meloidæ*.

(Amer. Nat., June, 1882, xvi, p. 515.)

J. Lichtenstein states that the triungulin of *Melæ proscarabæus* was described in J. L. Frisch's "Beschreibung von allerley Insecten in Teutschland," 1727, vi, p. 15; all knowledge of it, however, was afterward lost.

———— Hibernation of the army worm.

(Amer. Nat., June, 1882, xvi, p. 516.)

Gives confirmation of author's views, as revised in 1880, in regard to the hibernation of *Leucania unipuncta*; mentions preferred localities for oviposition; states prospects of extensive injury by these insects in the more northern States in 1882.

———— The utilization of ants in horticulture.

(Nature, 8 June, 1882.)

Abstract of C. J. Macgowan's "Utilization of ants as insect destroyers" in China (North China Herald, 4 April, 1882); capture and sale of two species of ants which build nests in trees, and colonization of these ants in orange orchards to destroy the insects injurious to those trees.

———— Repelling insects by malodorants.

(Amer. Nat., July, 1882, xvi, p. 596.)

This is a critical review of J. A. Lintner's "A new principle in protection from insect attack" (Proc. Western N. Y. Hort. Soc. for 1882, v. — p. —); states that odorous substances repel insects more by their toxic properties than by their odor; mentions failure of attempts by the use of strongly smelling substances to prevent oviposition, and shows that the senses of sight, touch, and taste are generally more important in the insect economy than the sense of smell.

———— Habits of *Coscinoptera dominicana*.

(Amer. Nat., July, 1882, xvi, p. 598.)

Announces discovery by F. H. King that *Coscinoptera dominicana* is inguillinous in ants' nests in its earlier stages; occurrence of similar habits in related species.

———— Change of habit; two new enemies of the egg-plant.

(Amer. Nat., Aug., 1882, xvi, p. 678-679.)

Describes sudden acquisition by *Doryphora juncta* and by *Cassida texana* of the habit of feeding on *Solanum melongena*, these species having been found previously on *S. carolinense* and *S. elaeagnifolium*, respectively; occurrence of *C. texana* on *S. carolinense*; geographical distribution of these two insects.

RILEY, CHARLES V. Notes on Microgasters.

(Amer. Nat., Aug., 1882, xvi, p. 679-680.)

A critical review of A. S. Packard, jr.'s, "Descriptions of some new ichneumon parasites of North American butterflies" (Proc. Bost. Soc. Nat. Hist., 1880, xxi, p. 18-38); synonymical notes on *Microgaster carinata* [= *M. gelechia* var.], *M. pieridis* [specific name preoccupied] [= *Apanteles congregatus* var. *pieridivora* n. var.], *M. atalantæ* [= *Apanteles congregatus* var.], *M. [Apanteles] carduicola* and *M. [A.] lunatus*.

— The "overflow bugs" in California.

(Amer. Nat., Aug., 1882, xvi, p. 681-682.)

Extract from a letter of Mrs. A. E. Bush, describing the occurrence of *Platynus maculicollis* in California in such abundance at certain seasons as to become a nuisance to man.

— Probable sound organs in Sphingid pupæ.

(Amer. Nat., Sept., 1882, xvi, p. 745-746.)

Describes occurrence of a peculiar structure on the abdominal joints of the pupæ of certain *Sphingidæ*; genera in which this structure is observed; probable connection of this structure with the function of producing sound, as observed in *Sphinx atropos*.

— Is *Cyrtoneura* a parasite or a scavenger?

(Amer. Nat., Sept., 1882, xvi, p. 746-747.)

Describes *Cyrtoneura stabulens* bred from pupæ of *Aletia argillacea*; states usual food of this species; expresses doubt whether the species is a parasite or is only a scavenger in decayed pupæ; thinks *Phora aleticæ* merely a scavenger; describes great liability of pupæ of *Aletia* to decay.

— *Denoderus pusillus* as a museum pest.

(Amer. Nat., Sept., 1882, xvi, p. 747.)

Describes imagos of *Dinoderus pusillus* feeding on cork and paper lining in an insect box; states that they occur usually in drugs and other stored and dry vegetable products.

— Habits of *Polycaon confertus* Lec.

(Amer. Nat., Sept., 1882, xvi, p. 747.)

The imagos of *Polycaon confertus* bore in twigs of apple and pear trees and grape vines; the larvæ probably live in the dead and dry wood of forest trees.

— Myrmecophilous Coleoptera.

(Amer. Nat., Sept., 1882, xvi, p. 747, 748.)

Announces discovery, by Lawrence Bouner, that larvæ and imagos of *Euphoria hirtipes* live in hills of *Formica rufa* in Nebraska; and by Theodor Pergande, of pupæ of *Hymenorus rufipes* in nest of *Formica fusca*, and of *H. obscurus* in nest of another species of ant; mentions known myrmecophilous habits of *Cetonia*, *Cremastochilus*, *Euparia castanea* (in nests of *Solenopsis xyloni*), *Tenebrionidæ* and *Anthicus*; work of E. A. Schwarz upon myrmecophilous coleoptera.

— *Cicada septendecim*.

(Gardener's Monthly, Sept., 1882, v, p. —.)

A critical review of "the short paragraph on cicada" (*op. cit.*, Aug., 1882, —, p. 247), with reprint of the notes on "*Cicada septendecim*," in Bull. No. 6, U. S. Entom. Comm., 1881, p. 58-59; gives orthography of the names of H. Mis. 26—12

RILEY, CHARLES V.—Continued.

C. septendecim and *C. tredecim*; and the natural relations or specific distinctness of the two forms so named, and shows the indistinguishability of the species of certain genera by the examination of cabinet specimens; states that dimorphic forms of identical species are more numerous than usually recognized, and that *Massospora cicadina* is parasitic on *Cicada*.

— Buffalo tree-hopper injurious to potatoes.

(Amer. Nat., Oct., 1882, xvi, p. 823.)

Describes habits, food-plants, and ravages of *Ceresa bubalus*.

— A new museum pest.

(Amer. Nat., Oct., 1882, xvi, p. 826.)

Announces the discovery, by Mrs. A. E. Bush, of *Perimegatoma variegatum* as a pest in collections of insects.

— Remarkable felting caused by a beetle.

(Rural New Yorker, 14 Oct., 1882.)

— Modified reprint, with same title.

(Amer. Nat., Dec., 1882, xvi, p. 1018-1019.)

This is a description of the felting of the interior of a pillow-ticking, with fragments of feathers, formed by the ravages of *Attagenus megaloma* within a feather pillow.

— The Buckeye leaf-stem borer.

(Amer. Nat., Nov., 1882, xvi, p. 913-914.)

States that the insect mentioned as *Scricoris instructana* in [author's] "The permanent subsection of entomology at the recent meeting of the A. A. S.," (Amer. Nat., Dec., 1881, xvi), p. 1009-1010, is totally different from that species, and is here named *Scricoris claypoleana* n. sp.; gives habits and food-plants of this species and of *Proteoteras esculana*, and points out distinctions between these two species.

— Species of *Otiorhynchidae* injurious to cultivated plants.

(Amer. Nat., Nov., 1882, xvi, p. 915-916.)

Of North American *Otiorhynchidae* the development and earlier stages of only one species (*Aramigus fulleri*) are known; imagos of two species have become noticeably injurious; the food-plants of eight other species were previously known; announces discovery, by G. P. Peffer, of the injuries of *Anametis grisea* upon roots of apple and pear trees, and gives list of food-plants of the above-mentioned species.

— A new rice-stalk borer; genus grinding.

(Amer. Nat., Dec., 1882, xvi, p. 1014-1015.)

An extract from the author's "The rice-stalk borer" (Rept. [U. S.] Commiss. Agric. for 1881 and 1882, 1882 [Jan., 1883]), p. 134-135, with additional remarks; *Chilo oryzaecellus*.

Is the same as *Diphryx prolatella*; mentions that the genus *Diphryx* was stated by Lord Walsingham [T. de Grey] to have been founded by A. R. Grote on a mutilated specimen (as suspected by the author), with mistake of maxillary for labial palpi.

— The army-worm in 1882.

(Amer. Nat., Dec., 1882, xvi, p. 1017.)

States occurrence of *Leucania unipuncta* in great abundance and with disastrous effects, especially in southern United States, in 1822.

RILEY, CHARLES V. The wheat-stalk worm on the Pacific coast.

(Amer. Nat., Dec., 1882, xvi, p. 1017-1018.)

Announces reception, from J. A. Starnes, of *Isosoma tritici*, injuring wheat-stalks in Washington Territory; prior notices of this insect.

—— The bean weevil.

(Rural New Yorker, 9 Dec., 1882.)

Answers inquiry of R. J. B.; gives habits of and means to be pursued against *Bruchus fabae*.

—— Emulsions of petroleum and their value as insecticides.

(Rural New Yorker, 9 Dec., 1882.)

Abstract of a paper read at meeting of American Association for the Advancement of Science, at Montreal, ——, 1882; gives results of experiments made by several persons (named) upon methods of using petroleum as an insecticide without injury to plants; states that soap and milk emulsions are the most available, and gives methods of preparing them.

—— [United States] Department of Agriculture—Entomologist, 1882 (C. Valentine Riley). Report of the Entomologist. (Report [U. S.] Commiss. Agric. for 1881 and 1882, 1882 [Jan. 1, 1883], pp. 61-214, pl. 1-20, with 3 p. expl. of plates.)

Separate author's edition, entitled "Report of the Entomologist, Charles V. Riley, M. A., Ph. D., for the fiscal year ending June 30, 1882. From the 1 report of the Department of Agriculture for the year 1881. Issued December 1, 1882." Wash., Government, t.-p. cover + t.-p., 8 + 167 p. (with original pagination also), 20 pl.

Consists of an "Introduction," sketching the plan of the report, the past and present organization and work, the projects and future needs of the entomological division of the U. S. Department of Agriculture, and the relation of this division to the U. S. Entomological Commission and the National Museum; of "Extracts from correspondence," containing brief notes upon numerous insects not otherwise treated in the report; and of chapters bearing the following titles, cited, unless otherwise indicated, under the name of C. V. Riley as author, to which chapters reference should be made for further analysis:—Silk culture.—Pyrethrum: its use as an insecticide.—Chinch-bug notes.—The army-worm *Leucania unipuncta* Haw.—HUBBARD, H. G. Scale-insects of the orange. Remedies and their application.—Insects affecting the rice plant.—Insects affecting corn or maize.—The cotton-worm, *Aletia zylina* Say.—Miscellaneous insects.—COMSTOCK, J. H. Report on miscellaneous insects.

—— Silk-culture. (Report of the Entomologist, 1881-1882, pp. 67-76 [7-16].)

A report of work done by the entomological division of the U. S. Department of Agriculture in the promotion of silk-culture in 1881-1882; with extracts from letters and reports of correspondents; list of the now active silk-culture associations and business enterprises, and statement of work done by them; reprint of author's preface to 2d ed. of special report No. 11 of U. S. Department of Agriculture, giving a summary of the present condition and prospects of the silk-producing industry in United States; caution against extensive prosecution of this industry under present tariff laws.

RILEY, CHARLES V. PYRETHRUM: Its use as an insecticide (pp. 76-87 [16-27], pl. 3, 4).

Contains a reprint of the "Circular in reference to pyrethrum," issued by the U. S. Commissioner of Agriculture [G. B. Loring] in 1882, giving a history of the discovery and application of pyrethrum as an insecticide and directions for the preparation and application of this substance; reports from correspondents and from the author of their experience in the growth of the plants.

———— Chinch-bug notes (pp. 87-89 [27-29]).

Gives a verification of Cyrus Thomas's predictions in relation to the ravages of *Blissus leucopterus* in 1881 and 1882; extracts from correspondence reporting the abundance of this insect early in 1882; letter from J. G. Barlow on the weather and the ravages of the *Blissus* in Washington County, Missouri, in 1882; irrigation, cremation, and other means against these insects.

———— The Army-worm, *Leucania unipuncta* Haw. (pp. 89-103 [29-46], pl. 2; pl. 6, figs. 1-3).

Gives a history of investigations into the natural history of *Leucania unipuncta*; states place and manner of oviposition of this moth; its prolificacy; the duration of the egg and larva stages; describes habits and characteristics of this larva and of larvæ of *Leucania* generally; gives means of predicting and preventing their ravages, and extracts from letters received in 1882; includes also the following subchapters: HOWARD, L. O. Report of observations upon the army-worm, 1881. LOCKWOOD, S. Account of the invasion of 1880 in New Jersey.

———— Insects affecting the rice plant (pp. 127-138 [67-78], pl. 6, figs. 4-5; pl. 7, figs. 1, 4-5).

This contains a statement of the amount of rice produced in the United States in 1879, and of the investigation made by L. O. Howard, in 1881, into the injuries done to the rice crop by insects; with subchapters entitled: The rice grub (*Chalepus trachypygus* Burm.).—The water-weevil (*Lissorhoptrus simplex* Say).—The rice-stalk borer (*Chilo oryzaeellus* n. sp.).—White blast.—Other insects injurious to growing rice.

———— The rice grub, *Chalepus trachypygus* Burm. (pp. 128-129 [68-69], pl. 6, fig. 5).

Gives report of L. O. Howard on the habits and ravages of and means against *Chalepus trachypygus*, with references to earlier observations; describes structural characters and geographical distribution of the genera *Cyclocephale* and *Chalepus*, and gives description and figure of larva and imago of *Ch. trachypygus*.

———— The water weevil, *Lissorhoptrus simplex* Say (pp. 130-133 [70-73], pl. 6, fig. 4).

Gives seasons, habits, ravages, classification, and synonymy of *Lissorhoptrus simplex*, with description and figures of larva and imago; includes extract from J. Screevens in author's "The 'water-weevil' of the rice plant" (Amer. Nat., June, 1881, v. 15), p. 483, and extract from a report by L. O. Howard; *Spalacopsis suffusa* and *Hippopsis lemniscata* boring in stems of *Chenopodium anthelminticum*.

———— The rice-stalk borer, *Chilo oryzaeellus* n. sp. (pp. 133-135 [73-75], p. 3 [167], pl. 7, fig. 1).

RILEY, CHARLES V.—Continued.

Extract in author's "A new rice-stalk borer; genus grinding."
(Amer. Nat., Dec., 1882, v. 16, pp. 1014-1015.)

Gives description and figures of larva, pupa, and imago of *Chilo bryzaeellus* n. sp.; *Diphryx prolatella*; refers to report of L. O. Howard upon its habits, enemies, and ravages, and means against it; describes structural character, of the genus *Diphryx*, stated by Lord Walsingham [T. de Grey] (as suspected by author) to have been founded on a mutilated specimen, with mistake of maxillary for labial palpi.

— White blast (pp. 136-137 [76-77]).

Publishes letter from J. Screveu and report from L. O. Howard on the phenomena and supposed causes of "white blast" in rice plants; mentions insects found on rice plants; states probable production of white blast by insects.

— Other insects injurious to growing rice (p. 138 [78], pl. 7, fig. 4-5).

Mentions habits and food-plants of *Laphygma frugiperda*; refers to occurrence of certain other insects doing minor damage on rice-plants.

— Insects affecting corn or maize (pp. 138-152 [78-92], pl. 1; pl. 7, figs. 2-3; pl. 8, fig. 2; pl. 12, fig. 1).

This consists of the following subchapters: The corn bill-bug. *Sphenophorus robustus* Horn.—The smaller corn stalk-borer. *Pempelia lignosella* Zeller—The boll-worm alias corn-worm. *Heliothis armigera* Hübu.—JOHNSON, L. Report upon *Heliothis armigera*.

— The corn bill-bug. *Sphenophorus robustus* Horn (pp. 138-142 [78-82], pl. 7, fig. 2; pl. 8, fig. 2).

Gives history of earlier observations on the species of *Sphenophorus* injurious to maize in the United States; report of observations on *S. robustus*, by L. O. Howard; habits and ravages and description and figure of larva, pupa, and imago of *S. robustus*; description of larvæ of *Rhodobanus tredecimpunctatus* and *Rhynchophorus zimmermanni*, and figures of imago of the former; characters distinguishing *Sphenophorus* and *S. robustus* and the four other species allied to it from other genera and species.

— The smaller corn-stalk borer. *Pempelia lignosella* Zeller (pp. 142-145 [82-85], pl. 7, fig. 3).

Mentions ravages, habits, seasons, natural history, geographical distribution, and synonymy of and means against *Pempelia lignosella*; gives description and figures of larva, pupa, and imago, of structural details of mouth-parts and antennæ of male imago, of markings of larva, and of injury done to cornstalks.

— The boll-worm alias corn-worm. *Heliothis armigera* Hübu. (pp. 145-149 [85-89], pl. 1; pl. 12, fig. 1).

This is an advance reprint, from the fourth report of U. S. entomological commission, of the section on the food-plants of *Heliothis armigera* other than cotton, with a list of these food-plants, and of authorities upon which the respective statements are made; gives history of first proofs of identity of this species on maize, with the same on cotton; and habits of the larvæ in their several broods; with figures of all stages of the insect.

RILEY, CHARLES V. The cotton-worm. *Aletia xyliana* Say, (pp. 152-167 [92-107], pl. 9).

An extract from the author's address on the cotton-worm (U. S.—*Dept. Agric.—Cotton convention held in Atlanta, Ga., Nov. 2, 1881*; the address of Hon. Geo. B. Loring, 1881), pp. 21-29; a reprint of the author's "The cotton-worm. How its ravages may be prevented" (New Orleans Times-Democrat, May 7, 1882); and an illustrated description, by W. S. Barnard, of a machine for spraying cotton plants from beneath; a summary [by J. R. Dodge] of damage done by *Aletia xyliana* in 1881; a reprint of the author's "Possible food-plants for the cotton-worm" (Amer. Nat. April 1882, v. 16, pp. 327-329); and an extract from paper read by author at annual session of National Academy of Sciences, May, 1882, on the hibernation of *Aletia xyliana*.

— Miscellaneous insects (pp. 167-194 [107-134], pl. 8, fig. 1; pl. 10, figs. 1-2; pl. 11, fig. 1; pl. 12, figs. 2-3; pl. 13).

This contains the following sub-chapters: The urena anomis. *Anomis erosa* Hüb.—The clover leaf-beetle, *Phytonomus punctatus* Fabr.—The vagabond crambus, *Crambus vulgivagellus* Clem.—The wheat isosoma, *Isosoma tritici* Riley.—The sorghum web-worm, *Nola sorghiella*, new species.—The catalpa Sphinx, *Sphinx catalpæ* Boid.—The osage orange sphinx, *Sphinx hageni* Grote.

— The urena anomis. *Anomis erosa* Hüb. (pp. 167-170 [107-110], pl. 8, fig. 1).

Gives a detailed comparison of eggs of *Anomis erosa* and *Aletia xyliana*; figures and description of all states of the former species; seasons, habits, and food-plants of this insect.

— The clover leaf-beetle. *Phytonomus punctatus* Fabr. (pp. 171-179 [111-119], pl. 10, fig. 1).

Mentions the food-plants and habits of the species of *Phytonomus* in Europe and United States; gives the civil and natural history, number of annual broods, ravages, enemies, and geographical distribution of and means against *Ph. punctatus*; description and figures of eggs, larva (four stages), and pupa of this species; figures of imago and of injured plant; and report, by E. A. Schwarz, of observations on this insect in New York; states that *Hylesinus trifolii* seems to feed only on *Trifolium pratense*; and that Coleoptera imported from Europe are usually confined to the neighborhood of the Atlantic coast.

— The vagabond crambus. *Crambus vulgivagellus* Clem. (pp. 179-183 [119-123], p. 3 [167], pl. 10, fig. 2).

This gives the civil and natural history of *Crambus vulgivagellus*; the habits, ravages, and parasites of and means against this insect; a description and figures of egg, larva, and imago; figures of cocoons and injured grass; a description of the pupa; and a list of articles written concerning this insect; mentions similarity of the habits of *Crambus warringtonellus* of England to those of *C. vulgivagellus*.

— The wheat isosoma. *Isosoma tritici* Riley (pp. 183-187, [123-127], pl. 12, fig. 3).

Gives history of observations on *Isosoma tritici*; and comparison of this species with *I. hordei* and of the European *I. linearis*; its habits, ravages, parasites, and number of annual broods, and means against it; gives list of articles written concerning it; states that the insect described by G. H. French as *Isosoma allyui* is a *Eupelmus*, and perhaps parasitic on *I. tritici*; describes *Stectonotus isosomatis* n. sp., parasitic on *I. tritici*.

RILEY, CHARLES V. The sorghum web-worm. *Nola sorghiella* new species (pp. 187-189 [127-129], pl. 11, fig. 1).

Gives habits, ravages, and classificatory relations of *Nola sorghiella*, with pupae and description of larva, pupa, and imago, and figure of head of sorghum injured by the larva.

— The catalpa sphinx. *Sphinx catalpæ* Boisd. (pp. 189-193 [129-133], pl. 13).

States relative excellence of *Catalpa speciosa* and *C. bignonioides*, as timber-trees, according to J. A. Warder; gives geographical distribution, habits, ravages, and parasites of and means to be taken against *Sphinx catalpæ*; with description and figures of all stages of this insect; and description of supposed sound-producing organs in pupa of this and other species.

— The osage orange sphinx. *Sphinx hageni* Grote (pp. 193-194 [133-134], pl. 12, fig. 2).

Gives list of insects injurious to *Maclura aurantiaca*; with geographical distribution and classificatory relations of *Sphinx hageni*; and references to other accounts of this insect; with description and figures of larva and imago.

SHUFELDT, R. W. Notes upon the osteology of *Cinclus mexicanus*.

(Bull. Nutt. Orn. Club, No. 4, October, 1882, VII, pp. 213-221.)

— Osteology of the *Cathartide*.

(Twelfth annual report U. S. Geol. & Geog. Survey, 1882, pp. 727-788, pls. 15-24.)

— Remarks upon the osteology of *Opheosaurus ventralis*.

(Proc. U. S. Nat. Mus., 1881, IV, pp. 392-400.)

TRUE, FREDERICK W. Fish parasites.

(Forest and Stream, No. 20, XVIII, p. 390.)

Refers to *Ligula simplissima* as probably the tape-worm occurring in Adirondack fish.

— On the North American land tortoises of the genus *Xerobates*.

(Proc. U. S. Nat. Mus., 1881, IV, pp. 434-449.)

— On the rare rodent *Cricetodipus parvus*, (Baird) Coues.

(Proc. U. S. Nat. Mus., 1881, IV, pp. 474-475.)

— A Darwinian bibliography.

(Proc. Biol. Soc. Wash., 1882, I, pp. 92-101.)

— On four mules in milk. By Alfred Duges.

Translated from the French.

(Proc. U. S. Nat. Mus., 1882, V, pp. 223-225.)

WARD, LESTER F. Sketch of Professor John W. Powell.

(Popular Science Monthly, January, 1882, XX, pp. 390-397.)

An account of the early life and exploits of Major Powell, and also of his later career as an explorer and geologist, as well as of his official labors as Director of Geological Surveys and of the Bureau of Ethnology. A portrait forms the frontispiece of the number.

WARD, LESTER F. On the cause of the absence of trees on the great plains. A paper read before the Biological Society of Washington, December 9, 1881.

(Kansas City Review of Science and Industry, March, 1882, pp. 697-702.)

A discussion of the question from the writer's observations, a statement of the leading facts, a review of current theories, and a statement of the conclusions which seem best warranted by all the data attainable.

——— Guide to the flora of Washington and vicinity, by Lester F. Ward, A. M. Washington, Government Printing Office, 1881. 8vo. pp. 264, with map of Washington and vicinity.

This forms Bulletin of the United States National Museum No. 22, and Smithsonian Publication No. 444, and contains a general discussion of the botanical peculiarities of the country around Washington, an annotated catalogue of the plants, a summary by orders and groups, a check-list, and an appendix of suggestions to beginners; also a map of the region.

——— Directions for collecting and preserving plants, by Lester F. Ward.

From Bulletin of the United States National Museum, No. 22. Washington: Published by the Smithsonian Institution, 1882. pp. 209-237.

——— Check-list. Flora of Washington, D. C., and vicinity, by Lester F. Ward.

From Bulletin of the United States National Museum, No. 22. Washington: Published by the Smithsonian Institution, 1882. pp. 148-207.

——— Scientific basis of positive political economy.

(International Review, April and May, 1882, xii, pp. 352-365; 439-453.)

These papers are chiefly devoted to the consideration of a new method of classifying natural phenomena, with a view to proving that a large part of such phenomena, including many forms of social activity, is within the sphere of human control through the exercise of intelligence and foresight. Slightly modified they will form the latter portion of chapter viii (vol. II, pp. 76-106) of a work by the writer entitled "Dynamic Sociology, or Applied Social Science," in press.

——— Kant's antinomies, in the light of modern science.

(Journal of Speculative Philosophy, October, 1881, xv, pp. 381-395.)

A paper read before the Centennial Anniversary Convention, of Kant's "Critique of Pure Reason," at Saratoga Springs, New York, July 6, 1881.

An argument to prove that the "theses" and "antitheses" of Kant's antinomies are legitimate scientific questions, and that modern science, in at least three of the four antinomies, points to the truth of the antithesis.

——— Darwin as a botanist.

(Proceedings of the Biological Society of Washington, 1882, I, pp. 81-86.)

Read before the Darwin memorial meeting of the Biological Society of Washington, May 12, 1882.

A review of Darwin's botanical works, an explanation of his methods, and a summary of the philosophic results of his labors in this field.

WARD, LESTER F. List of water-plants for carp-ponds.

(Bulletin of the United States Fish Commission, 1882, pp. 22-25.)

A list of names of aquatic plants furnished by the superintendent of the carp-ponds is here revised, modern names substituted for obsolete ones, the locality and range of the species briefly indicated, and the plants arranged according to the prevailing system of botanical classification.

———— Catalogue of a collection of Japanese woods presented to the United States National Museum by the University of Tokio, Japan.

(Proc. U. S. Nat. Mus., 1882, II, pp. 308-311.)

The names appearing on the specimens of this collection are here arranged in their proper systematic order and their synonymy is given. A few partially named species were determined from the figures accompanying the specimens.

———— Politico-social functions. Abstract of a paper read before the Anthropological Society of Washington, D. C., March 15, 1881.

(Trans. Anthro. Soc., Wash., 1882, I, pp. 39-42.)

This paper is chiefly devoted to pointing out the importance of a certain amount of judicious regulation on the part of society as a collective whole, of the more or less injurious and ruinous operations which must necessarily go on within it in the absence of such regulation.

———— The postage question.

(Botanical Gazette, August and September, 1882, VII, pp. 97-99.)

Gives a correspondence between the Post-Office Department and the writer on the Department rulings relative to the form of label which would come within the law as third-class matter.

———— "Documaria barbara."

(Botanical Gazette, 1882, VII, pp. 99-100.)

An account of its collection in the Dismal Swamp of Virginia.

———— Proterogyny in *Sparganium eurycarpus*.

(Botanical Gazette, 1882, VII, p. 100.)

A note recording the observation of this phenomenon in the District of Columbia.

———— The anthropocentric theory.

(Transactions Anthropological Society of Washington, I, 1882, pp. 93-103.)

A collection of facts tending to prove and to disprove the existence of an intelligent control of events in the interest of man. The paper forms part of chapter viii (vol. II, pp. 45-74) of "Dynamic Sociology." In press.

———— What Mr. Ward was ready to say. (Herbert Spencer in America. New York: D. Appleton & Co., 1883. pp. 76-79.)

Portion of a letter complimentary to Mr. Spencer, written at the request of the committee of arrangements, to be read on the occasion of the banquet given him in New York, October 9, 1882. Before finishing the letter the writer concluded to attend the banquet in person. The matter of it was subsequently furnished the committee for publication.

———— The organic compounds in their relations to life.

(American Naturalist, December, 1882, XVI, pp. 968-979.)

Read before the Philosophical Society of Washington, January 28, 1882, and

WARD, LESTER F.—Continued.

before the Biological Section of the American Association for the Advancement of Science at Montreal, August 29, 1882.

A statement of the physico-chemical theory of life. The discussion in a much enlarged form is embodied in chapter iv (vol. I, pp. 300-356) of the writer's work "Dynamic Sociology." In press.

WHITE, CHARLES A. New molluscan forms from the Laramie and Green River groups, with discussion of some associated forms heretofore known.

(Proceedings U. S. National Museum, v, 1882, pp. 94-99, plates III and IV.)

—— The molluscan fauna of the Truckee group, including a new form.

(Proceedings of the U. S. National Museum, v, 1882, pp. 99-101, plate v.)

—— On certain conditions attending the geological descent of some North American types of fresh-water gill-bearing mollusks.

(American Journal of Science, XXXI (3), pp. 382-386.)

—— Fossils of the Indiana rocks, No. 2.

(Eleventh Annual Report of the Geological Survey of Indiana, 1881, pp. 347-401, plates 37-55.)

—— Artesian wells upon the great plains.

(North American Review, CXXXV, pp. 187-195.)

—— Progress of invertebrate paleontology in the United States for the year 1881.

(American Naturalist, XVI, pp. 887-891.)

YARROW, H. C. The rapid preparation of large myological specimens, by M. Felix Plateau. (Translated from the French.)

(Proc. U. S. Nat. Mus., 1881, IV, pp. 388-391.)

II.—PAPERS BY INVESTIGATORS NOT OFFICERS OF THE MUSEUM.

BELFAST (Maine) REPUBLICAN JOURNAL. The successful propagation of codfish.

(Quoted in Forest and Stream, No. 10, October 5, 1882, XIX, pp. 192-193.)

BICKNELL, EUGENE P. A sketch of the home of *Hylocichla aliciaë bicknelli*, Ridgway, with some critical remarks on the allies of the new race.

(Bull. Nutt. Orn. Club, July, 1882, VII, pp. 152-159.)

The critical remarks in this paper have more or less relation to National Museum material.

BREWSTER, WILLIAM. On Kennicott's owl and some of its allies, with a description of a proposed new race.

(Bull. Nutt. Orn. Club, No. 1, January, 1882, VII, pp. 27-33.)

An elaborate and important review of the geographical races of *Scops asio*, based very largely on National Museum material, sent to Mr. Brewster for the purpose.

BREWSTER, WILLIAM. On a collection of birds lately made by Mr. F. Stephens in Arizona.

(Bull. Nutt. Orn. Club, Nos. 3 and 4, July and October, 1882, VII, pp. 135-147, and pp. 193-212.)

Occasional reference is made in this paper to examination of National Museum specimens, made conjointly by the author and the curator of the department of birds.

——— Notes on some birds collected by Capt. Charles Bendire, at Fort Walla Walla, Washington Territory.

(Bull. Nutt. Orn. Club, October, 1882, VII, pp. 225-233.)

This paper is based (in considerable part) upon specimens presented by Captain Bendire to the National Museum, and examination of other material in the national collection.

BROWN, NATHAN CLIFFORD. Description of a new race of *Peucaea ruficeps* from Texas.

(Bull. Nutt. Orn. Club, No. 1, Jan., 1882, VII, p. 26.)

The new race in question was described only after careful comparison with specimens in the National Museum collection.

——— Reconnaissance in Southwestern Texas.

(Bull. Nutt. Orn. Club, No. 1, Jan., 1882, VII, pp. 33-42.)

Although this paper relates chiefly to collections made by the author, it contains frequent mention of comparison with National Museum specimens, made at the author's request, by the curator of the department of birds.

COLLINS, J. W. An inquiry as to the capture of young codfish in Chesapeake Bay.

(Bull. U. S. F. C., 1882, I, pp. 401-402.)

——— Appearance of dog-fish (*Squalus acanthias*) on the New England coast in winter.

(Bull. U. S. F. C., II, p. 8.)

Captain Collins has since learned that the great schools of supposed dog-fish referred to in the above article were really porpoises.

See also GOODE, G. BROWN, and COLLINS, J. W.

FORBES, S. A. The gasper-gou.

(Forest and Stream, September 23, 1882, XIX, p. 165.)

GILBERT, CHARLES H. List of fishes observed at Punta Arenas, on the Pacific coast of Central America.

(Bull. U. S. F. C., October 13, 1882, II, p. 112.)

See also JORDAN and GILBERT.

GILL, THEODORE N. *Chiasmodus niger* and *Notacanthus rissoanus*.

(Nature.—)

——— A critical review of Günther's Study of Fishes.

(Proc. Biol. Soc., 1882, Wash., I, p. 29. Title only.)

——— On the affinities of the "great swallower," *Chiasmodus niger*.

(Proc. Biol. Soc. Wash., 1882, I, p. 35.)

GURNEY, J. H. Notes on a "Catalogue of the Accipitres in the British Museum," by R. Bowdler Sharpe (1874).

(The Ibis [London], iv, vii, April, 1882, pp. 290-321; October, 1882, pp. 579-598.)

In this series of valuable papers on the Falconidæ, occasional mention is made of specimens belonging to the National Museum collection, and loaned to the author for examination.

HAY, O. P. On a collection of fishes from the Lower Mississippi Valley.

(Bull. U. S. F. C., 1882, pp. 57-75.)

It is worthy of remark that an example in lot No. 2 of Professor Hay's invoice of fishes, upon which the foregoing paper was based, and identified by him as *Lepidosteus osseus*, is really *Litholepis spatula*; another one having the same invoice number and sent here as *Lepidosteus osseus* is young *L. platystomus*; a fish numbered 36 and said to be *L. osseus* is really *L. platystomus*. Professor Hay, therefore, should have recorded *Lepidosteus osseus* from Jackson, Miss., on the basis of his own collection.

HOENADAY, WILLIAM T. On the uses of clay as a filling material.

(Second Ann. Rept. Soc. Amer. Taxidermists. March 25, 1881, to March 24, 1882, pp. 31-34.)

INGERSOLL, ERNEST. On the mortality of marine animals in the Gulf of Mexico.

(Proc. Biol. Soc. Wash., 1882, 1, p. 30. Title only.)

JAPANESE LEGATION. Catalogue of a collection of Japanese cotton fiber, presented to the United States National Museum by the Government of Japan, together with the amount of the annual crop of Japan and the price of cotton.

(Proc. U. S. Nat. Mus., 1882, iv, pp. 449-453.)

JORDAN, DAVID S. Bull trout and pompano.

(Forest and Stream, Apr. 20, 1882, xviii, p. 230.)

——— Description of a new species of Blenny (*Isesthes gilberti*) from Santa Barbara, Cal.

(Proc. Nat. Mus., v, pp. 349-351.)

——— The gasper-gou.

(Forest and Stream, No. 10, xix, p. 192.)

——— The blue-back trout.

(Forest and Stream, No. 20, xix, p. 389.)

Contains list of all North American *Salmonidæ*.

JORDAN, DAVID S., and CHARLES H. GILBERT. List of fishes collected by Lieut. Henry E. Nichols, U. S. N., in the Gulf of California, and on the west coast of Lower California, with descriptions of four new species.

(Proc. Nat. Mus., 1881, iv, pp. 273-279.)

——— Descriptions of thirty-three new species of fishes from Mazatlan, Mexico.

(Proc. Nat. Mus., 1881, iv, pp. 338-365.)

JORDAN, DAVID S., and CHARLES H. GILBERT. Description of a new species of *Pomadasy*s from Mazatlan, with a key to the species known to inhabit the Pacific coasts of tropical America.

(Proc. Nat. Mus., 1881, iv, pp. 383-388.)

——— Description of five new species of fishes from Mazatlan, Mexico.
(Proc. Nat. Mus., 1881, iv, pp. 458-463.)

——— Descriptions of nineteen new species of fishes from the Bay of Panama.
(Bull. U. S. F. C., 1882, i, pp. 306-335.)

——— Description of four new species of sharks from Mazatlan, Mexico.
(Proc. Nat. Mus., 1882, v, pp. 102-110.)

——— Description of a new shark (*Carcharias lamiella*) from San Diego, Cal.
(Proc. Nat. Mus., 1882, v, pp. 110, 111.)

——— Description of a new Cyprinodont (*Zygonectes inurus*) from Southern Illinois.
(Proc. Nat. Mus., 1882, v, pp. 143, 144.)

——— Description of a new species of Uranidea (*Uranidea pollicaris*) from Lake Michigan.
(Proc. Nat. Mus., 1882, v, pp. 222, 223.)

——— Description of a new species of Xenichthys (*Xenichthys xenu-rus*) from the west coast of Central America.
(Proc. Nat. Mus., 1881, iv, p. 454.)

——— Notes on fishes observed about Pensacola, Fla., and Galveston, Tex., with description of new species.
(Proc. Nat. Mus., 1882, v, pp. 241-307.)

——— Description of a new species of Conodon (*Conodon serrifer*) from Boca Soledad, Lower California.
(Proc. Nat. Mus., 1882, v, pp. 351, 352.)

——— Catalogue of the fishes collected by Mr. John Xantus at Cape San Lucas, which are now in the United States National Museum, with descriptions of eight new species.
(Proc. Nat. Mus., 1882, v, pp. 353-371.)

——— List of fishes collected by John Xantus at Colima, Mexico.
(Proc. Nat. Mus., 1882, v, pp. 371, 372.)

——— List of fishes collected at Panama by Capt. John M. Dow, now in the United States National Museum.
(Proc. Nat. Mus., 1882, v, pp. 373-378.)

——— List of a collection of fishes made by Mr. L. Belding near Cape San Lucas, Lower California.
(Proc. Nat. Mus., 1882, v, pp. 378-381.)

JORDAN, DAVID S., and CHARLES H. GILBERT. List of fishes collected at Panama by Rev. Mr. Rowell, now preserved in the United States National Museum.

(Proc. Nat. Mus., 1882, v, pp. 381, 382.)

— Descriptions of two new species of fishes (*Sebastichthys umbrosus* and *Citharichthys stigmaeus*) collected at Santa Barbara, Cal., by Andrea Laro.

(Proc. Nat. Mus., 1882, v, pp. 410-412.)

— A review of the siluroid fishes found on the Pacific coast of tropical America, with descriptions of three new species.

(Bull. U. S. F. C., 1882, II, pp. 34-54.)

— Description of a new species of Goby (*Gobiosoma ios*) from Vancouver's Island.

(Proc. Nat. Mus., 1882, v, pp. 437, 438.)

— List of fishes collected at Mazatlan, Mexico, by Charles H. Gilbert.

(Bull. U. S. F. C., 1882, II, pp. 105-108.)

— List of fishes collected at Panama by Charles H. Gilbert.

(Bull. U. S. F. C., 1882, II, pp. 109-111.)

LAWRENCE, GEO. N. Description of a new species of swift of the genus *Chatura*, with notes on two other little-known birds.

(Ann. N. Y. Acad. Sciences, No. 8, March, 1882, II, pp. 245, 246.)

Chatura gaumeri; based in part on National Museum specimens.

— Descriptions of two new species of birds from Yucatan of the families *Columbidae* and *Formicariidae*.

(Ann. N. Y. Acad. Sci., No. 9, 1882, II, pp. —?, from unpagged overshoots.)

Leptoptila fulviventris and *Formicarius pallidus*, only rescinded after comparison with National Museum specimens.

LUCAS, FREDERIC A. A critique on museum specimens. 8^o, pp. 4.

Read at the general meeting of the Society of American Taxidermists, Boston, Mass., Dec. 14, 1881; also in second Ann. Rept. Soc. Amer. Taxidermists, March 25, 1881, to March 24, 1882, pp. 34-37.

— Bibliography of taxidermy.

(Second Ann. Rept. Soc. Amer. Taxidermists, March 25, 1881, to March 24, 1882, pp. 47-49.)

MCDONALD, MARSHALL. Experiments in the transportation of the German carp in a limited supply of water.

(Bull. U. S. F. C., 1882, I, pp. 215-218.)

— On retarding shad eggs.

(Forest and Stream, Apr. 20, 1882, No. 12, XVIII, p. 230; also in Trans. Amer. Fish Cult. Assoc., 1882, pp. 11-13.)

MCDONALD, MARSHALL. On the laws of the relation of periodicity in development to temperature.

(Proc. Biol. Soc., Wash., 1882, 1, p. 23. Title only.)

——— Recent experiments in fish-culture.

(Proc. Biol. Soc., Wash., 1882, 1, pp. 32, 33; also in Trans. Amer. Fish Cult. Assoc., 1882.)

——— Observations upon young shad in confinement.

(Proc. Biol. Soc., Wash., 1882, 1, p. 34. Oral communication.)

MASON, JOHN J. Minute structure of the central nervous system of certain reptiles and batrachians of America. Illustrated by permanent photo-micrographs, by John J. Mason, M. D. Series A. Author's edition. One hundred. Newport, 1879-1882. 4°, 24 pp., CXIII plates.

MATHER, FRED. The dead fish.

(Forest and Stream, Apr. 13, 1882, No. 11, XVIII, p. 212.)

Refers to tile-fish, *Lopholatilus chamaeleonticeps*.

——— The tile-fish.

(Forest and Stream, Apr. 27, 1882, No. 13, XVIII, p. 250.)

An illustration of the species furnished by Prof. S. F. Baird is here given.

——— (Editor.) Other dead fish.

(Forest and Stream, May 4, 1882, No. 14, XVIII, p. 270.)

Refers to *Peristedium miniatum*.

——— (Editor.) The gasper-gou.

(Forest and Stream, Aug. 17, 1882, No. 3, XIX, p. 45.)

Refers to *Haploidonotus grunnicus*.

——— (Editor.) Land-locked salmon in New York.

(Forest and Stream, Dec. 21, 1882, No. 21, XIX, p. 411.)

Refers to the salmon received from Mr. Thompson through Mr. Blackford.

——— (Editor.) The dead fish.

(Forest and Stream, Mar. 30, 1882, No. 9, XVIII, p. 170.)

Refers to the tile-fish mortality, but with some confusion as to the fish in question. This error is righted in the same paper, May 4, 1882.

——— (Editor.) New fishes in Chesapeake Bay.

(Forest and Stream, Mar. 30, 1882, No. 9, XVIII, p. 172.)

Mentions the capture of *Squalus acanthias* and *Phycis regui* by the "Fish Hawk."

NUTTING, C. C. On a collection of birds from the hacienda "La Palma," Gulf of Nicoya, Costa Rica. [With critical notes by R. Ridgway.]

(Proc. U. S. Nat. Mus., 1882, v, pp. 382-409.)

The specimens which form the basis of this paper are mainly in the National Museum collection. The paper was prepared by Messrs. Nutting and Ridgway, conjointly, the former furnishing the field-notes, and the latter being responsible for the nomenclature and all critical remarks. The new species are *Myiarchus nuttingi* Ridgw., and *Icterus pectoralis espinachi* Nutting.

PHILLIPS, BARNET. The tile-fish is not found.

(Forest and Stream, Oct. 5, 1882, No. 10, XIX, p. 190.)

Refers to finding *Scorpxna dactyloptera* abundantly.

ROBERTSON, R. R.—The gasper-gou is edible.

(Forest and Stream, Sept. 14, 1882, No. 7, XIX, p. 132.)

Refers to *Haplodonotus grunniens* sent to the U. S. National Museum.

RYDER, JOHN A. The protozoa and protophytes considered as the primary or indirect source of the food-fishes.

(Bull. U. S. Fish Comm., 1882, I, pp. 236-251.)

——— The micropyle of the egg of the white perch.

(Bull. U. S. F. C., 1882, I, p. 282.)

——— Development of the silver gar (*Belone longirostris*), with observations on the genesis of the blood in embryo fishes, and a comparison of fish ova with those of other vertebrates.

(Bull. U. S. F. C., 1882, I, pp. 283-301.)

——— On the nuclear cleavage-figures developed during the segmentation of the germinal disk of the egg of the salmon.

(Bull. U. S. F. C., 1882, I, pp. 335-339.)

——— Additional observations on the retardation of the development of the ova of the shad.

(Bull. U. S. F. C., 1882, I, pp. 422-424.)

——— On the eggs and teeth of young shad.

(Proc. Biol. Soc., Wash., 1882, I, p. 33. Verbal communication.)

SMITH, ROSA.—Description of a new species of *Uranidea* (*Uranidea rhothea*) from Spokane River, Washington Territory.

(Proc. Nat. Mus., 1882, v, pp. 347, 348.)

See also SMITH and SWAIN.

SMITH, ROSA, and JOSEPH SWAIN. Notes on a collection of fishes from Johnston's Island, including descriptions of five new species.

(Proc. Nat. Mus., 1882, v, pp. 119-143.)

SMITH, SANDERSON, and RICHARD RATHBUN.—List of the dredging stations of the U. S. Fish Commission, from 1871 to 1879, inclusive, with temperature and other observations. Arranged for publication by Sanderson Smith and Richard Rathbun.

(Report of the Commissioner of Fish and Fisheries for 1879, pp. 559-601.)

SMITH, SIDNEY I. 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. B. Bartlett, U. S. N., commanding. XVII. Report on the Crustacea. Part I. Decapoda, by Sidney I. Smith.

(Bulletin of the Museum of Comparative Zoology of Harvard College, x, No. 1, June, 1882, p. 103, 16 plates.)

Forty-seven species are described, of which 20 are new. Five new genera and one new subfamily are also defined.

STEJNEGER, LEONHARD. Description of two new races of *Myadestes obscurus*, Lafr.

(Proc. U. S. Nat. Mus., 1881, iv, pp. 371-374.)

Types of the new races (*M. obscurus insularis*, from the Tres Marias Islands, and *M. obscurus occidentalis*, Western Mexico), in National Museum collection.

— Synopsis of the West Indian Myadestes.

(Proc. U. S. Nat. Mus., 1882, v, pp. 15-27.)

A valuable review, based almost wholly upon National Museum material.

— Outlines of a monograph of the Cygninæ.

(Proc. U. S. Nat. Mus., 1882, v, pp. 174-233.)

A most important paper relating to the classification of the swans, and embracing critical notes upon all the known species, based in considerable part upon National Museum specimens.

STREET, THOMAS H. A study of the Phronimidæ of the North Pacific Survey Expedition.

(Proc. U. S. Nat. Mus., June, 1882, v, pp. 3-9.)

SWAN, JAMES G. Shad in Puget Sound.

(Bull. U. S. F. C., 1882, II, p. 152.)

SWAIN, JOSEPH. A review of the *Syngnathinæ* of the United States, with a description of one new species.

(Proc. Nat. Mus., 1882, v, pp. 307-315.)

— A review of the species of *Stolephorus* found on the Atlantic coast of the United States.

(Bull. U. S. F. C., 1882, II, pp. 55-57.)

See also SMITH and SWAIN.

TANNER, Lieut. Z. L., U. S. N. Report of an exploring trip of the steamer Fish Hawk in Chesapeake Bay in the early spring of 1882.

(Bull. U. S. F. C., Nov. 4, 1882, II, pp. 133-135.)

The unpublished results of this trip are of great interest. Numerous species of fishes whose presence in the bay at that time of year was quite unexpected, were taken in abundance. Among them were the following: *Raia ocellata*, *Squalus acanthias*, *Brevoortia tyrannus*, *Clupea vernalis*, *Clupea astivalis*, *Stolephorus* sp., *Phycis regnis*, *Phycis chuss*?, *Pogonias chromis* juv., *Gobiosox* sp., and *Gobiosoma alepidotum*.

TURNER, LUCIEN M. On *Lagopus mutus*, Leach, and its allies.

(Proc. U. S. Nat. Mus., 1882, v, pp. 225-233.)

Based entirely upon National Museum material.

VERILL, A. E. Notice of the remarkable marine fauna occupying the outer banks off the southern coast of New England. No. 3. (Brief Contributions to Zoology, from the Museum of Yale College.)

(Amer. Jour. Science, February, 1882, xxiii, pp. 135-142.)

A general account of the deep-sea investigations of the U. S. Fish Commission for September, 1881, with a list of the dredging stations and of the more interesting Echinoderms, with notes. The following new species are described: *Archaster bairdii*, *Ophioglypha aurantiaca*, and *Amphiura macilenta*.

VERBILL, A. E. The same continued. No. 4.

(Brief Contributions, etc. *Ibid.*, March, 1882, xxiii, pp. 216-225.)

A complete list of the Echinoderms found in the same region; 48 species. New genera and species are described as follows: One genus and species of Holothurian, one species of the Asterias, one species of Ophiuran, and six species of Actinians.

———— The same continued. No. 5.

(Brief Contributions, etc. *Ibid.*, April, 1882, xxiii, pp. 309-316.)

Continuation of the list of Anthozoa, with notes on the more interesting species.

———— The same continued. No. 6.

(Brief Contributions, etc. *Ibid.*, May, 1882, xxiii, pp. 406-408.)

“Remarkable modes of growth and repair in *Parasmilia lymani*.” “Restoration of the disk in Ophiurans.”

———— The same continued. No. 7.

(Brief Contributions, etc. *Ibid.*, Nov., 1882, xxiv, pp. 360-371.)

A general account of the investigations of U. S. Fish Commission, for the summer of 1882, with a partial list of the dredging stations, and a discussion of the principal discoveries. “Evidence of great destruction of life last winter.” “Additions to the fauna of Vineyard Sound; surface dredgings.”

———— The same continued. No. 8.

(Brief Contributions, etc. *Ibid.*, December, 1882, xxiv, pp. 447-452.)

“Nature and Origin of the Sediments.”

APPENDIX C.—ACCESSIONS TO THE MUSEUM IN 1882.

Department of Antiquities.

CHARLES RAU, Curator.

The principal accessions of this department during the part year are as follows:

- Prof. William Boyd Dawkins, Owens College, Manchester, England.* Collection of rude stone implements and bones of extinct animals from the Creswell caves, N. E. Derbyshire, and from Windy Knoll, Castleton, Derbyshire, England.
- A. E. Douglas, New York, N. Y.* Three flint drills of peculiar shape from Chariton and Saline Counties, Missouri. *Casts.*
- Capt. G. M. Wheeler, U. S. Geographical Survey.* Collection of leaf-shaped implements, arrow-heads, perforators, stone axes and mauls with double grooves, and specimens of pottery from different localities in New Mexico. This collection had been loaned to Mr. F. W. Putnam, of the Peabody Museum, Cambridge, Mass., and some of the specimens are figured in Vol. VII of the U. S. Geographical Surveys west of the 100th meridian.
- Otto Simsky, Philadelphia, Pa.* Nine amber beads from Bronze-age tumuli on the Baltic coast north of Königsberg, Prussia.
- Dr. F. M. Endlich, Reading, Pa.* One specimen of unhusked charred corn, from ruins on the San Juan River, New Mexico.
- E. M. Brigham, now in South America.* Collection of ancient pottery, painted and ornamented, from the island of Marajo, Brazil. Worthy of especial mention are two very large burial vases.
- William Taylor, Allapaha, Berrien County, Georgia.* Human bones from mounds in Georgia. Among them two tibiae exhibiting platycnemism in a high degree.
- José C. Zeledon, Costa Rica, C. A.* A valuable collection of stone implements and carvings, clay vessels, and grotesque images from Costa Rica.
- C. L. Stratton, Knoxville, Tenn.* Large collection of stone implements, &c., from the neighborhood of Knoxville, and collection from a mound on French Broad River, 15 miles above Knoxville, consisting of pin-shaped objects of shell, shell beads, shell gorgets with human faces carved on them, and others ornamented with lines and dots, small clay vessel, one human skull and thigh-bone.

- M. Tandy, Dallas City, Hancock County, Illinois.* Large collection of flint implements, polished celts (one of hematite), hematite chisel, grooved axes (some of peculiar shape, differing from any in the museum exhibit), pestle, hammer-stones, hematite sinker, polished spear-head, catlinite bead, paint-stones, &c., from Hancock County, Illinois. Two large mortars from a mound in Dallas City.
- M. H. Thomson, Pecan Point, Mississippi County, Arkansas.* Collection of stone and bone implements and clay vessels from Indian graves near Pecan Point.
- Rev. T. D. Weems, Griggsville, Pike County, Illinois.* Collection from mounds in Pike County, consisting of flint implements, hammer-stones, grooved axes, &c.
- J. P. Maclean, Hamilton, Butler County, Ohio.* Collection from the principal shell-heap on Blennerhassett's Island, Ohio River, namely, shells of which the heap is composed, rude implements, arrow-heads, celts, shell-sinkers, bone tools, and human skull, jaws, teeth, &c.
- Dr. J. F. Bransford, U. S. Navy.* A valuable collection from Costa Rica, C. A., consisting of clay vessels, plain or ornamented, tripod vessels, small double vessel with handle, fragments of clay vessels with grotesque figures and faces in relief, grotesque clay figures, clay whistles, and fragments of pottery with different styles of painted ornamentation, small stone celts, and ornaments (beads, &c.) of jadeite and other kinds of stone; stone tube from Tonala, Mexico; large clay vase, painted and ornamented, small clay vessel (bottle-shaped), fragments of pottery, one with human head, others made in imitation of flowers, &c., obtained from a mound near San José, Guatemala.
- H. S. Rusby, Silver City, New Mexico.* Collection of rude stone tools from an aboriginal mine near Clifton, Ariz.
- J. J. McLean, U. S. Signal Service, Sitka, Alaska.* Collection of ethnological specimens from Baranoff, an island in S. E. Alaska, consisting of stone implements, charms with family totems carved on one side or both, horn spoons, wooden spoons, dishes, trays, &c., halibut hooks and club, wooden floats in the shape of ducks, knives with carved handles, carved wooden pipes and images, dance rattles, dancing mask, wooden helmets and head dresses, drum used at festivals, bag of gambling sticks, bark rope dancing belts, packing straps, hunting bag, food sack made of bear intestines, leather suits of armor, dancing shirts painted and ornamented, model of fish-trap, dolls with heads of carved bone, cakes of pressed blackberries, and spruce bark.
- M. Tandy, Dallas City, Hancock County, Illinois.* Collection from a mound and stone grave in Henderson County, near Dallas City, consisting of arrow and spear heads, perforators of stone and bone, stone sinkers, paint stones, marine shells, shell beads and gorgets, pierced teeth of animals, and 1 pearl bead, 1 human skull with flint perforator driven, not shot, through the left temple.

L. S. Bliss, Dallas City, Hancock County, Illinois. One stone pipe from mound above mentioned.

Henry Gillbreth, Dallas City, Hancock County, Illinois. Collection from the same mound, consisting of rude implements, arrow and spear heads, celts, and fragment of large jasper pebble.

Louis Bierman, Dallas City, Hancock County, Illinois. Collection (surface finds) from the vicinity of the mound in Henderson County, consisting of leaf-shaped implements, arrow and spear heads, grooved axes, &c.

William Green, Dallas City, Hancock County, Illinois. Collection (surface finds) from the vicinity of the mound in Henderson County, composed of rude flint implements, arrow-heads, and one broken spear-head, chipped on one of the sides to serve as a concave scraper.

Wm. Rockel and M. Tandy, Dallas City, Hancock County, Illinois. Collection from mounds on the farm of Conrad Rockel, Henderson County, Illinois, consisting of rude flint implements, scrapers, spear-head-shaped implements, arrow-heads, flakes, celts, grooved axe, rude maul, rubbing-stone, paint-stone, and one clay vessel of peculiar form and ornamentation. The specimens presented by Messrs. Bliss, Gillbreth, Bierman, Green, and Rockel, were procured through the influence of Mr. Tandy, and, with his own donation, are a valuable addition to the Museum.

John B. Wiggins, Waverly, Tioga County, New York. Collection from Chula, Amelia County, Virginia; namely, flakes, arrow-heads, grooved axes, and large quartz crystals showing use as tools, and pot-stone vessels. The quartz crystals were used by the Indians in making pot-stone vessels.

Prof. W. A. Kite, Milligan College, Johnson City, Washington County, Tennessee. Collection from burial-places and camping-grounds in Greene and Hawkins Counties, Tennessee, composed of leaf-shaped implements, scrapers, perforators, arrow and spear heads, celts, grooved axes, pestles, stone gaming disks, and fragments of human bones.

A. T. Gamage, Damariscotta, Lincoln County, Maine. Collection from oyster and clam shell heaps on Damariscotta River; namely, flint and bone implements, fragments of pottery, &c.

C. L. Herrick, Florence, Lauderdale County, Alabama. Large collection from mounds near Chickasaw, Colbert County, Alabama, consisting of flakes, rude implements, chipped celts, cutting tools, hammer-stones, arrow and spear-heads, and fragments of pottery. Collection from shell-heaps near Waterloo and from Cheatham's Ferry, Lauderdale County, Alabama, consisting of shells of which the heaps are composed of flint flakes, rude implements, arrow and spear heads, one clay vessel, fragments of pottery, and of human skull and bones.

Thomas Herran, Antioquia, United States of Colombia, South America.

Small collection from Indian graves at Cundinamarca and Antioquia, United States of Colombia, South America, consisting of clay vessels, clay spindle-whorls, cartouche, &c.

M. C. Keith, Costa Rica, Central America. Collection of antiquities found on the line of the Port Limon Railroad, Costa Rica, composed of clay vessels, plain or ornamented in relief, stone pestles, rubbing-stones, plain or with carved handles, metates, plain or ornamented, fragments of very large metates, and stone-carvings, human and animal. This is a valuable collection, especially as regards the stone implements and carvings.

Department of Mammals.

FREDERICK W. TRUE, Curator.

Prof. J. A. Allen, Cambridge, Mass. Fragments of a human skull, from Corsicana, Tex.

Mr. Sylvanus Bailey. A human skull from Point Providence, East Siberia.

Dr. M. Baker, U. S. Coast Survey, Washington. A box of human skulls and dog skulls from Chernooofsky, Alaska, and Plover Bay, Siberia.

Messrs. Barnum, Bailey, and Hutchinson, Bridgeport, Conn. A puma (*Felis concolor*); four baboons (*Cynocephalus* spp.); an ant-eater (*Myrmecophaga jubata*); an African gnu (*Cataplepus gnu*). All of these specimens were received in the flesh.

Capt. L. A. Beardslee, U. S. N. A piece of whalebone from Crisp Sound, Alaska.

Mr. L. Belding, Stockton, Cal. A collection of rodents and deer antlers and heads from Lower California.

Capt. Charles Bendire. Four foetal rodents from Fort Walla Walla.

Mr. C. K. Brace. A bat from Nassau, Bahamas.

British Museum, London, England. A collection of bats and rodents in alcohol from India and Asia Minor. An ornithorhynchus in alcohol from Australia.

Mr. E. L. Brown, Durand, Wis. A mole skin (*Scalops argentatus*).

Lieut. L. M. Cook, U. S. A. A skin and skeleton of Rocky Mountain sheep, from Fort Missoula, Montana.

Mr. Jonathan Cook, Provincetown, Mass. An ear-bone of a whale.

Dr. Jos. H. Corson, U. S. A. Three living round-tailed spermophiles (*Spermophilus tereticaudus*) from Fort Yuma, California.

Dr. F. C. Dale, U. S. N., U. S. Steamer Palos, Yokohama, Japan. One box of mammal skins from China.

Mr. John Darr, Washington, D. C. A living bat (*Atalapha noveboracensis*) from the District of Columbia.

Mr. Waldo Dennis, Oshkosh, Wis. A horse's foot with supernumerary toe.

- Mr. F. L. Donnelly, *Havre de Grace, Md.* A fœtal calf in alcohol.
- Capt. J. M. Dow, *New York City.* A living deer and three monkeys (*Œdipus titi* and *Nyctitiphecus rufipes*) from Central America. These specimens are on exhibition in the rotunda of the Museum.
- Prof. Alfred Dugès, of the Museum, *Guanajuato, Mexico.* A squirrel and two bats from Guanajuato; a tibia of horse (*Equus* sp.).
- Mr. Vinal N. Edwards, *Wood's Holl, Mass.* A skull of deer from Naushton Island, Massachusetts; two vertebræ.
- Mr. Gustav Eisen, *Fresno, Cal.* A collection of rodents, bats, and weasels in alcohol, including nine specimens of the least pocket mouse (*Cricetodipus parvus*); from California.
- Mr. Wm. J. Fisher, *Kodiak, Alaska.* Two rodent skins and a fœtal sea-otter; from Kodiak, Alaska.
- Mr. Adam Forepaugh. The African elephant "Mungo," which died in his menagerie while in Washington.
- Dr. Bernard Gilpin, *Nova Scotia.* A rodent from Nova Scotia.
- Mr. G. Brown Goode, *U. S. National Museum, Washington.* One horn of pronghorn antelope (*Antilocapra americana*).
- Dr. W. C. Gorgas, *U. S. A., Fort Brown, Tex.* Two anatomical specimens of mammals.
- Mr. M. Green, *U. S. Fish Hatching Station, McCloud River, California* (through Mr. Livingston Stone). The skin of a cinnamon bear (*Ursus cinnamomeus*); from the U. S. Trout Ponds, McCloud River, California.
- Mr. G. Goward. A human skull, from the Samoan Islands.
- Mr. A. H. Hamilton, *Cape May Point, N. J.* Bones of a young sperm whale (*Physeter macrocephalus*) stranded at Cape May.
- Mr. H. C. Harman, *Stafford Cliffs, Md.* A vertebra of a fossil whale.
- Mr. C. J. Hering. A bat, from British Guiana.
- Dr. Edward S. Jones, *Washington, D. C.* A living marmoset (*Jacchus vulgaris*).
- Messrs. Jones and Williams. Two skulls of the pronghorn antelope (*Antilocapra americana*); two skulls of the beaver (*Castor canadensis*) (?) from Warm Springs, Wyo.
- Mr. George O. Knowles, *Provincetown, Mass.* An ear-bone of a fin-back whale.
- Officers of the steamer *Lookout.* A dolphin (*Delphinus* sp.) in the flesh, from Point Lookout, Maryland. (Cast.)
- Mr. E. F. Lorquin, *San Francisco, Cal.* A bridled weasel (*Putorius frenatus*), from California.
- Mr. McDavid (through Mr. S. T. Walker), *Boston, Mass.* One horn of domestic goat, from Escambia Bottom, Florida. Found 6 or 8 feet below the surface of the soil.
- Mr. William Macleay, *Sydney, Australia.* The skeleton of a male dugong (*Halicore dugong*); from the museum of the Linnæan Society of New South Wales.

- Dr. J. C. Merrill, U. S. A., Fort Brown, Tex.* Three specimens of Texan rodents; one Texan bat.
- Mr. J. H. Moulton, Saint Paul's, Alaska.* The head of an Alaskan walrus; two skins of seals; from Alaska.
- Mr. Clark Mills, Washington, D. C.* A metallic cast of a portion of a whale's throat.
- Mr. C. L. McKay, U. S. Signal Service.* A collection of Alaskan mammals.
- Mr. E. W. Nelson.* One pair of deer antlers in velvet; from Alaska.
- Mr. P. W. Norris, Yellowstone Park.* Bones of bison, deer, and grizzly bear; from Yellowstone National Park.
- Mr. Willard T. Nye, New Bedford, Mass.* One skull of porpoise; from near Wood's Holl, Mass.
- Mr. Frederick A. Ober, Beverly, Mass.* A young monkey in alcohol; the skin of a monkey; both from St. Kitt's Island, West Indies.
- Miss Tillie Piper, Washington, D. C.* A bat (*Atalapha noveboracensis*), in alcohol.
- Mr. A. Pitts, Sherborn, Mass.* The skull of a woodchuck (*Arctomys monax*); from Sherborn.
- Mr. Edgar Quick, Brookville, Ind.* Five specimens of the field mouse (*Synaptomys cooperi*); from Brookville, Ind.
- Mr. Robert Kidgway, U. S. National Museum, Washington.* The skin of a mink (*Putorius vison*); one skin of a mole; both from Wheatland, Ind.
- Mr. Theodore Roosevelt, New York City.* A collection of eighty-five skins and skulls of weasels, rodents, and bats, mostly from New York. Includes a number of Egyptian bats.
- Mr. William J. Rhees, Washington, D. C.* Two bats in the flesh; from Washington.
- Mr. Charles Ruby, Fort Fred. Steele, Wyoming.* The skin of a puma (*Felis concolor*), and a fragment of a human skull; from Wyoming.
- M. H. Schwank, U. S. N. (through Mr. T. M. Ramsay).* The skin of a fox; from Hakluyt Headland, Spitzbergen.
- Mr. George B. Sennett, Texas.* Three opossums (*Didelphys virginianus*); from Lonita Ranch, Texas.
- Dr. R. W. Shufeldt, U. S. A.* The head of a pronghorn antelope (*Antilocapra americana*), from Sweet Water Valley, Wyoming; the skin of a squirrel (*Sciurus carolinensis*), from Ithaca, N. Y.
- Dr. Leonard Stejneger, Smithsonian Institution, Washington.* A collection of skulls and skeletons of the Arctic sea-cow (*Rhytina gigas*); two skulls of ziphioid whales; from Bering Island, Kamtchatka. Among the *Rhytina* remains are included six almost perfect skulls and fragments of six others; also four partially complete series of vertebrae, a large number of ribs and arm bones, and two scapulae.
- Mr. Livingston Stone, Charleston, N. H.* The skull and a humerus of the grizzly bear (*Ursus horribilis*); from California.

- Mr. James G. Swan.* Two jaws of the killer whale, (*Orca atra*); from Cape Flattery, Wash.
- Mr. J. Tate (through Dr. T. E. Wilcox, U. S. A.).* A pair of antlers of mule deer; from Boise Barracks, Idaho.
- Prof. George Thurber, New York City.* A cinnamon bear (*Ursus cinnameus*), in the flesh; from Ward County, Pennsylvania.
- Mr. Aurelius Todd, Elkhead, Oreg.* Eleven rodent skins; one skin of *Urotrichus Gibbsi*; the skin of a shrew; the skeleton of a spermophile.
- U. S. Fish Commission, Washington.* The skeleton of porpoise; from Wood's Holl, Mass.
- U. S. National Museum, Washington.* A large common rat, in the flesh.
- Mr. S. T. Walker, Boston, Mass.* A raccoon (*Procyon Hernandezii*); from Tampa Bay, Florida.
- Mr. John Wallace, New York City.* The skeleton of a baboon (*Cynocephalus porcarus*).
- Mr. William W. Ware, (through Mr. Robert), Washington, Pa.* One head of domestic sheep; from Westmoreland County, Pennsylvania.
- Dr. T. E. Wilcox, U. S. A.* Two rodents in alcohol; one gopher (*Thomomys talpoides*) in alcohol; one pronghorn head and antlers; two pairs of antlers; one fossil tibia; all from Boise Barracks, Idaho.
- Mr. John B. Wiggins, Waverly, N. Y.* A fox (*Vulpes fulvus*), alive; from Waverly, N. Y.
- Mr. A. F. Wooster, Norfolk, Conn.* A bat in alcohol.

Department of Birds.

ROBERT RIDGWAY, Curator.

ACCESSIONS IN 1882.

How obtained.	Skins.			Nests and eggs.		
	Number of accessions.	Specimens.	Species.	Number of accessions.	Specimens.	Species.
a. By gift.....	69	1,337	657	20	150	85
b. By exchange or purchase.....	30	434	331	5	63	63
c. From collectors employed by the Smithsonian Institution.	39	1,193	683	8	37	21
d. From other departments of the Government.*	13	745	286	3	48	18
e. By deposit.....	1	1	1	.....	.....	.....
e. Miscellaneous†.....	.....	51	46	.....	2	2
Total accessions during 1882..	152	3,761	2,004	36	300	189‡

* Chiefly through the U. S. Signal Service.

† Mostly specimens which, having lost their original labels, were re-entered, or in regard to which there are no data.

‡ The actual number of species is of course much less, identical species being often represented in various collections. In some cases, however, especially among the

The accessions of greatest interest are from the following sources:

(SKINS.)

- Mr. J. Belding, of Stockton, Cal.* Three hundred and eighty-four specimens, two hundred and sixteen species, chiefly from Lower California. A very valuable collection, embracing two new species, two others new to the North American fauna, and a fine series of the several species peculiar to the Cape Saint Lucas fauna. (C.*)
- Capt. Chas. Bendire, U. S. A.* Seventy-nine specimens, thirty-five species, of very desirable Northwestern birds from Fort Walla Walla, Wash., including several examples of the rare Kennicott's owl (*Scops asio Kennicotti*) and a very fine series of the wax-wing (*Ampelis garrulus*). (G.)
- Count von Berlepsch, Münden, Germany.* One hundred and thirty-one specimens, one hundred and two species, of Neotropical birds, previously not represented in the collection. (Ex.)
- Mr. Wm. Brewster, Cambridge, Mass.* Nineteen specimens, thirteen species, of birds from various localities, the same being principally special plumages wanted to complete the collection of North American birds. (Ex.)
- Prof. A. Dugès, National Museum of Mexico.* Fourteen specimens (same number of species) of Mexican birds, some of them rare in collections. (G.)
- Mr. William J. Fisher, U. S. Tidal Observer.* Fifty-two specimens, thirty-four species, from Kodiak Island, Alaska. An interesting collection, containing some very rare species and one new to science (*Æstrelata fisheri*). (Ex.)
- Mr. G. Goward, U. S. Consul to Samoa.* Twenty-three specimens of birds from the Fiji Islands, most of the species new to the collection (G.)
- Mr. P. L. Jouy, of Washington, D. C.* Three hundred and sixty-nine specimens, one hundred and fourteen species, from China and Japan. A majority of the species new to the National Museum collection. (C.)
- Mr. Geo. N. Lawrence, New York City.* Thirteen specimens (as many species), of tropical American birds, the same being desiderata to the collection. (Ex.)

skins of Old World birds, there are a few species not yet determined, and which have not been included in the above enumeration.

The total number of accessions during the year to the collection of the Department of Birds is 188.

*The source of these accessions is designated by the initial "C" for those received from collectors of the Museum, or those making explorations under its auspices; "G" for those presented as a gift; "Ex." for those obtained in exchange, &c.

Prof. William Macleay, Linnæan Society, Sydney, New South Wales. Forty-three specimens, thirty-two species, of birds chiefly from West Australia, and, with one or two exceptions, all new to the collection. (Ex.)

Mr. Charles L. McKay, U. S. Signal Service. One hundred and twenty-eight specimens, seventy-four species, from Bristol Bay and Nushagak River, Alaska. (Signal Office.)

Sergants John Murdoch and Middleton Smith, U. S. Signal Service. Two hundred and forty specimens and thirty-five species, from Point Barrow, Alaska. A fine collection, including interesting series of well-prepared specimens. (Signal Office.)

Mr. Raymond L. Newcomb, Naturalist attached to the Jeannette expedition. Seven specimens, five species, from the Arctic Ocean north of Siberia, including three specimens of the excessively rare Ross's Gull (*Rhodostethia rosea*). (Navy Department.)

Norwich Museum, Norwich, England (through Mr. J. H. Gurney). Twenty-four specimens, sixteen species, of raptorial birds, chiefly new to the collection. (Ex.)

Mr. C. C. Nutting, of Carlinville, Ill. Three hundred and twenty specimens, one hundred and ninety species, from Costa Rica. This collection forms the basis of two special papers in the "Proceedings" of the National Museum (Vol. 5, pp. 382-409; the other not yet printed). (C.)

Mr. Theodore Roosevelt, New York City. Five hundred and ninety-six specimens, one hundred and ninety-five species of birds, mostly North American (a few from Egypt). (G.)

Shanghai Museum, Shanghai, China (through Mr. P. L. Jouy). Seventy-seven specimens, sixty-five species, mostly new to the collection. (Ex.)

Mr. George Shoemaker, Assistant in Department of Birds, U. S. National Museum. Eighty-three specimens, fifty-four species, of birds from the District of Columbia and Alexandria County, Virginia. The specimens all very finely prepared. (G.)

Dr. R. W. Shufeldt, U. S. A. Two hundred and ninety-six specimens, one hundred and eighty-six species, chiefly from Connecticut and Wyoming Territory. This collection is exceptionally fine as regards preparation of the skins, a considerable number of which have been mounted for the exhibition series of the Museum. (G.)

Dr. Leonhard Stejneger, U. S. Signal Service. One hundred and ninety-eight specimens, ninety species, from the Commander Islands and Petropolovski, Kamtchatka. An important collection, containing several new species. (Signal Office.)

(NESTS AND EGGS.)

Mr. L. Belding, Stockton, Cal. Twenty-four specimens (*i. e.*, entries), twelve species, from Lower California. (C.)

- Mr. George A. Boardman, Calais, Me. Eggs of the Florida courlin, or limpkin (*Aramus pictus*), from Florida. (G.)
- British Museum, London, England. Forty-five species, from Pegu (all new to the collection). (Ex.)
- Mr. E. Dickinson, Springfield, Mass. One set of eggs of *Totanus melano-leucus*, from Manitoba. (New to the collection.) (G.)
- Governor Feneker, Godhavn, Greenland. Eighty-seven specimens (entries), twenty-four species, from Greenland.
- Mr. Wm. J. Fisher, U. S. Tidal Observer. Fifteen specimens, fifteen species, from Kodiak Island, Alaska, and vicinity. The most interesting specimens are eggs of the bald eagle (*Haliaëtus leucocephalus*) and black oystercatcher (*Hæmatopus niger*).
- Mr. R. G. Hazard, 2d, Peace Dale, R. I. Eggs of *Spheniscus demersus*, *Eudypes chrysocome* and *Diomedea culminata*, from Falkland Islands.
- Mr. George N. Lawrence, New York City. One egg of the Honduras turkey (*Meleagris ocellata*), from Yucatan. (New to the collection.) (Ex.)
- Dr. J. C. Merrill, U. S. A. One set of eggs of the pink-sided snow-bird (*Junco annectens*), from Big Horn Mountains, Montana Territory. (New to the collection.) (Ex.)
- Sergeants John Murdoch and Middleton Smith, U. S. Signal Service. Forty-six specimens (*i. e.*, entries), sixteen species, from Point Barrow, Alaska. Two of the species new to the collection, if not to science, viz, *Actodromas maculata* and *Pelidna alpina americana*.

Department of Reptiles.

HENRY C. YARROW, Honorary Curator.

Two hundred and thirty entries have been made in the herpetological record book, which would probably represent not less than nine hundred and twenty specimens.

Thirty-one specimens of fourteen species of reptiles, many of them very rare, were received in exchange from the British Museum, through Dr. Günther.

Valuable collections have been received from Mr. James Bell, of Gainesville, Fla., and Mr. L. Belding, of California, employed as collectors by the National Museum, and from Mr. Robert Ridgway, Mr. Lucien M. Turner, Mr. Gustav Eisen, and others.

The accessions of greatest interest are the valuable collection of Mr. L. Belding, made in Lower California, which contained a beautiful specimen of *Crotalus mitchelli*, the only one at present in the Museum; *Crotalus enyo*, *Bufo beldingi* (sp. nov.), *Crotaphytus copei* (sp. nov.), *Uta elegans* (sp. nov.), and *Sceloporus rufidorsum* (sp. nov.). In the collection made by Mr. Robert Ridgway, at Wheatland, Ind., was found a new subspecies of *Ophibolus*, which has been called *Ophibolus getulus niger*. In Mr. Gustav Eisen's collection, made near Fresno, Cal., two new subspecies of *Ophibolus* have been discovered, which are named *Ophi-*

bolus getulus eiseni and *Ophibolus getulus multicinctus*. Prof. E. D. Cope has presented to the Museum a new and valuable species of *Eumeces* from Texas, and Mr. Roosevelt, of New York, has presented quite a large collection of our domestic reptiles, made by himself. Prof. A. Dugès, of Mexico, has continued his contributions, which are always valuable, and we have also been favored similarly by Professor Sumichrast.

Department of Fishes.

TARLETON H. BEAN, Curator.

The total number of accessions during the year was 95, and 78 of these were made by individuals.

SOURCE OF ACCESSIONS.

By gift	55
Exchange or purchase	7
Smithsonian collectors	9
Other Government departments	24
Deposit	1

The U. S. Fish Commission is considered as one of the "other departments of the Government." The single collection received on deposit is from Dr. Shufeldt, at New Orleans, who proposes to monograph the fauna of Lower Louisiana.

For the sake of convenience the list of accessions is arranged alphabetically, and the number of the accession is given. A summary of accessions of greatest interest follows the alphabetical list.

Akers, 00000. Tennessee. One carp (*Cyprinus carpio*), four weeks old, raised in Tennessee.

Alliance, U. S. Steamer. 00000. Arctic seas. One tank of fishes in alcohol.

Atkins, C. G. 12040. Bucksport, Me. Three fresh Kennebec *Salmo salar*.

Baird, W. C. 11366. Chattanooga, Tenn. One head of *Amia calva*.

Baldwin, A. S. 11124. Jacksonville, Fla. One *Erimyzon Goodei*.

Bean, T. H. 11230. Potomac River. One fresh *Tinca vulgaris* from Broad Creek.

———— 11546. Havre de Grace, Md. One tank of fishes in alcohol.

———— 11619. Potomac River. One fresh *Tinca vulgaris*.

Behr, von. 11044. Austria. Twenty specimens of *Umbrakrameri*.

Blackford, E. G. 11127. New York. One fresh *Micropterus salmoides* (10½ pounds).

———— 11189. New York. Four fresh *Pomoxys sparoides*.

———— 11196. Florida. One fresh *Lutjanus Blackfordii*.

———— 11296. New York. One box of salmon and trout from various localities.

———— 11356. New York. Two fresh *Peristedium miniatum*.

———— 00000. New York. One living *Ophidium marginatum*.

———— 11870. New York. One fresh *Hippoglossoides platessoides*.

- Bradfield, H. L.* 11917. Dougherty, Tex. One fossil tooth of *Galeocerdo falcatus*.
- Chester, H. C.* 12056. Noank, Conn. Four jars of fishes in alcohol.
- Clark, Frank N.* 11701. Northville, Mich. Two *Catostomus commersonii* in alcohol.
- Clark, J. W. B.* 11559. Deil's Island, Chesapeake Bay. Two *Chasmodes Boscianus* and two *Gobiosoma alepidotum*.
- Collins, Capt. D. E.* 12076. Gloucester, Mass. One smoked *Scomber DeKayi*.
- Cumming, W. M.* 11643. Wilmington, N. C. Three *Gambusia patruelis*.
- Dabney, Wm.* 00000. Lodi, Miss. An *Etheostomatid* (dried) in letter.
- Davis, W. E., & Son.* 11488. Wilmington, N. C. One fresh *Megalops atlanticus*.
- Dugès, Prof. A.* 11113. Guanajuato, Mexico. One *Centropomus* and one *Mugil* from Tepic.
- Edwards, V. N.* 11036. Wood's Holl, Mass. One *Lophopsetta maculata* ? juv.
- 11101. Wood's Holl, Mass. Two skeletons of *Phycis*, one of *Tautoga onitis*.
- Ferber, Dr.* 11754. Canada. One young *Salmo salar*.
- Fisher, William J.* 00000. Kodiak, Alaska. One keg and five bottles of fishes in alcohol.
- Fish Hawk, U. S. F. C. steamer.* 11206. Chesapeake Bay. Two boxes alcoholic and one keg of fresh fishes.
- Gering, Frederick.* 12080. Gloucester, Mass. One *Menticirrus nebulosus*.
- Gilmer, G. K.* 11131. Richmond, Va. Four fresh *Dorosoma cepedianum*.
- Gorgas, W. C.* 11915. Fort Brown, Tex. One can of alcoholic specimens.
- Haller, G. M.* 12048. Puget Sound. One *Clupea sapidissima* in alcohol.
- Hay, O. P.* 11738. Tennessee and Mississippi. One tank fresh-water fishes in alcohol.
- Henshall, Dr. J. A.* 11429. Florida. One tank of fishes in alcohol.
- Herrera, Alfonso.* 11279. City of Mexico. Three *Heros* sp. and three *Chirostoma Humboldtianum*.
- Hodge, E. B.* 00000. Plymouth, N. H. One *Salvelinus fontinalis* in bad condition.
- Horan, Henry.* 12004. One salted *Selene argentea*.
- Howell, D. Y.* 11477. Sandusky, Ohio. Six vials embryonic *Stizostedion vitreum*.
- Hubbs, A.* 12155. Mounds, Mo. Five *Enneacanthus* sp. in alcohol.
- Hudson, George A.* 11150. Cedar Keys, Fla. Seven fresh *Clupea sapidissima*.
- Jamaica Institute.* 11760. Kingston, Jamaica. One hundred and eighty-three specimens of marine fishes.

- Jones, Dr. Wm. H., U. S. N. 12163. Alaska. One keg fishes, &c., in alcohol.
- Jordan, D. S., and Gilbert, Charles H. 11500. Mazatlan, Panama, Lower California, Texas, Florida, and Italy. Six tanks of fishes in alcohol.
- Jouy, P. L. 11262. China. Two tanks of fishes in alcohol (many species).
- 11804. Japan. One tank fishes in alcohol.
- Larco, Andrea. 11461. Santa Barbara, Cal. One box of fishes in alcohol (many species).
- Linnæan Society, New South Wales. 00000. New Guinea. Two hundred and seven specimens of fishes in alcohol.
- Lütken, Dr. Chr. 11181. Iceland. One *Trachypterus arcticus* in alcohol.
- Manitoba Historical and Geological Society. 11897. Winnipeg. One tank of fishes in alcohol.
- McAdams, William. 12052. Illinois River. One box of fishes in alcohol.
- McDonald, Col. M. 11047. Cherrystone, Va. Two bottles of fishes in alcohol.
- 11209. Potomac River. Three *Clupea sapidissima*.
- 11211. Washington, D. C. Two *Cyprinus carpio* shipped to Texas and back alive.
- 11615. Fredericksburg, Va. Four species of fresh-water fishes.
- Merriam, Dr. C. Hart. 11462. Woodhull Lake, New York. One *Salmo salar* var. *sebago*.
- Mitchell, Capt. J. C. 11495. Charleston, S. C. Two tanks of fishes in alcohol.
- Moore, G. H. H. 11618. Colorado River, Texas. One fresh *Haploidenotus grunniens*.
- Norny, E. R. 11031. Odessa, Del. Skin of *Anguilla rostrata*.
- Nye, Willard, jr. 12000. New Bedford, Mass. One bottle *Anguilla rostrata* in alcohol.
- Packard, A. S., and Kingsley. 11208. Wood's Holl, Mass. Reproductive organs of supposed male eel.
- Polk, W. L. 11324. Vicksburg, Miss. One *Carpiodes* (?) from Mississippi River.
- Radeliff, Captain. 00000. Fifteen miles southeast of Cape May. One salted *Peristedium miniatum*.
- Rathbun, Richard. 11984. Brazil. Five photographs of fishes.
- Reed, George H., U. S. N. 11409. Potomac River. One *Micropterus salmoides* and one *M. dolomieu*.
- Shufeldt, Dr. R. W., U. S. A. 12122. New Orleans, La. One box of fishes, &c., in alcohol.
- Stearns, Silas. 11015. Pensacola, Fla. One fresh *Batrachus tau* subsp. *pardus*.
- 11123. Pensacola, Fla. One fresh *Caulolatilus microps*.

- Stearns, Silas.* 11149. Pensacola, Fla. Three fresh *Caulolatilus microps*.
 ——— 11235. Pensacola, Fla. Spawn of *Trisotropis stomias* with
 entozoa.
 ——— 11496. Pensacola, Fla. Three tanks of fishes in alcohol.
Stearns, W. A. 11859. Labrador. Two tanks and one barrel of fishes.
Svan, James G. 11231. Port Townsend, Wash. One winter salmon,
Oncorhynchus chonicha.
Thompson, H. H. 12138. Woodhull Lake, New York. Two fresh *Cor-*
egonus artedi.
 ——— 12223. Woodhull Lake outlet. One fresh *Salmo salar* var.
sebago.
True, Frederick W. 11817. Essex County, New York. One tank fishes
 in alcohol.
U. S. Fish Commission. 11210. Germany. Two *Cyprinus carpio*; died
 in transit.
 ——— 11640. Northville, Mich. Two fresh *Salvelinus fontinalis* and
 one *Salmo irideus*.
 ——— 11715. Quantico, Va., and Battery, Md. Eggs and embryos
 of *Clupea vernalis*, *Petromyzon marinus*, hybrid between *Clupea sapi-*
dissima and *Perca americana*.
 ——— 11770. Washington, D. C. One *Carassius auratus* (Japanese)
 in alcohol.
 ——— 11772. Wood's Holl, Mass. Many species of marine fishes.
 ——— 11818. Wood's Holl, Mass. One tank and one box of fishes in
 alcohol.
 ——— 11682. Wood's Holl, Mass. One tank and one box of fishes
 in alcohol.
 ——— 11888. Wood's Holl, Mass. One half barrel fresh *Scorpana*,
Merlucius, *Phyeis*, &c.
 ——— 11891. Wood's Holl, Mass. One fresh *Raia laevis*.
 ——— 11918. Wood's Holl, Mass. One box of fishes in alcohol.
 ——— 12027. Havre de Grace, Md. One fresh *Clupea sapidissima*.
U. S. Signal Service. Point Barrow, Alaska. Four species of fishes in
 alcohol.
Weurer, George B. & Co. 12035. Seneca Lake, New York. One *Amia*
calva and one *Lota maculosa*, fresh.
Whitman, J. L. 11724. Valley Falls, Kans. Four *Stizostedium vit-*
reum in alcohol.
Wilcox, W. A. 11024. Boston, Mass. Three fresh *Brosmius brosme*.
Wild, George H. 11685. Red Bank, N. J. Four *Roccus lineatus* in
 alcohol.
Wood, Ensign M. L., U. S. N. 11568. Key West, Fla. One can of
 fishes in alcohol.
Wood, Lieut. W. N. 11372. Potomac River. One fresh shad.
Woodbury, J. G. 11790. San Francisco, Cal. Two *Roccus lineatus*;
 died in transit.

Wyoming Historical and Geological Society. 11431. Wilkes-Barre, Pa.
One deformed *Lepomis gibbosus*.

General summary of accessions of greatest interest.—Most of the collections here noticed were made by persons employed by the U. S. Fish Commission or by the Smithsonian Institution and the U. S. National Museum. Some very important accessions, however, have come from parties who have received nothing more than the tanks and alcohol for preserving fishes. Several very valuable additions were made by museums desiring collections in exchange. Other departments of the Government have contributed comparatively little this year; the U. S. Signal Service party near Point Barrow, Alaska, forwarded a collection, which is small in the number of species, but rich in individuals.

Bean, Tarleton H. 11230. March 20. P.

A fresh tench, *Tinca vulgaris*, which escaped from the United States ponds, Washington, and was captured in Broad Creek, a tributary of the Potomac, by Mr. Roum.

———— 11619. June 24. P.

A tench, *Tinca vulgaris*, which was brought here alive from the Potomac River and kept for some time in the Armory. It is worthy of note that the pharyngeal teeth of tench bred here have no trace of hook, but are worn off so as to have a broad grinding surface, in which respect they differ from examples of like size reared in Europe.

Belding, L. 11543. June 12. G.

Among the fishes received from Lower California, where they were obtained by Mr. Belding, are some species which are new to the localities. Professors Jordan and Gilbert have identified one of the eels from near Cape San Lucas as *Leptocephalus conger*. "No other specimen of this genus has been brought from the Pacific coast of tropical America." *Agonostoma nasutum* Günther, was taken in the river at San José, where it is known as *trucha* or trout. The name "trout" for a mugiloid fish is earnestly recommended to the attention of critics of the synonymy of Latin names of fishes.

Blackford, E. G. 11127. February 14. G.

One big-mouth bass, *Micropterus salmoides*, weighing 10½ pounds. The fish was cast and then preserved in alcohol.

———— 11296. April 6. G.

In a large lot of salmonoids received from Mr. Blackford on this date was an alleged hybrid between *Salvelinus fontinalis* and *Oncorhynchus chouicha*, and there was also a California salmon, *O. chouicha*, which was raised in Minnesota.

———— 11356. April 24. G.

Two fresh *Peristedium miniatum*, which were picked up dead at sea at the time of the tilefish mortality.

———— 00000. May 16. G.

A living example of the rare *Ophidium marginatum*, which was caught at Bay View, Long Island.

Collins, Capt. D. E. 12076. November 17. G.

An individual of the formerly rare and little-known mackerel, *Scomber DeKayi*, sent from Gloucester by request of Capt. J. W. Collins.

Davis, W. E., & Son. 11488. May 28. G.

A large and fine tarpum, *Megalops atlanticus*.

Fisher, William J. 00000. December 23. G.

Mr. Fisher sent from Kodiak a ten-gallon keg of fishes exceedingly well preserved, besides a few bottles. In this lot are many valuable specimens, among them four fresh-water species not before received from the island; these are, *Esox lucius*, *Lota maculosa*, *Catostomus longirostris*, and *Coregonus quadrilateralis*, all of which occur in the Yukon region, but were not expected on this island in the Gulf of Alaska. The first three at least are very old species, widely distributed, and preserving their identity with wonderful tenacity, no matter what change of environment may overtake them. They probably existed on the island before its separation as an island, and they have retained, apparently undisturbed, all the salient characters by which their relatives of the mainland are distinguished in the broad area over which they are found.

Gering, Frederick. 12080. November 17. G.

One example of the kingfish, *Menticirrus nebulosus*, which is extremely rare north of Cape Cod; this was taken in a herring-net in Gloucester Harbor, October 20, 1882.

Gilbert, Charles H. 11500. June 1. C.

Four tanks of Mazatlan and Panama fishes formed the larger part of this accession. Of the Panama species, 148 were taken; 19 of these are described as new in Volume I, Bulletin U. S. Fish Commission. From Mazatlan, Mexico, Mr. Gilbert sent 172 species; 33 of these are established as new in Proceedings National Museum, Volume IV.

Haller, G. M. 12048. November 16. G.

A shad, *Clupea sapidissima*, taken in a tributary of Puget Sound. The shad introduced by the U. S. Fish Commission into the Sacramento have multiplied and are spreading rapidly northward on the coast of California and beyond.

Hay, Prof. O. P. 11738. August 3. C.

A tank of fresh-water fishes collected by him in Mississippi, Tennessee, and other Southern States; 64 species were taken; they are recorded in Volume II, Bulletin U. S. Fish Commission, by Professor Hay. Of the 64 the following are established as new to science: *Ammocrypta vivax*, *Ioia vigilis*, *Pacilichthys butlerianus*, *Menidia audens*; *Tirodon*, new genus, represented by *Tirodon aminigenus*.

Professor Hay's collection contained *Lepidosteus platystomus*, although this does not appear in his list; he has it under the name *L. osseus*.

Professors Jordan and Gilbert consider *Pacilichthys butlerianus* identical with *P. Barratti* (Holbr.).

Henshall, Dr. J. A. 11429. May 13. G.

One tank of fishes collected by him in Florida. Among them are some species not before in the Museum, as, for example, *Pristipoma melanopteron* and a species of *Zygonectes* recently described as new under the name *Z. craticula*.

Hubbs, A. 12155. December 4. G.

Five specimens in alcohol of a species of *Enneacanthus*, which seems to be undescribed. These were caught at Mounds, Vernon County, Missouri, and sent on to ascertain whether or not they are carp.

Hudson, George A. 11150. February 21. G.

Seven small shad received by him at Savannah, Ga., from Cedar Keys, Fla., the first of the species he has known from that locality. These shad, in measurements, proportions, colors, &c., resemble individuals that the Museum has from Alabama.

Jamaica Institute Public Museum. 11760. August 12. G.

This large and very valuable collection of Jamaican species is the second of a series of shipments to the Museum in duplicate, one of each species to be kept here and the other returned, named, to the museum at Kingston. The first can was received in December, 1881. The second can contained 183 specimens, all of them in excellent condition and representing many species which will prove additions to our collection. The species are, at present, only partly determined.

Jordan, Prof. D. S. 11500. June 1. C.

Professor Jordan's collections, made at Galveston, New Orleans, and Pensacola, filled two large tanks and contained many new species, which are described in Proceedings National Museum, Volume V. Some of the species obtained are the following:

- Fundulus xenicus* Jor. & Gilb. (types).
- Paralichthys albigutta* Jor. & Gilb. (type).
- Chasmodes saburrae* Jor. & Gilb. (types).
- Paralichthys squamilentus* Jor. & Gilb. (types).
- Isestes scrutator* Jor. & Gilb. (types).
- Hippocampus zosterae* Jor. & Gilb. (types).
- Fundulus ocellaris* Jor. & Gilb. (types).
- Isestes ionthas* Jor. & Gilb. (types).
- Gobius boleosoma* Jor. & Gilb. (types).
- Gobiosoma virgatulus* Jor. & Gilb. (types).
- Opisthognathus lonchurus* Jor. & Gilb. (type).
- Chromis enchrysurus* Jor. & Gilb. (type).

It is proper to state that Professor Jordan was greatly assisted in making this collection by Mr. Silas Stearns, whose vessels brought in most of the new species described from Pensacola.

Jouy, P. L. 11804. August 28. C.

A tank of Japanese fishes, which have not yet been examined.

Jouy, P. L., and F. C. Dale. 11262. March 30. C.

A collection of Chinese fishes in two tanks. Many species are represented, but no examination of them has been made. These fishes were secured while the collectors were on the U. S. steamer Palos.

Larco, Andraea. 11461. May. 20. G. & P.

A large lot of alcoholic fishes sent from Santa Barbara by Mr. Larco contained the following among other good things: *Liocottus hirundo*, *Citharichthys* (type), *Sebastichthys umbrosus* (type), and *Isestes Gilberti* (types).

Linnæan Society, Sydney, Australia. 00000. May 7. E.

Two hundred and seven specimens of fishes collected in New Guinea, many of which are new to the collection. A list of some of the interesting ones is given in my report for May, 1882.

Lütken, Dr. Chr. 11181. March 7. E.

One alcoholic example, from Iceland, of *Trachypterus arcticus*, the first one obtained by the Museum.

McAdams, William. 12052. December 11. G.

A large number of fresh-water species from the mouth of Illinois River.

McDonald, Col. Marshall. 11211. March 14. D.

Two leather carp, *Cyprinus carpio*, that were sent to Texas and returned alive in a gallon pail, a convincing proof of the feasibility and desirability of shipping carp in a limited supply of water.

————— 11615. June 22. G.

Four species of fresh-water fishes, *Roccus lineatus*, *Catostomus commersonii*, *Amiurus catus*, and *Lepomis auritus*, caught after ascending over the McDonald fishway, at Fredericksburg, Va.,

Manitoba Historical and Scientific Society. 11897. October 2. E.

The Museum received from this society, located at Winnipeg, one tank of alcoholic fishes through Mr. H. A. Strong. The tank was received October 2, 1882. The species are all similar to those of the adjacent United States region, but none the less interesting, since we have few fishes now from the locality whence these came.

Mitchell, Capt. J. C. 11495. May 31. G.

In this collection was a fine specimen of *Lagocephalus xavignatus* and one of *Alutera scripta*, which has been rarely observed on the coast of the United States. *Fundulus majalis* is represented in the lot.

Nye, Willard, jr. 12000. November 9. G.

Three eels taken from the water-supply pipes at New Bedford, Mass.

Radcliff, Captain. 00000. June 12. G.

A salted specimen of *Peristedium miniatum* from 15 miles southeast of Cape May, found at the time of the great tilefish mortality.

Shufeldt, Dr. R. W., U. S. A. 12122. December 19. Dep.

In a box of alcoholic fishes collected at New Orleans, La., which were received here November 28, 1882, were several interesting species: A *Zygonectes*, apparently *chrysotus* Gthr., *Prionotus scitulus* Jor. & Gilb., and *Elassoma zonatum*, the last singular fish being represented by more individuals than the Museum possessed before from all other sources.

Stearns, Silas. 11496. June 1. G.

This is a large collection made at Pensacola, Fla., by Mr. Stearns, and includes many valuable species, a good portion of which were described as new in Volume V, Proceedings National Museum. A partial list follows:

- Gobius boleosoma* Jor. & Gilb.
- Ophidium Gressli* Poey.
- Erocatus Hillianus* Gosse.
- Chromis euchrysurus* Jor. & Gilb.
- Stenotomus caprinus* Bean.
- Mullus barbatus* var. *auratus* Jor. & Gilb.
- Ioglossus calliurus* Bean (n. g. and n. s.).
- Apogon maculatus* (Poey) Jor. & Gilb.
- Blennius stearnsii* Jor. & Gilb.

With two exceptions the above are all new species, and one represents a curious aberrant form of *Gobiidae* related to *Oryzometopon* Bleeker, from which, however, it differs in several important characters.

————— 11500. June 1. G.

See remarks under Jordan, Prof., D. S., Acc. 11500. Without the assistance of Mr. Stearns the collection would have been much less valuable.

Stearns, W. A. 11859. September 16. G.

Seventeen species of fishes collected by him in Labrador during the summer of 1882. Among them are some species of especial interest to us:

Scomber scombrus, rare from so far north;

Cottus scorpioides, far south of its recorded limit;

Gadus ogac;

Hippoglossoides platessoides; and a small

Somniosus brevipinne.

Tautogolabrus adspersus was found abundant.

Thompson, H. H. 12223. December 27. G.

A fresh land-locked salmon, *Salmo salar* variety *sebago*, taken from an outlet of Woodhull Lake, New York. This form of salmon was introduced into the lake through the aid of the U. S. Fish Commission, and has greatly multiplied there.

U. S. Fish Commission. 11206. March 15. D.

The cruise of the "Fish Hawk" in Chesapeake Bay, early in March, resulted in the discovery of some well-known species of fishes at an unexpected time. The common spined dogfish, *Squalus acanthias*, was plentiful, attracted there, no doubt, by the presence of large schools of small menhaden, *Brevoortia tyrannus*. *Raia ocellata* was also obtained. The young of several important economic fishes were taken in great abundance; among these were *Clupea vernalis*, *Clupea arctivalis*, *Pogonias chromis*, *Phycis chuss* (?), *Phycis regius*, and *Acipenser oxyrhynchus*. *Stolephorus* sp., *Gobiosoma*, *Gobiosox*, and many other species were found.

———— 11715. July 20. D.

Among other embryonic fishes received in this invoice from Battery Station, Maryland, were some hybrids between *Clupea sapidissima* and *Roccus lineatus*. Mr. Ryder has carefully examined these creatures and declares that they do partake of the characters of both parents. Development of eggs of one species after fertilization by milt of a fish belonging to a widely different family has heretofore been considered wholly improbable.

———— 11772. August 19. D.

In a large number of species of marine fishes sent from Wood's Holl, and received on above date, was *Leptoclinus aculeatus*, which has not previously been recorded from south of Cape Cod.

———— 11818. September 4. D.

One tank and one box of fishes in alcohol from Wood's Holl, Mass.

———— 11862. September 16. D.

A tank and a box of fishes from the summer station at Wood's Holl. One of the most interesting of the species is a *Brotulid*, first obtained by Prof. Alexander Agassiz, and now rediscovered by the Commission. For this genus Mr. Goode and I have proposed the name *Dicrolene*, on account of the peculiar structure of the pectoral; the single species obtained is to be called *Dicrolene introniger*. Another singular genus of *Sternoptychidae* widely different from all the known forms of that family is also with this collection. *Argyropelecus hemigymnus* was taken at station 1112.

———— 11888. September 28. D.

In a half-barrel of fresh fishes, with *Squalus acanthias*, *Merluccius bilinearis*, and *Phycistenuis*, were several large and brilliantly colored *Scorpana dactyloptera*, found plentifully by Capt. J. W. Collins while trawling on the "tilefish ground." It is thought that this last species may be caught in such abundance as to make it an important addition to the supply of food-fishes.

U. S. Fish Commission. 11918. October 9. D.

In a box of fishes received from Wood's Holl, Mass., October 9, 1882, were *Coryphanoides rupestris*, *Hippocampus hudsonius*, and a new *Mallthead* genus related to *Halieutichthys*, but with the dorsal base partly on the body, a very short tail, pectorals not exerted, and some other striking peculiarities.

— — 12027. November 7. D.

A fresh female shad, *Clupea sapidissima*, which had been detained in a pool at Battery Station, near Havre de Grace, Md., was received, November 7, 1882, in a spent condition.

U. S. Signal Service. 00000. December 22. D.

From the party at Ooglaamie near Point Barrow, Alaska, were obtained a large number of capelin (*Mallotus villosus*), as well as of the polar cod (*Boreogadus saida*); there were also two species of *Cottus*, one of which is either adult *C. verrucosus* or new, and the other is apparently undescribed.

Department of Mollusks.

WILLIAM H. DALL, Honorary Curator.

The accessions to the Museum comprise some twenty-seven separate lots, as received, in one hundred and thirteen boxes, barrels, and packages.

The largest in bulk and most important in its bearing on the science of any collections received during the year is the typical collection of land and fresh-water shells, sent in fifty-three boxes, by Dr. Isaac Lea, of Philadelphia. When this shall be available, with the series of Dr. Lewis, and that of Mr. W. G. Binney, the Museum need shrink from no comparison with the collections in these groups of all the world beside.

The next and for the Pacific coast the equally typical and important collection of Dr. R. E. C. Stearns, of California, has been received on deposit, under an arrangement by which it is intended to become the permanent ornament of the Museum. Comprising thirty cases in bulk, and probably over 10,000 species in number, its especial richness in all that relates to the Pacific coast of the United States, in addition to the Carpenter and Dall collections already in the Museum, will put competition in that field out of the question.

A very interesting and valuable collection of shells from La Paz, filling three boxes, with fresh and well-preserved specimens of marine shells, has been received from Consul L. Belding.

The Senckenburgian Museum of Frankfort-am-Main has contributed a small but valuable collection of 45 species of recently-described pulmonates, through Dr. W. Kobelt, their curator.

A collection of cephalopods long since lent to Prof. Japetus Steenstrup, of Copenhagen, for study, has been returned during the year.

Commander J. R. Bartlett, U. S. N., has presented some interesting cephalopods from the Gulf Stream, which were attracted to the vessel by the electric light used in the deep-sea-sounding work.

Other less remarkable but still interesting and valuable donations will be found enumerated in the card catalogue submitted herewith.

Department of Insects.

C. V. RILEY, Honorary Curator.

Accession No.

10807. *Alaus myops*, sent by John Dennett, Mobile, Ala
 10854. *Linnophilus* sp., sent by J. Sharp Nixon, Chambersburg, Pa.
 11110. Three boxes with Coleoptera; one bottle with miscellaneous insects in alcohol; sent by C. J. Hering from Surinam.
 11113. Six boxes with Mexican Coleoptera, with list of names, from Prof. Eugenio Dugès, Guanajuato, Mexico.
 11098. Various hymenopterous insects, from W. A. Williamson, Toronto, Canada.
 11229. Eggs of lacewing fly, from Joseph Schanno, Yakima, Wash.
 11267. Specimens never received, but were doubtless a species of black-fly, from M. H. Thomson, Peacan Point, Ark.
 11325. *Dynastes tityus*, sent by Geo. H. McKinney, Stanford, Ky.
 11439. *Smerinthus modestus*, from L. Belding, Stockton, Cal.
 11577. *Lucanus elaphus*, sent by J. H. Turner, Jonesville, Tex.
 11600. *Papilio turnus* and *Danaïs archippus*, from T. S. Wilcox, Boise Barracks, Idaho.
 11661. *Scorpio allenii*, from T. S. Wilcox, Boise Barracks, Idaho.
 11687. *Galeodes* sp., from E. C. Bradstreet, Greeley, Colo.
 11786. *Dynastes tityus*, from Messrs. Hall M. Caldwell and Andrew D. Cowles, Statesville, N. C.
 11798. Chrysalis of a noctuid moth, from J. S. F. Batchen, Chicago, Ill.
 11841. *Callidryus subule*, from Thos. S. Doran, Montgomery, Ala.
 11843. *Rhyssa lunator*, from F. O. Miner & Co., New Orleans, La.
 11848. *Papilio rutilus*, from C. A. Williams, Fort Lapwai, Idaho.
 11850. Larva of *Eacles imperiales*, from W. W. Karr, Washington, D. C.
 11871. Larva of *Oiketicus* sp., from J. C. Wells, Grenada, W. T.
 11877. *Citheronia regalis*, from J. F. Lewis, Quinnimont, W. Va.
 11916. Eighteen boxes with pinned Lepidoptera. Source not indicated.
 11931. *Lucilia macellaria*, from Dr. Fred. Lambert, Alton, Ill.
 11960. Pupa of *Papilio troilus*, from the U. S. Signal Officer, Fort Myer, Virginia.
 11960 [bis]. *Belostoma grande*, from C. T. Davis, Nevada, Mo.
 11988. Larva of *Empretia stimulea*, from James W. Rogan, Rogersville, Tenn.
 12063. *Gasterocantha cancer*. Source not indicated.

Without accession number, a very interesting collection, by Mr. L. M. Turner, from the Aleutian Islands, and a series of miscellaneous specimens lately collected during the winter at New Orleans, La., by Dr. R. W. Shufeldt.

Most of the specimens above enumerated were received in such poor condition as to be unfit for preservation. It will also be noticed that most of them are quite common species. The chief contribution is that

by Prof. Eugenio Dugès, of Guanajuato, Mexico, consisting of a number of named Mexican Coleoptera, upon which I have made to Professor Dugès such report as was possible without examination of foreign collections. In this connection I would remark that there is in this country no public collection of any extent of foreign insects. Hence the need of such is very greatly felt, since every specialist is now under the necessity of traveling to Europe to study material inaccessible so far in this country.

A considerable collection, in fair condition, of undetermined exotic Lepidoptera has also been received, but without any indication of its source.

The chief, and in fact the only, collection of insects made within the limits of the United States is that already mentioned, by Mr. L. M. Turner, from the Aleutian Islands, Alaska. This collection is very interesting, and I have already submitted a full report upon it.

Under this head I would also mention the fact that Congress has purchased the copper plates and manuscript notes of Mr. Townend Glover, and these have been deposited in the Museum, and make a valuable relic of Mr. Glover's industry that can be at any future time used and referred to. The one full set of colored impressions from these plates, which used to hang in the Entomological rooms of the Department of Agriculture, is, however, not to be found among the material turned over to the Museum. This is to be regretted, as this set was of more value than the other plates and notes, and could have been made good use of if placed on exhibition as forming part of an exhibition collection.

Department of Marine Invertebrates.

RICHARD RATHBUN, Curator.

The principal accessions to this department for 1882, as for the two previous years, were from the United States Fish Commission. Prior to 1880 the extensive marine-invertebrate collections of the Fish Commission, which had then been accumulating for nine years, were all stored at the Peabody Museum of Yale College, New Haven, Conn., under the care of Prof. A. E. Verrill, who, with several associates, was preparing a series of reports upon them. Up to that time sufficient space could not be given to these materials in the Smithsonian building, and it was only after certain of the other collections had been transferred to the National Museum building that the Fish Commission collections were ordered sent on. During the past three years, however, a large part of the bulk of these collections has been brought to Washington, and is now available for reference. Very many duplicates have been disposed of to the best interests of the Museum. In addition to the specimens received through Prof. Verrill large quantities of material have been sent direct to Washington every fall, beginning in 1880, from the summer headquarters of the Fish Commission. During 1880,

while the fishery-census experts were visiting every part of the American coast, they obtained many extensive faunal collections, among the more interesting of which were those of Prof. D. S. Jordan, from the California coast; of Mr. Silas Stearns, from the Gulf of Mexico; and of Messrs. Earll and MacDonald, from the Southern Atlantic coast. The collections brought in by the Gloucester fishermen on behalf of the Fish Commission, from 1878 to 1882, are also very extensive and of extreme value.

These large receipts of valuable specimens from the United States Fish Commission have naturally rendered the collections of this extensive survey the most important feature of this department. Up to January 1, 1883, there had been received from Professor Verrill 1,973 packages and bottles of Fish Commission specimens, representing the several groups, as follows:

Crustacea, 138 species.

Worms, 31 species.

Mollusca, 33 species.

Bryozoa and Tunicates, 31 species.

Echinoderms, 44 species.

Anthozoa, 24 species.

Hydroids, 12 species.

A total of 313 species, and over 200,000 specimens, not counting a large number of the smaller species, of many of which there are several thousand specimens each. Nearly all of the above species are represented by several specimens from each known locality, constituting a part of the so-called reserve or reference collection of the Museum, the balance being duplicates. The following groups are the ones most fully illustrated in the reserve series from the Fish Commission: The Decapod and Isopod Crustaceans, Pycnogonids, shore Annelids, Cephalopods, Echini, Starfishes, Gorgonians, and Actinians. The miscellaneous collections sent direct from the summer stations to Washington have not been fully catalogued, and no definite statement can be made concerning their extent, but they will probably add 50 more species and many thousand specimens.

The curator, during the past three summers, as an assistant to the Fish Commission, has devoted the most of his time to collecting and studying the marine *Copepoda*, both free-swimming and parasitic, which are very abundant upon our coast. The collection of Copepods thus far obtained and now in the Museum is one of the largest, if not the largest, in the world, and fills over 1,500 vials and bottles.

From Mr. Vinal N. Edwards, who is in the permanent employ of the Fish Commission at Wood's Holl, Mass., the Museum has been in constant receipt of marine invertebrates, collected in the neighborhood of Wood's Holl, at intervals through the year, but mainly during the winter, spring, and fall seasons, when this region is seldom visited by naturalists. By collecting at these times Mr. Edwards has procured several

interesting species, which have never been obtained by the summer party at this station.

The other important accessions to this department during 1882, demanding special notice, are as follows:

From Mr. Alexander Agassiz, Cambridge, Mass., a first installment of the duplicates of the Blake exploring expedition, consisting of 13 species of Anthozoa, 25 species of Sponges, 5 species of Crinoids, 8 species of Cephalopods, and 33 species of Crustaceans.

From Dr. F. C. Dale, U. S. N., and Mr. Pierre L. Jouy, naturalists of the U. S. steamer "Palos," engaged in surveying on the coasts of Japan and China, a large and exceedingly interesting series of marine invertebrates, chiefly Crustaceans and Radiates, from those regions. This collection derives additional value from the fact that it replaces, in part, old collections of the Museum burnt at the great Chicago fire of 1871. In that conflagration the National Museum lost its alcoholic collection of Crustaceans, obtained by the United States exploring expedition under Captain Wilkes, and described by James D. Dana, and nearly the entire collection of marine invertebrates secured by the North Pacific exploring expedition, which was being studied and described by Dr. William Stimpson, naturalist to that expedition, and director of the Chicago Academy of Sciences, where both collections were stored. The specimens from the latter expedition had been described only in part, and the Palos collection will probably be found to contain much new material when it has been properly worked over. It is entirely in alcohol, and in a fine state of preservation.

The U. S. steamer "Alliance," in search of the "Jeannette," has sent alcoholic collections of marine invertebrates, obtained by dredging and towing in the vicinity of Spitzbergen, August, 1881.

Dr. William H. Jones, U. S. N., U. S. steamer "Wachusett," has furnished a fine collection of Crustaceans and Echinoderms, from the west coast of British Columbia and Alaska.

The United States Signal Service party at Point Barrow, Alaska, have supplied littoral marine Crustaceans and fresh-water Entomostraca from the vicinity of the signal station.

The U. S. steamer "Alert" has sent twenty-five samples of soundings from the vicinity of the Bonin Islands, Pacific Ocean.

Dr. Thomas C. Craig, U. S. N., U. S. steamer "Jamestown," has contributed a small collection of marine invertebrates from the South Atlantic.

Lieutenant Elliott, U. S. Marine Corps, has sent one tank of alcoholic marine invertebrates from the Arctic regions.

Mr. Ernest Wilkinson, midshipman, U. S. N., has furnished a small collection of Sea-urchins and Crustaceans from the Arctic regions.

The Museum Nacional de Rio de Janeiro, Brazil, has sent, in exchange, a complete collection of all the known species of Brazilian corals, consisting of 144 specimens, and 34 species, procured between Maran-

hao, in the north, and Rio de Janeiro, in the south. The greatest value of this collection arises from the fact that it contains several undescribed species, and represents a portion of the zoological researches of the Geological Commission of Brazil, of which the late Prof. Ch. Fred. Hartt was chief. Our knowledge of the coral fauna and coral reefs of Brazil dates from the second journey of Professor Hartt to that country, in 1866, when he collected 19 species of corals, which were described by Prof. A. E. Verrill, in 1868. The Geological Commission of Brazil, of which the curator was a member, during the period of its continuance, from 1874 to 1878, brought together a very large collection of corals, amounting in all to several thousand specimens, which were placed in the writer's hands for study and description. Thirty-four species were readily distinguished, but the means of properly identifying them were not at hand, and the completion of the report was postponed until the materials for making suitable comparisons could be obtained. The arrival of this collection at Washington will permit the accomplishment of this object. The writer's notes on the Brazilian collections are very full, and are accompanied by many photographs.

Dr. Charles Lütken, Copenhagen, Denmark, has sent a fine collection of European marine annelids, containing 85 species, mostly from Denmark, carefully determined and in good condition. This collection is of special value as a means of making comparisons with North American species, the annelid fauna of both sides of the Atlantic being very similar, and including many identical species.

Dr. Gustav Eisen, Fresno, Cal., has forwarded a large collection of identified earth-worms, from Northern Europe and California.

Mr. Winifred Stearns, of Amherst, Mass., has sent a collection of marine crustaceans, radiates, and worms, from Labrador, made for the National Museum. This collection has been referred to Prof. A. E. Verrill for examination; it contains quite a variety of forms.

The museum of Wesleyan University, Middletown, Conn., has sent a collection of dry and alcoholic marine-invertebrates from Bermuda, collected by Dr. F. V. Hamlin.

Dr. George W. Hawes, U. S. National Museum, has sent a small collection of marine invertebrates, in alcohol, from Bermuda.

Mr. E. G. Blackford, Fulton market, New York City, has sent twenty-five specimens of edible cray-fish (*Cambarus virilis* Hogen) from Milwaukee, Wis. These specimens were selected from market supplies in Fulton market, received from Milwaukee, which city, with Montreal, Canada, furnishes all the cray-fish consumed in New York City during the summer and fall. Also an 18-pound lobster from the coast of Maine. This specimen is now being mounted dry, for the exhibition cases, and will also be sent to the London fishery exposition.

From Mr. C. L. Herrick, Minneapolis, Minn., has been purchased a small but interesting collection of cray-fish, from numerous localities in

Alabama, and representing two or three species. Also several varieties of *Cambarus virilis* from Minnesota.

Prof. D. S. Jordan, Bloomington, Ind., has furnished specimens of squilla and cuttlefish from Venice, Italy; shrimps and crabs, from Mazatlan, Mexico; and shrimps, squids, and Physalia, from Galveston, Tex.

Mr. L. Belding, Stockton, Cal., has sent a small collection of dried specimens of corals and Echinoderms from La Paz, Cal.

Prof. R. E. C. Stearns, Berkeley, Cal., has sent five specimens of *Radicipes pleurocristatus* Stearns, a new genus and species of Penatula, obtained from the coast of Japan, by Mr. W. J. Fisher.

Messrs. McKesson & Robbins, New York City, have sent four specimens of cultivated sheepswool sponges (*Spongia gossypina*), from Key West, Fla., grown from cuttings planted by the agent of Messrs. McKesson & Robbins. These specimens represent the first successful attempt at cultivating the commercial sponges of this country (a result which must have considerable influence upon the future supply of Florida), which are apparently much less abundant now than formerly, from the continuous drain made upon the fishing-grounds during the past ten or fifteen years. The specimens in question exhibit a growth of six months, in a depth of two and one-half feet of water, and the largest specimen has increased to fully six times the size of the cutting from which it was grown. In addition, there is a much larger donation of Florida sponges from the same dealers, containing 53 specimens, and all the varieties and grades known to the trade. The exact locality and depth of water from which each specimen was obtained have been furnished, thereby greatly enhancing the value of the collection. This collection will form the basis of the economic display of sponges in the Museum, and Messrs. McKesson & Robbins have promised to add to it equally complete assortments of all the Bahama and Mediterranean commercial grades. In order to better perfect the collection of American sponges and increase the size and attractiveness of the exhibit, a purchase was made from Messrs. McKesson & Robbins of thirty additional specimens of their finest Florida sheepswool sponges. This entire collection of sponges will be sent to the London fishery exhibition of 1883 as a part of the American exhibit.

From Prof. H. L. Smith, Geneva, N. Y., have been obtained (by purchase) 1,275 microscopic slides of oceanic Foraminifera, selected from the soundings of several of the United States naval surveying expeditions, and of the British exploring steamer "Challenger," mounted by Professor Smith. This collection is of much value, and has been studied and identified only in part. Professor Smith made these preparations with the intention of writing a monograph upon the group, but other labors interfering he was induced to dispose of them to the National Museum at the mere cost of the materials used in mounting them. The

future working up of so complete a series of the Foraminifera, from so many parts of the globe, would reflect much credit upon the Museum.

During this year Mr. William H. Dall has turned over to this department his very extensive and unique collection of Alaskan invertebrates, excepting the mollusks, all of which he had previously retained in his own possession for safe keeping. Beyond the hydroids, which were studied and described by Prof. S. F. Clark, and the annelids, now in the possession of Prof. H. E. Webster, nothing has yet been done toward working up this interesting mass of material.

Fossil Invertebrates.

CHARLES A. WHITE, Curator.

The accessions to this department have been by gift from private persons, and by transfer from other departments of the Government. The personal donations are as follows:

J. W. Archer. One package fossils from Indiana.

Prof. Samuel Aughey. One package of Cretaceous and Laramie fossils from Western Nebraska.

Dr. Robert Battersly. One package Tertiary fossils from Ireland.

Prof. G. C. Broadhead. One package of Permian fossils from Kansas.

Prof. Samuel Calvin. One box Paleozoic fossils.

Ellis Clark, jr. One package fossils from Haxiaco, Mexico.

A. Gattinger. An artificial cast of *Conularia gattingeri* Safford.

Theo. Heilscher. One box Cretaceous fossils from Eagle Point, Tex.

J. L. Parr. One mass fossiliferous Cretaceous limestone from Texas.

H. D. Pride. One box of fossils from the Utica slate formation, New York.

C. F. Rauchfuss, jr. One box of fossils from Illinois.

Rev. J. Havens Richards. One box Tertiary fossils from Maryland.

F. A. Sampson. One package Cretaceous fossils from Texas.

Prof. S. H. Trowbridge. One box fossils.

Prof. Henry A. Ward. One package of fossil crabs from an island in the Gulf of Tonquin.

W. S. Yeates. One package fossils from Cooperstown, N. Y.

Besides these a few small packages of specimens have been sent in by different persons, but they are not of sufficient value to be awarded a place in the Museum.

The following accessions have been received from other departments of the United States Government:

Ninety-eight trays of fossils from the United States Geological Survey.

Four boxes of fossils from Colorado; from the Agricultural Department, being collections made by the Commission for locating experimental artesian wells.

Of the accessions by gift, those from Professor Calvin and Dr. Bat-

tensely, respectively, are most important. All the others are acceptable, and some of them are of considerable importance.

Those which have been received from the United States Geological Survey are of especial interest, as they have served as the basis of certain official reports.

Those which were received from the Artesian Wells Commission contain large additions to the molluscan fauna of the Laramie group, and among them are the types of several new species.

Department of Minerals.

WILLIAM S. YEATES, Acting Curator.

The department has had 368 accessions by gift, a few being valuable; while a large majority were specimens sent in to the department for examination and report, and proved worthless.

Some very good specimens have been obtained by exchange, notably a fine lot of cancrinite and its associated minerals from Litchfield, Me. Two specimens have been purchased during the year; one a very rare and handsome twin-crystal of calcite, the other an immense beryl.

The following are some facts with regard to the most interesting specimens received during the year 1882:

Col. P. W. Norris has contributed a handsome specimen of Egyptian jasper from the Ruby Valley, in Montana.

The twin-crystal of calcite, obtained by purchase, is associated with native copper, to which the crystal is fastened; it is from the Lake Superior copper region; and since the year 1861 it has been in the possession of a gentleman in Washington, from whom it was purchased.

The large crystal of beryl, also obtained by purchase, is from the noted locality, Grafton, N. H. It is 2 feet 10 inches long, and 1 foot 11½ inches in diameter, and it weighs 1,022 pounds. It is a twin-crystal, and its faces are remarkably fine, the angles all being perfect.

From Rev. C. A. Harvey, of Washington, have been obtained by exchange nine handsome crystals of apatite from Renfrew, Canada. These crystals are a valuable addition to our collection of apatite.

Probably one of the most interesting accessions during the year was a lot of specimens from the meteoric fall of May 10, 1879, in Emmet County, Iowa. These were the gift of Mr. Charles P. Birge, of Keokuk, Iowa. One of the specimens shows very distinctly the new magnesium iron silicate, Peckhamite, discovered by Dr. J. Lawrence Smith. The specimen in our possession is the identical one used by Dr. Smith in determining the new mineral.

Dr. F. M. Endlich, the predecessor of the late Dr. Hawes in the management of this department, has contributed quite a number of European minerals to the collection, some of them being very rare specimens.

A specimen of malachite and azurite, one of crystallized cuprite, and one of native copper were secured for the department from Mr. F. H.

Smith, of Washington, by Dr. F. W. Taylor, the chemist of the Museum. The specimens, which are quite handsome, are from the Longfellow mine in Arizona.

Department of Metallurgy.

FREDERICK P. DEWEY, Curator.

In 1882 there were 56 accessions by gift to the department, but none by exchange or purchase. Upon a trip to Colorado, where I was sent by the Smithsonian Institution, I collected 42 specimens of the ores and metallurgical products of that State, which are very interesting and valuable. I have also collected a suite of characteristic specimens of iron ores from Virginia. The only other department of the Government that has contributed to this department is the General Land Office, which has sent 297 specimens by the surveyor-general of Montana, and 161 specimens by the surveyor-general of Arizona. There have been no specimens left upon deposit.

The accessions worthy of special mention in the order of their receipt are two large pieces of ferruginous cerargyrite (chloride of silver) from the Lake Valley, Doña Ana County, New Mexico, presented by Prof. B. Silliman, representing ores from a region which is attracting a great deal of attention on account of the peculiarities of its formation and the richness of its ores, besides which the specimens contain a considerable amount of silver. A suite of 12 specimens of cinnabar (sulphide of mercury) and sulphur, with their associates, from Sulphur Bank, California, presented by Prof. Jos. Leconte, are especially interesting, as representing some of the phenomena connected with the deposition of a metaliferous vein which is forming at the present time, an occurrence which is not going on at any other locality with sufficient rapidity to have been observed as yet. A collection of ores and metallurgical products representing the resources of the Territory of Dakota, presented by the commission seeking the admission of Dakota into the Union as a State, one specimen of gold ore being especially interesting, and valued at \$100. Among the specimens collected by myself in Colorado should be especially mentioned a solid lump of cerargyrite (chloride of silver), from the Robert E. Lee mine, Leadville, Colo., containing \$100 worth of silver; also two specimens of embolite (chloro-bromide of silver), in chert, from the same mine, all presented by the superintendent of the mine, Captain Jackson; and finally a suite of specimens representing the course of the Ziervogel process for the extraction of silver from cupreous ores as practiced in Colorado.

Department of Rocks and Building Stones.

GEORGE P. MERRILL, Acting Curator.

Accessions.—The number of specimens of rocks presented to the department during the year is 117; the number obtained by purchase, 40;

the latter including a valuable collection of Italian marbles, collected by Hon. William T. Rice, United States consul at Leghorn, Italy.

No additions to the collection have been made by persons in the employ of the Smithsonian Institution, but 454 specimens have been received from other departments of the Government, chiefly from special agents in the employ of the Tenth Census.

The accessions of greatest interest during the year have been the collection of building stone collected under the auspices of the Tenth Census, and the marbles from Italy already mentioned. Besides these are six samples of granite from the works of McDonald, Field & Co., Aberdeen, Scotland, a polished slab 35 by 35 by 2½ inches of gray granite from Henry Barker & Son, Quincy, Mass.; ten blocks, each 1 foot square and 2 inches thick, representing the different styles of cutting and polishing, from the Vermont Marble Company, Sutherland Falls, Vt.; and similar blocks of sandstone and granite from the McDermot and Berea Stone Company, Cleveland, Ohio, and H. Barker & Sons, Quincy, Mass., respectively.

Department of Library.

FREDERICK W. TRUE, Librarian.

Accessions in 1882.—The establishment of the library being a comparatively recent event, the scientific world is as yet scarcely aware of its existence. Its nucleus consists of the books presented by the Director of the Museum from his private collection. By far the greater portion of the remainder are deposited by the Smithsonian Institution. For the rest, the library is indebted to our National and State Governments and to a number of scientific men and institutions in various parts of the world.

The distribution of the Museum publications has not directly aided in building up the library to any considerable degree. It has, however, undoubtedly tended to increase the mass of literary matter received by the Smithsonian Institution, which is practically the desired result.

Less than twenty volumes have been purchased with Museum funds during the year; our resources in this direction being insignificant.

Messrs. B. Westermann & Co., prominent importers in New York, have kindly sent to the library from time to time copies of newly imported books for inspection, with a view to purchase. About seventeen volumes have been bought by the Institution for the Museum during the year.

The various bureaus of the National Government, particularly those engaged in scientific research, have shown much liberality. I should especially notice the Geological Survey, which has supplied copies of all its publications as fast as issued.

Mr. G. Brown Goode has permitted to be made a catalogue of his private collection of ichthyological and other works to be kept in the

library. By this liberal arrangement the officers of the Museum are able to consult a considerable number of books not in its library.

One of the most important accessions is the Meek library, consisting of the books collected by the late Professor Meek and purchased from his estate by the Smithsonian Institution. It includes many interleaved copies of important conchological works, filled with manuscript notes and drawings. The Linnæan Society of London has generously given a complete set of its valuable Transactions and Proceedings, and in like manner the Linnæan Society and the Entomological Society of New South Wales. The French Academy has given a partial series of the *Comptes Rendus*. The Imperial Academy of Sciences and the Geological Institute of Vienna have also sent partial sets of their publications. The French Government has presented a copy of the "*Études*" of the *Mission Scientifique au Mexique*. We are indebted to the Bureau of Statistics and Industry of New Jersey for a set of its reports. It is impossible to refer to the contributions of individuals in this place.

Department of Plants.

The Museum has acquired, through the mediation of Prof. Asa Gray, as a gift from the Royal Gardens and Herbarium at Kew, England, the extensive herbarium of Mr. Joad. Concerning this collection Professor Gray reports that "it is very large, apparently representing almost all European, temperature Asiatic, and North African plants, in copious specimens from the best botanists and best collections, which have been distributed in sets—in perfect order—having been wonderfully cared for."

This collection has been thoroughly mounted and relabelled under the supervision of Professor Gray and Mr. Srenno Watson, at the Botanic Gardens, Cambridge, and will soon be available for study in Washington.

The herbarium of the National Museum, which was in early days deposited in New York under the care of Dr. John Torrey, was in 1868 brought to Washington and placed in the custody of the Department of Agriculture, where it has been well cared for by Dr. George Vasey, the botanist of that institution. This herbarium is, as is well known, particularly rich in the plants of North America, including the collections of all the Government exploring expeditions, as well as expensive material gathered by exchange and special exploration under the direction of Dr. Vasey.

Section of Materia Medica.

Dr. James M. Flint, honorary curator of the section of materia medica, reports as follows upon the material under his charge:

"1. The materia medica section of the Museum has been enriched during the year 1882 by the accession of 1,590 specimens of medicines, most of them drugs in their crude state, as received by the manufacturing

chemist and wholesale dealer. Of these 1,188 were the gift of large commercial firms engaged in this branch of business, notably Messrs. W. H. Schieffelin & Co., of New York, Parks Davis & Co., of Detroit Mich., and Wallace Brothers of Statesville, N. C. Four hundred and two specimens, consisting of drugs from various Central and South American countries, which formed a part of the exhibits of those countries at the United States Centennial Exhibition in the year 1876, have been transferred by the Agricultural Department of the Government to this section of the Museum. Some of these it is impossible at present to identify, since in some cases the name has become effaced from the label; in others they bear only the vernacular name without reference to botanical source. There are, however, many among them of much interest, which it would have required considerable time and effort to have obtained otherwise.

“With the exceptions just mentioned the accessions have consisted principally of standard articles of the materia medica, including most of the new remedies to which the attention of the medical profession is at present directed.

“Deserving of special mention is a fine collection of cinchona barks, presented, through Messrs. Schieffelin & Co., by the firm of Howard & Sons, of London, which comprises 35 specimens of carefully identified barks from the cinchona plantations of India, Ceylon, and Java, where the cultivation of the various species of cinchona tree has become an important industry; important not only to those engaged in it, but to mankind in general, as giving the assurance of a regular and unfailing supply of this most valuable of all known remedies. This collection of East Indian barks is supplemented by specimens of the usual commercial barks from South America; by cultivated barks from Mexico, presented by Señor Hugo Finck; and by barks and herbarium specimens of the flowering branches of the officinal species of cinchona, from the Royal Gardens at Calcutta. Objects of interest in this section, also, are varieties of Turkey opium, in the original packages, and a number of rare drugs of the Indian pharmacopœia, obtained by Messrs. Schieffelin & Co., from the museum of the Pharmaceutical Society of London.

“Special effort has been made to obtain illustrated works on medical botany, in order that as complete a series as possible of drawings of the plants furnishing the drugs of commerce might be shown. These books have been obtained by purchase, and are already sufficient to supply good colored plates of the most important medicinal plants of this and other countries. Photography has also been employed in botanical illustration, and samples of its work have been received which prove the applicability of the method as a cheap substitute for hand-drawing.

“2. An alphabetical catalogue of the whole collection has been prepared, with class references, by means of which the specimens already on exhibition may be found, and the proper portion of those in reserve indicated.

“The classification adopted is as follows:

“*Primary divisions.*—1. Animal products; 2. Vegetable products; 3. Products of fermentation and distillation; 4. Inorganic products. The first division follows the usual order of animal classification from highest to lowest. The second division is arranged in the sequence given in Bentham and Hooker’s “*Genera Plantarum.*” The fourth division follows the classification of Roscoe and Schorlemmer in their “*Treatise on Chemistry.*”

“A separate exhibit has been made of a large collection of Chinese medicines, which came into the possession of the Museum after the Centennial Exhibition at Philadelphia in 1876; 630 of these articles were found to be in sufficiently good condition for exhibition, and have been inclosed in the standard jars of the Museum and arranged in the cases in the order given above, except that in the second division the classification has been founded on the part of the plant furnishing the drug, as roots, barks, flowers, seeds, &c. This was necessary on account of the impossibility of determining the botanical sources of many of these drugs. In the light of the valuable researches of Dr. Porter Smith, medical missionary in China, as published in his work on the Chinese materia medica, this collection will be found to possess very great interest.

“The regular series commences with an illustrative exhibit of the forms in which medicines appear in commerce and are prepared for administration by the pharmacist. This terminological collection consists of characteristic sample illustrating the definitions of roots, rhizomes, tubers, and all other forms of crude vegetable drugs; the metals, metallic salts, mineral and vegetable acids, and other chemical products; and the pharmaceutical preparations, both solid and liquid, such as pills, plasters, tinctures, sirups, and the rest.

“Following this are the articles of the materia medica, arranged according to the classification previously given.

“About 500 labels have been prepared, most of which are now in the hands of the printer. The labels are of two kinds: 1st. Generic cards, that may be of any required size, and are intended to give a concise statement of the varieties, sources, modes of collection and preparation, commercial value, and other facts of interest concerning each of the important crude drugs; 2d. Individual or specific labels, limited to a few lines, giving name, source, therapeutic uses and doses. The preparation of these labels is believed to be the most important work in hand in this section, since the information thereon presented must supply to the general visitor whatever of interest can attach to the monotonous rows of bottles which comprise the collection.

“3. Early in the organization of this section, arrangements were made to obtain the latest editions of the pharmacopœias of all nations where such publications could be found. These pharmacopœias have an official character, and contain lists of those substances of the materia medica

whose value as medicinal agents have been established by a large experience, and also those preparations and combinations which, from the frequency or convenience of their use, demand that authoritative titles be given them, and such methods of preparation be established as will insure uniformity of strength and composition in all cases.

“Collectively, then, they include the principal substances used as medicines in civilized countries at the present day. Much of the information regarding these pharmacopœias was received in answer to letters sent out, through the courtesy of the State and Navy Departments, to the United States ministers and consuls-general resident abroad, and to medical officers of the Navy serving on foreign stations. All but one of the pharmacopœias of any considerable importance, so far as can be ascertained, are now in the library of the Museum. Much time and labor have been expended during the past year, and considerable progress made, in the preparation of a universal pharmacopœia, which shall contain a list of all the drugs of all the pharmacopœias, with their full official synonymy, and tables showing the constituents and comparative strength of all the preparations. This work being considered as subordinate to that relating to the arrangement and labeling of the collection, progress in it has been slow.

“4. The collection, in its present state, consists of 3,163 specimens, of which 2,530 are permanently inclosed in standard jars and bottles of the Museum, and 2,150 are arranged in the cases and open to public inspection. Comparatively few duplicates are on hand, consisting chiefly of the small surplus that sometimes remained after filling the exhibition jars. Nearly all the specimens are in excellent condition and are secure from all ordinary causes of deterioration, except such as may come from exposure to light.

“5. For the further development of the materia medica section, arrangements have been completed whereby an herbarium of medicinal plants will soon be obtained. It is proposed to exhibit the more important of these plants, in association with the colored drawings before mentioned, the former to present form and dimensions, the latter color, and details of botanical structure. It is a part of the general plan also to show enlarged drawings representing the minute structure of drugs, wherever structural peculiarities may exist that would aid in the identification of the drug. Promise has been given of a valuable contribution to the collection, to consist of the cinchona alkaloids and other constituents, in their various stages of preparation and combination. It is hoped that some generous and public-spirited manufacturing chemist will undertake the preparation of the corresponding series of the opium products. Mineral waters will also find a suitable place in this section, being popular and often efficient remedies in very general use. The plan proposed is to show each in the quantity of 10 liters, and with it 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 salines

ingested with a given quantity of water, and furnishing a quantitative table, without the use of figures, for comparison. Bottles of the required dimensions are in process of manufacture, and the necessary materials are at hand, so that very soon some of the best-known waters may be exhibited in this way.

“Among the desirable acquisitions in the future, though perhaps the most difficult to obtain, are the so-called ‘active principles’ upon which the therapeutical properties of vegetable drugs chiefly depend. Many of these are known only by name, except to the few chemists who have isolated them, often at the expense of much labor and material. Doubtless they may be added from time to time, when the Museum shall become known as a suitable repository for such treasure.

“The history of medicine ought also to receive attention in this section, and specimens should be sought of the remedies peculiar to the practice of former times; these to be presented with an account of their supposed virtues and modes of use.

“The medical practice of semi-civilized and savage races of men may likewise be illustrated by a collection of the things used by them, in whatever manner, in the treatment of disease. The fine display of Chinese medicines, already referred to, is an important contribution in this direction. Medical superstitions form another branch of the subject, of great interest, and illustrative objects may be found, not only among the unlearned and uncivilized, but also in the most highly civilized communities, and in use by the most intelligent individuals. To bring together objects of the several classes just mentioned, and to collect the information necessary to make them of value, will require much time, and can only be accomplished by awakening the attention and interest of many people, in widely separated districts, who may pick up articles here and there and note isolated facts. In the classification adopted by the Museum, medicine, surgery, pharmacology, and hygiene are classed together. Into the section under consideration, therefore, will naturally fall everything that relates to the treatment and prevention of disease. The instruments used in medical examinations, such as the stethoscope, sphygmograph, and clinical thermometer; surgical instruments, including dental instruments of all kinds, ancient and modern; the appliances used in the treatment of fractures, dislocations, and deformities—all should be presented in this section, and a collection of such instruments and appliances must prove extremely useful as a record of the progress that has been made in the art of medicine and surgery, and suggestive of improvements that may be hoped for in the future. To obtain these objects will involve considerable expense on the part of the Museum, or corresponding generosity on the part of manufacturers and dealers, but they must certainly be classed under the head of *desiderata*.

“The formation of a Museum of Hygiene, to be established in this city, having been undertaken by the Bureau of Medicine and Surgery of the

Navy, it seems unnecessary to make any suggestions for the development in this direction of the *Materia Medica* section of the National Museum."

Section of Building Stones and Rocks.

Mr. George P. Merrill, acting curator of the department of building stones, reports as follows:

"The work of cataloguing has been carried on as rapidly as possible in connection with the other work of the Museum, the specimens being entered upon the Museum registers as soon as possible after their reception; 611 numbers have thus been added to the register during the year, and a card catalogue prepared of about the same number.

"The work upon the reserve series has been almost wholly for the purpose of classifying, arranging, and preparing for exhibition. Several thousand specimens, which have heretofore been packed away in boxes for lack of proper space, have within a short time been unpacked, and will be classified and arranged as rapidly as possible. This work is now in progress, and will yet require some time for completion. In connection with this work some 1,500 thin sections, principally of building-stones, have been prepared for microscopic study. With the death of the curator of the department, Dr. George W. Hawes, this entire branch of the work has fallen upon me, and has been performed to the best of my ability. The work upon the exhibition series has been of the same nature as that upon the reserve, so far as methods of classifying are concerned. Various styles of cases for the exhibition of specimens have been designed and are now in process of preparation; a form of label has also been decided upon, and several hundred prepared, though as yet unprinted. No duplicate specimens have been distributed during the year.

"The state of the collection has been such as to offer but few inducements for work to persons not connected officially with the Museum. As already noted, the building-stone collection of the tenth census is placed in the Museum, and every possible facility has been furnished their special agent for properly working up the material. My own labors have been very largely directed to furnishing what aid I was able in the way of preparing thin sections and submitting them to microscopic examination.

"Owing the delay of work, caused by the sickness and death of the curator of the department, and the limited time I have had it in charge, but little has been published during the year; a single article, 'On a Phosphate Sandstone from Hawthorne, Florida,' from the pen of the late Dr. George W. Hawes, comprising all that has appeared.

"The number of specimens at present in the collection cannot, owing to the limited time it has been under my control and its consequent unassorted condition, be told with exactness; the following figures are, however, very nearly correct.

"The total number constituting the reserve series is 9,075; of these but 7,288 are as yet entered upon the Museum registers, and for lack of cases only about 100 are placed permanently upon exhibition. For reasons already stated the number of duplicates can only be estimated; it will, however, probably not vary far from 1,500, making a total for the whole collection of 10,575 specimens, of which only some 1,100 are as yet entered upon card catalogues.

"Of the 7,288 specimens at present registered, 3,478 belong properly to the collection of building and ornamental stones, and are mostly of sufficient size to be dressed into cubes of four inches and upwards in diameter, 1,322 having already been thus dressed, and only await proper cases to be placed permanently upon exhibition. The remaining 3,810 specimens are mostly hand specimens collected by the United States Geological and various State surveys throughout the country.

"The collection comprises at present 2,500 thin sections of rocks prepared for microscopic study.

"The following is a list of the apparatus belonging to the department:

- "1. One machine for grinding thin sections of rocks.
- "2. One diamond saw for slicing rocks.
- "3. One Bonwill's dental engine for sawing, boring, drilling, or cutting away the matrix from around fossils.
- "4. One set of blow-pipe apparatus.
- "5. One Crouch binocular microscope.
- "6. One Fness's lithological microscope.

"It is eminently desirable that the various specimens constituting the building-stone collection be properly dressed and placed upon exhibition as soon as possible. The collection will then contain upwards of 2,000 specimens of building and ornamental stones, representing all the quarries of importance at present worked in the United States, as well as many foreign ones, and will constitute an invaluable reference series.

APPENDIX D.—LIST OF CONTRIBUTORS TO THE MUSEUM IN 1882.

- Aby, Hon. Thomas Y.* Alcoholic specimen of viviparous fish (*Gambusia patruelis*); from near Vicksburg, Miss.
- Abert, Charles.* Specimen of bird-skin (*Zamelodia ludoviciana*); from District of Columbia.
- Adams, Dr. M. M.* Specimen of fungus found growing at root of radish; from Indiana.
- Adams, Mayhew.* Specimen of boat-chock; from Massachusetts.
- Agassiz, Prof. Alex.* Collection of sponges and crinoids; mainly from the Blake Expedition.

- Ainslee, Hon. George.* Vial containing lock of hair cut from the head of Sir Walter Scott during his last illness.
- Allan, Robert.* Four coopers' drafts of whaling vessels' holds for casks; from Massachusetts.
- Allard, P. A.* Two specimens pyrite and hornblende; from Kansas.
- Allen, F. S.* One butter knife made on shipboard, one pair of bone scrapers, one cleaning knife, two gudgeons, one egger's bomb lance; from New Bedford, Mass. Model of life-raft and windlass, one sword-fish iron; from Connecticut.
- Allen, J. A.* Three fragments of a superior maxillary, and frontal bones; from mound in Texas.
- Allen, William C.* Four specimens of fossils; from Wisconsin.
- Alling, Charles E.* Two microscopic slides of worms; from the canal-feeder at Rochester, N. Y.
- Ames, G. A.* Two samples building stones made by the McKnight process.
- Anderson, J. W.* One twin watermelon; from Texas.
- Anderson, John C.* Specimen of asbestos; from Idaho.
- Anderson, William.* Six eggs of black snake (*Basanium constrictor*); from Maryland.
- Archer, J. W.* Twelve specimens of Indian implements and two specimens of fossils (*Stigmaria ficoides* Brongt.); from Indiana.
- Archer, Thomas C., Edinburgh, Scotland.* Model of Meuszynski apparatus for transporting live fish.
- Ashmead, T. Graham.* Skins of snow-bunting and red-winged black-bird; from New York.
- Asken, L. M. C.* Specimen of insect; from Mississippi.
- Aughey, Prof. Samuel.* Four specimens of Cretaceous and Laramie fossils; from Nebraska.
- Babbs, Arthur V.* Small box of Indian relics, fossils, and shells; from Illinois.
- Baker, George O., & Co.* Specimens of cotton-seed and products; from Alabama.
- Baker, N. G.* Specimen of mound pottery; from Tennessee.
- Baird, Prof. Spencer F.* Specimen of old piano, bought in 1805.
- Baird, Mrs. Prof. S. F.* One white, hand-woven spread, about 100 years old.
- Baird, W. C.* Specimen of head of fish (*Amia calva*); from Chattanooga, Tenn.
- Baldwin, A. S.* Alcoholic specimen of fish (*Erimyzon goodeni*); from Florida.
- Baldwin, C. C.* Two specimens of bird-skins: Java sparrow, Napoleon finch.
- Baldwin, Isaac P.* Specimens of minerals and sand; from Virginia.
- Ball, James N. (deceased), through his daughter, Mrs. Laurie Wilkins, city.* Collection of minerals, rocks, fossils, Indian relics, etc.

- Barney, Colonel.* Leaves and fruit of plant from U. S. of Colombia, said to be a remedy for dropsy.
- Barnum, Bailey & Hutchinson.* Specimens in flesh of ant-eater (*Myrmecophaga jubata*); gnu (*Cataplepa gnu*); baboon (*Cynocephalus babouin*); puma; leopard; ape; black and gray ostrich; hornbill (*Buceros bicornis*); 3 cockatoos (*Cacatua galerita*); toucan (*Rhamphastos cuvieri*); flamingo (*Phœnicopterus*), species, died in captivity at Bridgeport, Conn.
- Barnum, P. T.* Specimen of fabulous bird, and stuffed skin of snake with three heads, made in Japan.
- Barnum, Richardson & Co.* Collective exhibit of ores, iron, car-wheels, etc.
- Bartlett, George.* Specimen of bird-skin (*Ardea herodias*); from District of Columbia.
- Bartlett, I. H., and Sons.* Specimens of lance-bag and iron crotch for whale-boat.
- Barton, D. R., Tool Company.* Collective exhibit of edged tools; from Rochester, N. Y.
- Barton, James.* Specimens of whale-boat fittings; from Massachusetts.
- Batchen, John S. F.* Collections of minerals, fossils, building stones, Indian relics, with specimens from the great fire at Chicago, Ill., October 8, 1871.
- Bateman, T. P.* Specimens Indian relics, four perforators, five spear-heads, one catlinite pipe, one steatite pipe; from Tennessee.
- Bathersby, Robert.* Through Barbara Bathersby, one slide of diatoms; from Toome Bridge. Also small tertiary shells; from Antodes, Ireland.
- Bay State Iron Company, Boston, Mass.* Three specimens flanges, iron, etc.
- Bean, Dr. Tarleton H.* Specimens of fresh fish, tench (*Tinca vulgaris*). Also tank of alcoholic fishes from Susquehanna River at Havre de Grace, Md.: *Clupea sapidissima*, *Clupea æstivalis*, *Carpionides*, *Catostomus* (two species), *Lepomis gibbosus*, *Anguilla rostrata*, *Amiurus catus*, *Belone longirostris*, *Perca americana*, *Roccus americanus*, *Esox reticulatus*, *Roccus saratilis*, *Semotilus bullaris*.
- Bearce, Gideon.* Two specimens of rocks; from Maine.
- Beardsley, Wilson.* Box of oysters-shells; from Long Island, N. Y.
- Beardsley Scythe Company, West Winfield, Conn.* An exhibit of edged tools, scythes, axes, etc.
- Beeber, M., & Co.* Twenty-nine specimens showing method of the manufacture of gloves, from the skin to the finished article.
- Beetle, James.* Specimen of boat-knee, steam-bent, model of fishing boat, frost fish spear, live-car, bluefish squid, model of whale-boat.
- Beetle, Rudolphus.* Dried specimen of frog found in molasses; from Massachusetts.

- Behr, Herr von V.* One bottle alcoholic fishes (*Umbra krameri*); from Germany.
- Belding, L.* A large number of specimens of the skins, nests, and eggs of birds, living and alcoholic specimens of snakes, toads etc., corals, shells, Indian relics, alcoholic fishes, insects, mammal skins, etc.; from southern portion of Lower California.
- Belfield, Dr. R. A.* Old English penny, dated 1619, found on "Stratford," Westmoreland County, Virginia (General Washington's birth-place).
- Bell, James, United States Land Office.* A large collection of living and alcoholic snakes, birds' skins, nests, eggs, and skeletons, Indian relics, plants, and pair slippers made from skins of snakes (*Crotalus adamanteus*, *Ophibolus getulus*).
- Bendire, Capt. Charles, U. S. A.* Forty-six specimens and (twenty-two species) birds' skins; from Washington Territory. One box birds' skins. (Deposited.)
- Benedict, James E.* One rake-dredge for collecting in shallow water.
- Benedict & Burnham Manufacturing Company, Waterbury, Conn.* Collective exhibit of brass, crude and manufactured.
- Benton, Hon. J.* Casts of stone ax and hammer; from Harrison County, Indiana.
- Berry, F. J.* Specimen of *tuckaho*; from Tennessee.
- Bessels, Dr. Emil.* Specimens of dog and cockato in flesh; from Washington, D. C.
- Bibbins, F. L.* Specimen of aluminous hematite.
- Bierman, Louis.* One box of Indian relics; from Illinois.
- Birge, Charles P.* Specimen from large meteorite which fell in Emmet County, Iowa, in 1879.
- Bishop, James N.* Specimens of shells; from Connecticut. Also bottle containing five parasites taken from a common hog.
- Blackford, E. G.* Large collection of native and foreign oysters, lobster weighing 18 pounds, specimens of living and fresh fishes; from Atlantic coast from Maine to Florida. *Salmonidæ*; from west coast and Territories. Living tortoise (*Chelonoides tabulata*); from Venezuela. Living cray-fishes; from Wisconsin.
- Bliss, L. F.* Stone pipe; from Illinois.
- Bloss, Joseph B.* Two sections of sperm-whale jaws scrimshawed on shipboard by sailors.
- Boardman, George A.* Three boxes of birds' skins; from Maine.
- Bogart, James P.* One box of shell oysters; from Connecticut.
- Booker, T. H. (through John B. Wiggins).* One specimen of bird in flesh; from Virginia.
- Bourne, Jonathan.* Specimens of whale-boat fittings; from Massachusetts.
- Boughton, Mrs. S. H. (deceased), through J. P. Newland.* Specimen of agate; from near Manitou Island, Lake Michigan.

- Bourland, Dr. A. M.* One box of Unios; from Arkansas.
- Bowron, Willam M.* Specimen of manganese oxide dendrite; from Virginia.
- Brackett, Col. A. G., U. S. A.* Specimen of humming-bird's nest; from Jefferson Barracks.
- Bradfield, H. L.* Specimen of fossil shark's tooth (*Galeocerdo falcatus*); from Texas.
- Bradford, H.* Twenty vials, with specimens of ore separated by machinery.
- Bradfute, Charles S.* Specimen of gypsum; from Nevada.
- Bradlee & Co. Empire Chxin Works, Philadelphia, Pa.* Specimens of iron cables for hoisting and lowering anchors, with specimen of anchor.
- Bradley, Col. L. P., U. S. A.* Section of fossil tree; from near Fort Winu-gate, N. Mex.
- Bradstreet, E. C.* Specimen of spider (*Galcodes*); from Colorado.
- Brady, E. J.* Fourteen skins of Australian birds. (Purchased.)
- Brandin, Gibbs & Co.* "The imperial plow."
- Bransford, Dr. J. F., U. S. N.* Eight boxes of pottery, clay vessels (large and small), stone images, polished celts, etc.; from department Liberia, eanton of Nieoya, Costa Rica. Also specimen of Honduras turkey (*Melegaris ocellata*); from Guatemala.
- Brewster, William.* Seventeen specimens of birds' skins; from Arizona. Three specimens Virginia Warbler (*Helminthophaga virginiae*).
- Briand, Capt. A., steamer "St. Germain."* Two living albino siremons, bred from a pair of black axolotls; from France.
- Broadhead, G. C.* Package of fossils; from Kansas.
- Broadnax, Benjamin H.* One box of Indian relics; from Louisiana. One alcoholic specimen (*Necturus lateralis*).
- Brown, E. L.* Box of birds' nests and eggs, skin of owl (*Asio wilsonianus*), skin of mole (*Scalops argentatus*); from Wisconsin.
- Brown, John E.* Specimen of arrow-head; from Maryland.
- Brown, James Temple.* Two specimens of coral, thirty-nine specimens of ethnology; from Hudson's Bay. Flukes of porpoise, seven lobster pegs; from Massachusetts.
- Brown, S. C.* Specimen of mineral; from Tennessee.
- Brownlow, W. P.* Two boxes of minerals; from Tennessee.
- Brush-Swan Electric Company.* One No. 5 electric machine, two lamps, one parabolic reflector and case complete, one No. 6 lamp. (Loan.)
- Buell, A. E.* Specimen of vertebra of whale; from North Carolina.
- Bullion, T. J.* Specimen of mineral; from Arkansas.
- Burden, H., & Co.* Collective exhibit of horse and mule shoes, with specimens and models of hoofs.
- Burger, Peter.* Specimen of mat made of fibers; from Japan.
- Burkart, W., Brunn.* Forty specimens of the woods of Europe used in manufactures.
- Burke, Clarence.* Skin of Soldier bird; from Australia.

- Burkhart, H. Z.* Three specimens of ores; from Wood River, Idaho.
- Burnham, David.* Three boat models; from Massachusetts.
- Burnham, A. M.* Two boxes fishing apparatus; from Massachusetts. (Purchased.)
- Burr, Fearing.* Cast of stone pestle; from Massachusetts.
- Burr, Col. R. T., U. S. A.* Living specimen of Gila monster (*Heloderma suspectum*); from Arizona.
- Butler, A. W.* Ten specimens of birds' skins; from the Valley of Mexico. Six skins of worm-eating warblers (*Helmitherus vermivorus*); from Indiana.
- Butler, Cyrus W.* Two alcoholic specimens of water moccasin (*Ancistrodon piscivorus*); from Illinois.
- Butler, Hon. M. C.* Specimen of phosphate rock; from South Carolina. Also silver ore; from New Mexico.
- Buttrick, J. T.* One box of ship's bread; from Massachusetts.
- Byron, Oliver D.* Nickel-plated railroad spike from the track used to transport the car with the late President James A. Garfield, to and from cottage where he died.
- Calcutta Royal Botanic Gardens.* Specimens of *Cinchona* products, barks (three varieties), herbarium specimens, and alkaloids; from India.
- Caldwell & Cowles.* Specimen of beetles (*Dynastes tityus*); from North Carolina.
- Calver, Mrs. Alice E.* Suit of buckskin clothes, trimmed with beads, worn by "Little Raven," chief of the Arapahoes.
- Camacho, Simon.* Skin of boa-constrictor; from Venezuela.
- Cambria Iron Works, Johnstown, Pa.* An exhaustive exhibit of iron and steel manufactured at their works.
- Camden, Hon. J. M.* Specimen of bituminous shale; from West Virginia.
- Capehart, W. R.* Specimens of fossil shark's tooth; from North Carolina.
- Capner, Thomas.* Four eggs of Brahmin hen, laid in two days, April 9 and 10, 1882.
- Carson, T. Burr.* Nine stone implements; from Tennessee.
- Carter, Hon. George W.* Specimen of rock used for paving streets of Caracas, Venezuela; also seed and hull of mahogany tree; from Plaza Bolivia, Caracas.
- Carter, Samuel R.* Four stone relics and thirty-six specimens of minerals; from Maine.
- Cates & Nials.* Specimens of minerals; from Tennessee.
- Carileer, C.* Red River cart of old pattern, harness, and photograph of post-office and house at Pembina, Dak.
- Centennial Commission (Philadelphia, Pa., 1876).* Nine specimens of building stones, also eleven boxes Centennial records and pictures.
- Chadwick, Mr.* Specimen of Greener harpoon; from Edgartown, Mass.
- Chalfant, E. C.* Specimen of mineral; from Indiana.

- Chappel, Frank W. One living specimen of alligator (*Alligator mississippiensis*); from Florida.
- Chase, James H. Specimens of chalcedony; from Magdalena, Mexico.
- Chase, George. Specimens of oil-stones; from Wachita, Ark. Turkey, etc., with samples of oil used in sharpening tools.
- Cheshire, W. W. Rude flint implement; from Indiana.
- Chester, Capt. H. C. Four jars alcoholic fishes; from Noank, Conn.
- Childs, T. A. Six specimens native gold in quartz; from Eagle Shaft, Virginia.
- Church, Joseph, & Co. One bottle sea-water; from Point Judith, R. I.
- Clark, Ellis. Ten specimens fossils; from Mexico.
- Clark, Hon. J. B. Specimens of minerals; from Texas and New Mexico.
- Clark, J. W. B. Four specimens of alcoholic fishes (*Chasmodes boschianus*, *Gobiosoma boscii*); from Massachusetts.
- Clark, Frank N. One bottle alcohol fishes; from Lake Michigan.
- Clark, A. Howard. Specimens of boat-fittings from Massachusetts.
- Clark, E. R. Specimen of arrow-head; from Indiana.
- Clark, Martin. One box of Indian relics; from Ohio.
- Clay, Henry. One specimen of clapper or "Nantucket bell"; from Massachusetts.
- Cleaveland, W. P. Two microscopic slides, with sections of coral; from the Cincinnati group, Ohio.
- Clements, Hon. J. C. Specimen of limestone; from Georgia.
- Cleveland, William B. One specimen birds' eggs (*Ampelis garrulus*); from Michigan.
- Coffin, C. E. Three specimens minerals; from Maryland.
- Coffin, J. W. Specimens of Indian relics, cane made from whalebone on shipboard, and fossils; from Massachusetts.
- Coke, Hon. Richard. Specimen of limonite; from Texas.
- Cole, Luther. Eight specimens of harpoons and lances; from Massachusetts.
- Collins, D. E. Specimen of mackerel (*Scomber Dekayi*); from off Thatcher's Island.
- Collins, Jos. W. Collection of fishing apparatus; from Massachusetts.
- Collins, P. E. Oil paintings of vessels and fishing scenes.
- Collins, W. H. Specimens of wild-pigeon eggs; from Michigan.
- Colorado, State of. Large collection of gold, silver, and lead ores, and building stones (eighteen tons); from Centennial Exhibition, Philadelphia, Pa., 1876.
- Conklin, William G. Specimen of iron pyrites; from Michigan.
- Connell, D. Specimens of Baker harpoon-gun and blackfish-blubber hook. (Purchased.)
- Cook, H. S. One harpoon, four slabs of finback bone. (Purchased.)
- Cook, Jonathan. Specimen of ear-bone of whale.

- Cook, Lieut. L. M., U. S. A.* Skin and skeleton of Rocky Mountain goat; from Montana.
- Cook, N. N.* Pair of duck trousers worn by Mr. Cook when bitten by a shark.
- Cook, Stephen.* Specimens of boat-fittings; from Massachusetts.
- Coolbaugh, Benjamin.* Iron bear-trap and anchor, two anchor stones; from Susquehanna River. Box of stone relics, from Bradford County, Pennsylvania (through John B. Wiggins.)
- Co-operative Dress Association.* Æsthetic dresses of the period 1880-1882.
- Cope, Prof. E. D.* Alcoholic specimen of *Eumeces semilineatus*; from Texas.
- Coplay Cement Company.* Cement, crude and prepared, with illustrations showing its uses.
- Coppel, E. C.* Specimen of steatite pipe; from mound in Florida.
- Corbin, P. & F.* Large collective exhibit of builder's hardware, artistic and ornamental designs in bronze.
- Corey, L. C.* One bottle sample copying ink.
- Cornell, J. & J. B.* Collective exhibit of over forty objects, embracing articles of ornamental and practical iron work employed in the building industry.
- Corson, Dr. Jos. R., U. S. A.* Three living spermophiles (*Spermophilus tereticaudus*); from Fort Yuma, Cal.
- Coues, Dr. Elliott, U. S. A.* Five bills of *Melanetta velvetina*; from Massachusetts.
- Craig, Dr. Thomas C., U. S. N.* Alcoholic invertebrates and birds' skins (*Phacetreria fuliginosus*, *Chionisalpa*, *Priocella tenuirostris*); from South Atlantic.
- Crow Island Club (through Isaac Hineckley).* Eight specimens of swans in flesh, also specimen of 'goose (*Bernicla hutchinsi*); from Currituck Sound, North Carolina.
- Cumming, W. M.* Three alcoholic specimens of fishes (*Gambusia patruelis*), also box of living plants, Venus fly-trap, Venus pitcher, trumpet plants; from North Carolina.
- Cunningham, Capt. A. F.* Alcoholic specimen of snake.
- Cunningham, J. H.* One small box of minerals; from Arkansas.
- Cunningham, Patrick.* Wooden model of the first breech-loading darting-gun; series of exploded lances cut from whales.
- Schooner "Lucille Curtis."* Alcoholic specimen of deadly poisonous snake "Oro-co-co"; from Demerara River, West Indies.
- Dakota Delegation, Centennial Exhibition, Philadelphia, Pa., 1876.* Large collection of minerals and ores; from Dakota.
- Dale, F. C., U. S. Steamer "Palos."* One tank alcoholic fishes, invertebrates, and box of birds' skins; from China.
- Darr, John.* Living specimen of bat (*Altalapha noveboracensis*); from Agricultural Grounds, Washington, D. C.

- Dartmouth College.* Large crystal of beryl (weight 1,000 pounds), piece of red porphyry, and samples of marble.
- Darison, J. L.* Specimen of bird's egg; from New York.
- Davis, C. T.* Specimen of insect; from Missouri.
- Davis, Hon. H. G.* Specimens of minerals, ores, and coke; from West Virginia.
- Davis, J. N.* Specimen of malformed corn-cob (of the shape of the human foot with five toes); from Maryland.
- Davis, W. E., & Son.* Fresh specimen of tarpum (*Megalops atlanticus*) from Wilmington, N. C.
- Dawson, H. M.* Specimen of sulphide of lead; from West Virginia.
- Day, Richard H.* Specimen of coral (*Primnoa reseda*); from Maine.
- De Lisleue Docteur.* Small box of insects; from Europe.
- De Long, J. W.* Specimen of mineral; from Ohio.
- Dennison Manufacturing Company.* Collection of indestructible "game-counters."
- Dennis, Waldo.* Two bones of fore leg of a horse, with supernumerary toe; from Wisconsin.
- Dent, J. P.* Specimen of quartz crystal; from Texas.
- Department of Agriculture, Raleigh, N. C., (through S. G. Worth).* Two sections of trees, with tools and products of the pitch and turpentine industry of North Carolina.
- Derby, Prof. O. A.* Seeds of *Victoria regia*; from Brazil.
- Devoe, F. W., & Co.* One can of luminous paint.
- Dewey, Fred. P.* Specimens of iron and silver ores; from Virginia and Colorado.
- Diamond State Iron Company, Wilmington, Del.* Collective exhibit of iron and steel, railroad rails, etc.
- Dickinson, E.* Three specimens of birds' eggs (*Totanus melanoleucus*); from Manitoba.
- Dill, Jos. T.* Specimen of cotton-plant and two bags of cotton-seed; from South Carolina.
- Dix, Dr. D. W.* Specimens of minerals; from West Virginia.
- Dodge, Col. Richard I., U. S. A.* Piece of flexible sandstone; from North Carolina.
- Doherty, E. P.* Scales of alligator-gar; from Louisiana.
- Donaldson, Thomas.* Box of rocks and sheet-copper.
- Donnelly, Frank L.* Alcoholic specimen of embryo calf (*Bos taurus*, juv.); from Maryland.
- Doron, T. S.* Bottle of alcoholic fishes and three butterflies; from Alabama.
- Dorchester Union Freestone Company.* Collection of building stones and stone model of "Independence bell."
- Douglass, E. A.* Three arrow-heads; from Missouri.
- Douglas, James, jr.* Four stone-mining hammers; from ancient mine in Chili. Also package of Indian relics; from Peru.

- Douglas, John.* Living specimen of siren (*Siren lacertina*), of very large size; from Potomac Flats, Washington, D. C.
- Dow, Capt. John M.* One living Mexican deer (*Cervus mexicanus*); two living white-tufted marmosets (*Edipus titi*); one owl-monkey (*Nyctipithecus rufipes*); from Panama.
- Drake, Mrs. M. E.* Specimen of stone relic; from Mississippi.
- Drew, Benjamin F.* Armor worn by natives of Marshall and Caroline group of islands, South Pacific.
- Driggs, James D.* Three harpoons.
- Drum Edge-Tool Company, West Waterville, Conn.* Collection of edged tools, scythes, axes, etc.
- Dugès, Prof. Alfred.* Collection of mammals, birds, reptiles, fishes, and fossils; from Mexico.
- Duly, A. A.* Two eggs of "Seabright bantam."
- Dunn, Hon. Poindexter.* Two specimens of minerals.
- Dyer, W. Thistleton.* Box of botanical specimens and photographs of calabash carvings; from Royal Gardens, Kew, England.
- Earl, R. Edward.* Drum-fish, bass, blackfish, and whiting gear, used by Saint Augustine, Fla., fishermen; sounder to sake sounds from the throat of sea-trot.
- Ears, Captain.* Barnacle taken from the belly of a humpback whale.
- Eastabrook, Mrs. C. D.* Specimen of tale; from Florida.
- Eastman, Prof. J. R.* Fragment of meteorite which fell in Iowa County, Iowa, on the night of February 12, 1875.
- Eaton, M. L.* Specimens of frogs and eggs; from Iowa.
- Eckloff, T. W.* Two specimens building stones; from California.
- Edwards, Vinal N.* Nine boxes of specimens of alcoholic fishes (*Lophopsetta maculata*, *Phyeis*, *Tautoga onitis*), etc., invertebrates (*Chaetopterus pergamentaceus*, *Loligo pealii*, *Libinia dubia*), miscellaneous crabs, star-fishes, etc., skull of deer and miscellaneous bones, egg of black duck, birds' skins and skeletons (*Mergus serrator*, *Clangula albeola*, *Colymbus septentrionalis*), etc.; from Massachusetts.
- Egbert, Augustus R.* Drawing of Salmonoid fish; from Idaho.
- Eggers, S., sr.* Retchen gun and harpoon, Pierce & Eggers whaling gun. (Purchased.) One frost-fish spear.
- Eisen, Gustav.* One box of mammal skins and alcoholic collection of worms; from California.
- Elliott, Lieutenant, U. S. Marine Corps.* One tank alcoholic specimens; from Greenland.
- Emmerson, W. Otto.* Six specimens of birds' skins; from California.
- Endlich, Dr. F. M.* Collection of sixty-eight specimens of minerals, specimens of charred unshucked corn, taken seven feet below surface in old ruins on San Juan River, New Mexico.
- Evans, R. D.* Specimen of rock; from Virginia.
- Fain, George A. (through Dr. E. Pulmer).* Two stone axes and one large pipe; from Tennessee.

- Fair, H. D. M.* Specimen of perforated stone found near Arlington, two miles north of Newark, N. J.
- Fairbanks & Co.* One large platform scale.
- Farley, Hon. J. T.* Specimen of ores; from California.
- Farrier, I. W.* One barrel of mineral water; from Texas.
- Fearon, R. W.* Specimens of minerals; from Ohio.
- Fencker, G.* Specimens of birds' eggs and ethnologica; from Greenland.
- Fischer, Moritz.* Specimens of stone relics; from Ohio.
- Fish, E. J.* Specimens of minerals; from Georgia and Tennessee.
- Fisher, William J.* Specimens of alcoholic fishes, birds' skins, Indian relics, etc.; from Alaska.
- Fisk, E. C.* Specimen of living land puppy (*Amblystoma punctatum*), and also specimens of bull snakes (*Ptyophis sayi bellona*); from Illinois.
- Fitchett, W. H.* Specimens of minerals; from Texas.
- Fitzpatrick, S.* Specimens of fossil ferns; from New Brunswick.
- Flanagin, H. W.* Specimens of alcoholic reptiles; from New Jersey.
- Fletcher, Dr. Robert.* Specimens of *Orchilla*; from San Diego, Cal.
- Foot, J. Howard.* Large collection of musical instruments.
- Forepaugh, Adam.* Elephant in flesh, "Mungo;" died in menagerie while on exhibition in Washington on April 6 and 8, 1882.
- Fox, W. H.* Specimens of alcoholic lizards, centipedes, etc., also one skin (*Peneva illinoensis*); from Lookout Mountain, Tennessee.
- French, Penrhyn & Co.* Specimen of black marble; from Glen's Falls New York.
- Frost, S. A.* Specimen of Indian flute; from the Indian Territory.
- Fuller, A. N.* Three eggs of coot (*Fulica americana*).
- Gallaher, Miss L. Bernie.* Package of Japanese pamphlets.
- Galvin, C. D.* Specimens of clay and mica; from New York.
- Gamage, A. T.* Specimens of bone and stone implements, also fragments of pottery; from Maine.
- Gamble, Jos. B. (through Hon. William Heilman).* Specimens of ores; from Missouri.
- Gandy, John W.* Specimens of oysters in shells; from Cape May, N. J.
- Gannett, Mrs. E. A.* One whale-ship's log-book.
- Garnier, Dr. J. A.* Specimen of living Massasauga rattlesnake (*Caudisoma tergemina*); from Ontario, Canada.
- Gass, Master Willie.* Specimen of snake (*Ophibolus getulus*); from Maryland.
- Gatchet, A. S.* Specimens of arrow and spear heads; from Kentucky. Also teeth and scales of garfish; from Louisiana.
- Gattinger, A.* Cast of *Conularia gattingeri*; from Tennessee.
- Gere, J. D.* Specimens of Indian relics; from Wisconsin.
- Gering, Frederick.* Specimen of fish (*Menticirrus nebulosus*), caught in a herring-net in Gloucester Harbor.

- Gibbons, William G.* (through *Thomas Donaldson*). Model in gold, silver, and steel of the steamship "William G. Gibbons," built by Pusey & Jones Company, of Wilmington, Del.
- Gibbs, George J.* Specimen of cave deposit; from cave at Breezy Point, on Caicos Island.
- Gilbert, Charles H.* Alcoholic specimens of reptiles, turtles, etc.; from Mazatlan, Mexico.
- Gallbreth, Henry.* Specimens of Indian relics; from Illinois.
- Gillehan, Alonzo* (through *Dr. Timothy E. Wilcox*). Seven small specimens of arrow-heads; from mouth of Willamette River, Oregon.
- Gillis, T. N.* Specimens of mineral and rocks; from Mississippi.
- Gilmer, G. K.* Four specimens of fresh-herring (*Dorosoma cepedianum*); from James River, at Richmond, Va.
- Glasgow Iron Company* (through *J. W. Hoffman & Co., agents*). Specimens of iron used in shipbuilding.
- Godding, Dr. W. W.* Alcoholic specimens of snakes (*Heterodon platyrhinus*, *Ophibolus getulus*, and *Eutænia sirtalis*); from District of Columbia.
- Goode, Mrs. S. F. J.* Specimen of sable muff (American), period 1830-1840; also muff of the later period.
- Gorgas, W. C.* Alcoholic specimens; from Texas.
- Gould, J. Loomis.* Specimen of horn spoon, carved; from Alaska.
- Goward, G.* Specimens of skull, shells, sea-beans, candle-nut, tobacco, stone implements, gum, nuts used as a perfume when powdered, and skins (*Didunculus strigirostris*); from Samoan Islands.
- Gray, William.* Specimen of arrow-point; from Dakota.
- Gray, Prof. Asa.* Seeds of *Nymphaea scutifolia*, *latus*, and *dentata*, from Russia.
- Greely, Lieut. A. W., U. S. A.* One box of birds' skins; from Greenland.
- Greene, Dr. C. A.* Specimens of snails; from Pennsylvania.
- Green, General O. D.* Skeleton of trumpeter swan (*Olor buccinator*).
- Green, William.* Specimens of Indian relics; from Illinois.
- Greenwood Pottery Company.* Cask containing samples of pottery; from their works at Trenton, N. J.
- Greer, S. W.* Specimens of fossils and minerals; from Kentucky.
- Griffith, J. W.* Two specimens of ship timber (steam-bent).
- Grigsby, C. S.* Collection of Indian relics; from Tennessee.
- Groves, H. & J.* Package of botanical specimens; from England.
- Günther, Dr. A.* Specimens of birds' eggs, alcoholic mammals, and batrachians; from England.
- Gurney, J. H.* Specimens of birds' skins; from Europe (principally *Raptors*).
- Gutekunst, F.* Collection of seventy-six cabinet photographs of prominent men of America.
- Haller, W. J.* (through *E. P. Upham*). Specimens of Indian relics; from Huntington, W. Va.

- Haller, Mr.* Specimen of shad (*Clupea sapidissima*); from Puget Sound.
- Hammond, H., & Co.* Series of light and heavy hammers; from Hartford, Conn.
- Hammond, Rev. M.* Specimen of lignite; from Maryland.
- Hampton, Hon. Wade.* Specimens of minerals; from South Carolina.
- Hampton, Cutter & Sons.* Exhibit of kaolin; from New York.
- Haney, William M.* Specimen of rock and fossils; from Maryland.
- Hardy, E. D.* Specimen of cotton plant in bloom; from Georgia.
- Harford, W. G. W.* Two living specimens of land tortoises (*Xerobates Agassizii*); from California.
- Harmon, Henry C.* Section of the vertebra of a whale; from Stafford Cliffs, Md.
- Harper, Houstown R.* Specimens of arrow-heads; from Georgia.
- Harper, Smith.* An exhibit of rakes and hoes.
- Harrington, C. B (through Thomas Donaldson).* Model of yacht; from Maine.
- Harris, D. W.* Specimens of stone relics, fossils, concretions, etc.; from Louisiana.
- Harris, John S.* Collection of minerals and ores; from Montana.
- Harris, William C.* One alcoholic specimen of trout (*Salvelinus fontinalis* juv.).
- Harrison & Kellogg, Troy, N. Y.* Exhibit of malleable iron; full series of products, embracing wrenches.
- Hart, A. Wellington.* Specimens of Indian sash, belt, pouch, and two knife-cases worked in porcupine quills; from Canada.
- Harvey, F. L.* Specimens of living reptiles, and one living snake (*Heterodon*); from Arkansas.
- Haskell, Henry.* Three specimens of bricks used in the walls of the mound-builders at Aztalan, Jefferson County, and one stone implement; from Wisconsin.
- Hassell, William, New York.* Collection of fancy metal nails.
- Hawes, Dr. A. M.* Two saddles (one Indian and one Mexican); from the battle-ground where General Custer fell.
- Hawes, Dr. George W. (deceased).* Alcoholic specimens of marine invertebrates; from Bermuda.
- Hawkins, Capt. H. S., U. S. A.* Specimen of spear-head; from Fort Thornburgh, Utah.
- Hawley, E. H.* Two living specimens of axolotls, and seven stone implements; from France.
- Hawley, Wheeler.* Specimens of oysters in shell; from Connecticut.
- Hay, O. P.* Specimens of alcoholic fishes; from Indiana.
- Hayden, C. S.* Specimens of minerals, snail-shells, etc.; from Maine.
- Hayden, Walter.* Specimens of birds' skins, eggs, and Coleoptera; from Moose Factory, Hudson Bay Territory.
- Hayes, W. I.* Specimens of living salamanders; from North Carolina.

- Haywood, William P.* Specimen of model oyster-rake; from New Jersey.
- Hazard jr., Roland Gibson.* Six specimens of birds' eggs, three albatross, and three penguin; from Falkland Islands.
- Hazard Powder Company.* An exhibit of powder; from Hazardville, Conn.
- Heilscher, Theo. (through C. C. Cussick).* Collection of minerals and rocks; from Texas.
- Hemphill, Henry.* Specimens of land and fresh-water shells; from Minnesota.
- Henshall, J. A.* Specimen of alcoholic fishes; from Florida.
- Hercules Wind-Engine Company.* Model of wind-engine, for raising water.
- Hering, C. J.* Collection of alcoholic specimens of reptiles, shells, and insects; pottery, blue macaw; hammock made from fibers of the Yta plum; and one living *Iguana tuberculata*; three boxes of Coleoptera; dried; from Surinam.
- Herndon, Thomas H.* Specimen of rattlesnake (*Crotalus adamanteus*); from Leesburg, Fla.
- Herran, Thomas.* Eight specimens of pottery and stone relics from Indian graves in United States of Colombia, South America.
- Herrera, Alfonso.* Collection of alcoholic fishes and reptiles; from Mexico.
- Herriek, C.* Specimens of Indian relics and cray-fish; from near Florence, Ala.
- Hersey, J. Clarence.* Three specimens of shrews; from Colorado.
- Hessel, Dr. Rudolph.* Fresh specimen of lizard (*Laerta viridis*); from Germany.
- Heyman, S.* Box of rocks; from Tennessee.
- Historical and Scientific Society, Winnipeg.* Tank of alcoholic fishes; from Manitoba.
- Hobart, Aaron K.* Model of herring smoking and packing house; from Maine. (Purchased.)
- Hodge, E. B.* Specimen of brook trout (*Salvelinus fontinalis*); from New Hampshire.
- Ho'abird, S. B.* Pieces of iron taken from the stern bearings of U. S. S. "Ordnance."
- Holcomb, C. W.* Package of ferruginous clay.
- Holt, Hiram, & Co.* Series of tools, corn-cutters, etc.
- Hooper, C. W.* Specimens of clay and sandstone; from Alabama.
- Horan, Henry.* Salted specimen of fish (*Selene argentea*).
- Houck, Hon. L. C.* Specimen of galena; from Tennessee.
- Howe, Rev. S. S.* Specimens of Indian relics; from Iowa.
- Howell, D. Y.* Six bottles of embryonic fishes (*Stizostedium vitreum*); from Lake Erie.
- Hubbard, George A.* Transverse section of cherry tree $1\frac{1}{2}$ by 10 inches, showing rate of growth.

- Hubbs, A.* Can of alcoholic fish (*Enneacanthus* sp.); from Missouri.
- Hudson, George A.* Eight specimens of shad (*Clupea sapidissima*); from Cedar Keys, Fla.
- Hudson, William H.* Twelve botanical specimens and two specimens of lizard (*Crotaphytus collaris*); from Texas.
- Hudson, William H.* Specimen of gypsum (sulphate of lime); from Colorado.
- Hughes, F. M.* Box of Indian and mound relics; from Ohio.
- Humbert, Dr. Fred.* Small box of insects; from Illinois.
- Hungerford, Dr.* One box of shells; from China.
- Hunter, B. W.* Specimen of iron carbonate; from Maryland. Also lock from door of the State-house at Richmond, Va. (Used from 1861-'65.)
- Hunter, Thomas G.* Specimen of mineral; from California.
- Hussey, Wells & Co.* A large exhibit of manufactured steel, bar and shape.
- Hutchins, J. H.* Section of vine showing asserted hybrid growth of the grapevine with the pecan tree; from Texas.
- Hyams, C. W.* One box of shells; from South Carolina.
- Inman, Samuel W.* (treasurer International Cotton Exposition. Two large boxes of foreign cottons exhibited at the Atlanta Exposition, 1881.
- Iron Clad Paint Company, Cleveland, Ohio.* An exhibit of crude, lump, and manufactured paint.
- Irving, Thomas J.* Four specimens of lobsters (*Homarus americanus*) of a very young stage; from Massachusetts.
- Ivanhoe Paper Company.* An exhibit of paper and its manufacture.
- Jackson, Charles A.* Building model, scale $\frac{1}{2}$ inch to the foot, of menhaden carryaway boat; from Long Island, N. Y.
- Jackson, Capt. John D.* Specimen of chloride of silver ore, weight ten pounds, value \$100. One specimen of jasper; chlorobromide of silver, two specimens.
- Jamaica Institute, Public Museum of* (through James John Bowery). Alcoholic collection of fishes (one hundred and eighty-three specimens), forty species; from Jamaica.
- Johns, H. W.* Collection illustrating the uses of asbestos, with various samples.
- Johnson, S. M.* Four fresh lobsters from the coast of Maine, said to be $1\frac{1}{2}$ years old.
- Johnston, Walter.* Skin of duck (*Dendrocygna fulva*); from California.
- Jones, Dr. Edward S.* Living specimen of striated marmoset (*Jacchus vulgaris*).
- Jones, Dr. William H., U. S. N.* Three boxes of birds' skins, minerals, rocks, shells, etc., also one tank alcoholic fishes and invertebrates; from Alaska.
- Jones, James F.* Specimens of cotton seed, plant, and blooms; from Georgia.
- Jouett, Mrs. J. E.* Specimens of fossil bones and teeth; from bed of

- Beaufort River. Also alcoholic squid (*Loligo* sp.); from off Beaufort, S. C.
- Jordan, Prof. D. S. Alcoholic invertebrates; from Italy and Mexico. Six tanks alcoholic fishes, invertebrates, and reptiles; from Mexico and Texas.
- Jouy, P. L. Five boxes of natural history specimens (consisting in part of one hundred and thirteen birds' skins and one tank alcoholic fishes); from Japan.
- Julien, Dr. Alexis A. Dried skin of iguana (*Iguana tuberculata*); from Gulf of Mexico.
- Kane, D. Specimen of limonite; from New York.
- Kane, Dr. John J., U. S. A. Specimen of ore for report.
- Karr, W. W. Specimen of caterpillar (*Eacles imperialis*); from Washington, D. C.
- Keith, M. C. Large collection of clay vessels, and fragments of same; statues, stone pestles, rubbing stones, metates, and fragments; from Costa Rica.
- Kelleher, Daniel. Large Brand lance, hand-lance bomb Kelleher patent, Kentworthy, C. J. Silver button; taken from mound in Southern Florida.
- Kerr, W. C. Twenty crates of building stones; from North Carolina. (Purchased.)
- Kew, England, Royal Gardens. Seeds of *Cinchona ledgerina*.
- Kidwell, L. F. Three specimens of minerals; from Texas.
- Kellogg, Dr. D. S. One box of arrow-heads and fragments of pottery; from New York.
- Kimball, W. S., & Co. Collective exhibit of tobacco, fine cut, cigarettes, etc.
- King, Samuel L. Specimens of limestone and dolomite; from Tennessee.
- King, J. W. Jaw, with teeth, of fresh-water drum (*Haploidonotus grunniens*).
- Kite, W. A. One box of Indian relics; from Tennessee.
- Kite, Dr. J. Alban. One box alcoholic eggs of shad (*Clupea sapidissima*); from Quantico, Va.
- Knickerbocker Ice Company, Philadelphia, Pa. Wagon and tools used in cutting and handling ice.
- Knorr, Rudolph. Specimen of young whippoorwill; from Washington, D. C.
- Knowles, Thomas, & Co. Sixteen specimens of whaling apparatus. (Present.) One whaling-gun, one walrus tusk.
- Knowles, George. Specimen of ear-bone of finback whale; banjo made by negro whaleman on shipboard.
- Kobbe, Maj. William A., U. S. A. Two specimens of birds' eggs (*Cardinalis virginiana*, *Molothrus ater*); from Alabama.
- Kobelt, Dr. W. Forty-five species of new and rare land shells; from Europe.

- Krider, John.* Skin of white owl.
- Kumblauun, Alex.* Complete set of steel files; from Philadelphia.
- Kummerfeld, J. F.* Specimen of arrow-head; from Iowa.
- Ladd, H. T.* Fragments of Indian pottery; from Alabama.
- Lancroft, C. E. and H. S.* One box of salts of nickel.
- Langdon, S. J.* Small piece of Indian pottery; from the lava beds, Little Wood River, Idaho.
- Larco, A.* Box of alcoholic fishes (*Sebastes umbrosus*, *S. rubricinctus*, *Citharichthys*, *Liocottus hirundo*, *Annarhichthys ocellatus*, *Paralichthys*, *Lirolepis*), etc.; from California.
- Lawrence & Co.* Eighteen specimens of whaling apparatus; from Massachusetts.
- Lawrence, George N.* Two boxes of birds' skins, eggs, and mounted specimens.
- Lawson, Capt. Charles, Schooner Herman Babson.* Specimen of fish-hook cut from mouth of a halibut on coast of Greenland, summer of 1882, similar to those used by fishermen on coast of Northern Europe.
- Lea, Dr. Isaac.* Fifty-three boxes of shells, one box of minerals, one box marine invertebrates; from Chester County, Pennsylvania.
- Lea, J. S.* One specimen of mineral; from New Mexico.
- Le Baron, J. Francis.* Three specimens of shells; from mound in Florida.
- Le Conte, Jos.* Eleven specimens of minerals; from California.
- Lee, W. F.* Twenty-three specimens of agates; samples of natural, colored, and white cottons; four sketches of ruins; also one box (two specimens) of pottery, stone carvings, and implements.
- Leonard & Ellis.* Collection of oils and vaseline.
- Lewis, William.* Two harpoon-guns.
- Lewis, F. L.* One stone relic and fossil mollusk; from West Virginia.
- Lewis, James F.* One box of living rattlesnakes and larva of green worm (*Cithironia regalis*); from West Virginia.
- Lindsley, Dr. J. M.* Four specimens of Indian pottery; from Mississippi.
- Linnean Society (through William Macleay, Sydney, Australia).* One skeleton of dugong, forty-three birds' skins, and one keg of alcoholic fishes (two hundred and seven specimens); from Australia.
- Lipsey, W. B.* Specimen of Japanese persimmon raised at Archer, Florida.
- Little Rock and Fort Smith Railroad Company.* Collection of rocks and ores; from Arkansas.
- Logan, Hon. John A.* Three specimens of minerals from Illinois.
- Lord, H. & G. W.* Ninety-five samples of white, tanned, and tarred netting.
- Lothrop, L. D.* A collection of fishing-tackle used by the Gloucester fishermen on Grand Banks.
- Lougheed, S. D.* Specimens of shale; from Washington Territory.

- Love, William B.* Nine specimens of gold quartz; from Culpeper County, Virginia.
- Ludworth, George B.* Two alcoholic specimens of snakes (*Tropidoclonium kirtlandii*); from Michigan.
- Lugger, Otto.* Specimen of bird's nest (*Opyselus cayennensis*); from Demerara, West Indies.
- Lütken, Dr. Chr.* One alcoholic specimen of *Trachypterus arcticus*; from Iceland. Also collection of European annelids, comprising eighty-five specimens in alcohol.
- Luttrell, Chester.* One box of stone relics; from Alabama.
- Lyford, Dr. E. H.* Specimen of sea-mouse (*Aphrodita aculeata*); taken from lobster pot at Vinalhaven, Me.
- Mackey & Pindar.* Eight specimens of whaling apparatus; from Massachusetts.
- MacRae, Donald.* Specimens of siren and *Necturus punctatus*; from North Carolina.
- Macy, Joseph B.* Seven specimens of whaling apparatus used by Nantucket whalers.
- Macy, Zaccheus.* One whale-ship cooper's set. (Old.)
- Mauderville, W.* Specimen of sulphur oxide of manganese; from Pennsylvania.
- Mann, B. Pickman.* Living specimen of horned frog (*Phrynosoma cornutum*).
- Mapes, John C.* Six specimens of minerals; from New York.
- Marley, To Cee.* Three specimens of stone implements; from Tennessee.
- Marsh, Prof. O. C.* Cast of *Pterodactyle*, with wing membranes attached.
- Martin & Co.* Collective exhibit of lampblack and its manufacture.
- Martin, Capt. S. I.* Collection of eod and haddock trawls, lobster pots, herring-nets, etc. (Purchased.)
- Mason & Hamlin, New York.* Cabinet organ complete, with models showing interior workings of pianos and organs.
- Mason, H. B.* Specimen of gun-harpoon, and harpoon with explosive head.
- Mason, Prof. Otis T.* Fragments of pottery and piece of white jasper; from Cahokia mound, Illinois.
- Mather, Fred.* One bottle of living worms; from New York.
- Maw & Co., England.* Large and collective exhibit of ornamental tiles; from Centennial Exhibition at Philadelphia, Pa., 1876.
- Maxey, Hon. S. B.* Specimens of ores and minerals and mineral water; from Texas.
- Maxwell, John.* Specimen of building stone; from Pennsylvania.
- Maydole, D., & Co.* Full series of light and nickel-plated hammers.
- McAdams, Hon. William.* One tank alcoholic fishes; from Illinois.
- McBath, Edgar.* Mounted specimen of squirrel (*Sciurus carolineensis*).
- McCrary, J. A.* Package of hemp fiber; from Florida.

- McCullough, John.* Twenty-four specimens of whale-boat fittings.
- McDermott & Co.* Eight boxes of building stones; from Ohio.
- McDonald, Field & Co., Aberdeen, Scotland.* Six specimens of building stones; from Scotland.
- McDonald, E. G.* Three specimens of pyrite in slate; from West Virginia.
- McDonald, F. S.* One specimen of limonite and two specimens of pyrite; from Virginia.
- McDonald, Col. M., U. S. F. C.* Alcoholic specimens of shad (*Clupea sapidissima*), carp (*Cyprinus carpio*); from Potomac River. *Tylosurus longirostris*, *Achirus lineatus* *Lepomis gibbosus*, *Carassius auratus*, *Fundulus diaphanus*, also shells; from Cherrystone, Va. Specimens of fishes taken from top of McDonald fishway, Fredericksburg, Va. (*Roccus lineatus*, *Catostomus commersonii*, *Amiurus catus*, and *Lepomis pallidus*).
- McDougal, A. G.* Specimen of Indian pottery; from Arkansas.
- McDuffin, James B.* Specimen of glass snake (*Opheosaurus ventralis*); from Georgia.
- McKay, C. L.* Eighteen boxes of general natural history specimens and ethnologica; from Alaska.
- McKesson & Robbins, New York.* Three boxes of commercial sponges; from Florida.
- McKinney, George H.* Specimen of beetle; from Kentucky.
- McLain, G. M.* Builder's model of fishing schooner, $\frac{1}{2}$ inch to the foot; from Massachusetts.
- McLean, John J.* Four boxes of ethnologica, minerals, one bale snowshoes, specimens of basket-ware, etc.; from Alaska.
- McLean, J. P.* One box of Indian relics; from Ohio.
- McMannen, Dr. C. T.* One bird-skin (*Ampelis cedrorum*); from Florida.
- McNeil & Archer.* Large exhibit of iron, gas, and water pipe.
- Meehan, Thomas.* Two hundred and sixty bottles of seeds of plants and flowers. (Purchased.)
- Meigs, M. C.* One skull of Indian, skull of antelope (*Antilocapra americana*), two skulls of beaver (*Castor fiber*); from Iowa. Specimen of building stone; from Minnesota. Cinnabar; from Fort McKavett, Texas.
- Meinung, Alex. C.* One specimen of stone, natural formation; from North Carolina.
- Melzer, James P.* Small collection of insects taken from birds; from New Hampshire.
- Mercer, R. W.* Seven boxes of minerals, Indian relics; from Ohio, Tennessee, and Georgia.
- Merchant, C. B.* Three Brand's bomb-lances.
- Merchant, George.* Six boxes fishing apparatus.
- Merriam, Dr. C. Hart.* Box of birds' skins and fresh specimen of salmon (*Salmo salar* var. *sebago*); from New York.

- Merrill, George P. Eleven specimens of rocks; from Maine. Also one "planchette."
- Merrill, W. A. Living specimen soft-shell turtle (*Aspidonectes spinifer*); from Iowa.
- Metcalf, Charles. One box of quail eggs.
- Mikell, J. Jenkins. Specimen of cotton plant and three bags of cotton seed; from Edisto Island, South Carolina.
- Miklin, Dr. J. B. Three specimens of Indian relics; from Tennessee.
- Miles Brothers & Co. Collective exhibit of bristles, feathers, camel, and badger hairs used in the manufacture of brushes.
- Miller, J. H. Small package of flowers; from Texas.
- Mills, Clark. Metallic cast of section of the throat of 60-foot whale.
- Mills, Henry. Two boxes fresh-water sponges; from Niagara River.
- Minor, F. O. Specimen of insect; from Louisiana.
- Minton, Hollis & Co., Stoke-upon-Trent, England (through Sharpless & Watts, Philadelphia, Pa.). An exhaustive collection of useful and ornamental tiles.
- Mitchell, Capt. J. C. One tank alcoholic fishes, containing twenty-seven species; from southern coast of United States.
- Mitchell, Dr. W. Four specimens of stone relics; from Tennessee.
- Money, Hon. H. D. Specimen of pyrite; from Mississippi.
- Moore, George H. H. Specimen of fresh-water drum (*Haploidonotus grunniens*); from Colorado River, Texas.
- Morehead & Co. Sheet of rolled iron, 15 by 7 feet, $\frac{3}{8}$ inch thick.
- Morgan Hon. J. T. Box of clay and sand; from Missouri.
- Moulton, J. H. Head and tusks of walrus (*Rosmarus*); two skeletons of fur seal (*Callorhinus ursinus*); from Alaska.
- Mücke, Dr. Franz. Specimen of arrow-head; from near Sandford Lake, Florida.
- Myrick, A. M. Wooden mortar and pestle, formerly carried on whale-ship.
- Neal, Dr. James C. Two specimens of black snake (*Bascanium constrictor*); from Florida.
- Nedham, G. F. Specimen of bird-skin (*Cyanocitta cristata*), living king snake (*Ophibolus getulus*); from Maryland.
- Nehring, Prof. A. L. Small box of fossil mammals (*Myodes torquatus*, *Lagomys hyperboreus*); from Germany.
- Nelson, E. W. Specimen of deer antlers; from Alaska.
- Nelson, Wolfred. Alcoholic specimen of coral snake; from Panama.
- Nery, E. R. Skin of eel (*Anguilla rostrata*); from Delaware.
- New Bedford Cordage Company. Seven samples of cordage.
- Newcomb, R. L., U. S. N. Two small packages mosses, seven specimens birds' skins (*Rhodostethia rosea*, *Budytes flavus*, *Plectrophanes nivalis*, *Centrophanes lapponicus*, *Phalaropus fulicarius*); from Henrietta Island, Arctic Ocean.
- Newton & Co. Exhibit of fire-clay, and articles made from same.

- Nichols, J. R.* Specimen of "hell-fire rock" (dolomite); from Utah.
- Nickerson, Mrs. M. J.* Scrimshawed porpoise jaw; piece of right-whale's bonnet, with barnacles attached.
- Nissley, Jacob R.* Box of Indian relics; from Ohio.
- Norris, B. M.* Ceremonial weapon; from Ohio.
- Norris, Col. P. W.* Specimen of jasper; from Ruby Valley, Montana.
- Norton, John W.* One whale-ship log-book.
- Nutting C. C.* Three boxes of birds' skins, and stone images and pottery; from Central America. Specimen of sparrow (*Passer domesticus*.)
- Nye, jr., Willard.* Box of Indian relics; from Martha's Vineyard. One bottle alcoholic specimens of eels (*Anguilla rostrata*); from New Bedford, Mass.
- Nye, W. H.* Exhibit of watch and machine oils; from Massachusetts.
- Oregon, State of.* Specimens of stone, iron, and coal; from Centennial Exhibition, Philadelphia, Pa., 1876.
- Oriental Powder Company.* An exhibit showing powder and the materials used in its manufacture.
- Orton, Prof. Edward.* Specimen of limestone; from Kelly's Island, Ohio.
- Osborne, Charles B.* Bow and arrow; from South Sea.
- Osborne, James C.* Specimen of whale harpoon.
- Osborn, Philip (through Mary Fielder).* One box of fossils from Ohio. "Ruler made of piece of plank, and horseshoe made from bolt of the brig 'Niagara,' that caused the whole British fleet to surrender to Commodore Perry, September 10, 1813."
- Ozier, J. D.* Specimens of cotton plant, and samples of "ozier silk cotton"; from Mississippi.
- Ozier, T. L.* Two specimens of kaolin; from Pennsylvania.
- Packer, Hon. R. Asa (through John B. Wiggins).* Specimen of unfinished iron implement; from Pennsylvania.
- Paddock, Thomas B.* Cooper's marking iron, used in 1775.
- Page, E. W., & Sons.* Exhibit of oars, sweeps, and sculls.
- Palmer, Alex. S.* Specimen of fresh fish (*Selene argentea*); from Connecticut.
- Palmer, Dr. Edward.* Specimens of materia medica, ethnology, tobacco (leaf and twist); from Tennessee. Plants; from Indiana. Ladle or spoon made of hickory wood; from Illinois.
- Palmer, J. S.* Specimens of marble; from Virginia.
- Palmer, J. W.* Specimen of a very large oyster; from Maryland.
- Palmer, William.* Specimen of Bewick's wren (*Thryomanes bewicki*), in flesh, from Virginia. Also fresh specimen of *Carpoides*; from Potomac River.
- Park, Davis, & Co.* Specimens of materia medica.
- Parkhurst, A. L.* Specimens of birds; from California.
- Parr, J. L.* Specimen of white limestone fossils; from Rio Grande

- River, Pecos County, Texas, 296 feet above the level of the present river.
- Parsons, Capt. W. B.* (through *A. Howard Clark*). Specimens of old crockery, an old stone killick, in use by fishermen for more than fifty years, and one clam-chopper, used for chopping mackerel bait; from Massachusetts.
- Patterson, Samuel*. Specimens of stones; from Utah.
- Pauli, J. A.* Samples of bark; from United States of Colombia, South America.
- Peakes, Thomas M.* One whale-ship log-book.
- Peck & Synder*. Collection of base-ball supplies, cricket, archery, and skates; from New York.
- Pierce, Milton P.* Specimen of stag-beetle; from New Jersey.
- Pelican & Davis*. Specimen of silver ore, 2½ tons weight; from Colorado.
- Pencoyd Iron Works*. Six frames, eight bars; and one bundle of angle-iron, used in building.
- Pennsylvania Tack Works*. Large exhibit illustrating four hundred varieties of brass and copper tacks, also specimens of white metal, and iron and steel from which they are made.
- Phelps, Albert J.* Specimens of pottery, Indian and bone implements; from Maine.
- Philbrick, E. E.* Specimen of magnesium iron silicate; from Florida.
- Phillips, Barnett*. Pack of Chinese playing cards, and Chinese dagger-fan; from China.
- Phillips, Henry*. Specimen of antimony oxide, senarmontite; from East Canada.
- Phillips, William, & Son*. Whaling-gun, muzzle-loader, brass stock.
- Pierce, Eben*. Five patterns of whaling-guns. (Purchased.)
- Piper, John D.* Specimens of lobster-pots, and one dip-net; from Maine.
- Piper, S. E.* Specimen of porphyritic granite rock; from Maine.
- Piper, Miss Tillie*. Alcoholic specimen of bat; from Smithsonian building.
- Polk, W. L.* Alcoholic specimen of fish (young *Carpiodes*); from Mississippi.
- Porter, E. H.* Specimens of Indian relics; from Kentucky.
- Powell, George*. Specimens of fossil ferns; from Pennsylvania.
- Powell, Robert H.* Exhibit of coal, etc.; from Pennsylvania.
- Pratt, Capt. R. H.* Indian saddle and trappings.
- Price, E. B.* Specimens of ores; from New Mexico.
- Pride, H. A.* Specimens from the Utica slate found in New York.
- Prince Manufacturing Company*. Exhibit of metallic and fire-proof paint.
- Prindle, Edwin*. Two alcoholic specimens of reptiles (*Plethodon cinereus*, *P. erythronotus*); from Potomac River, north of Georgetown.
- Proctor, J. M.* Specimen of minerals; from Tennessee.
- Pumpelly, R.* Seven boxes of minerals (census collection of iron ores).

- Ramsay, Capt. T. M., U. S. N.* Skin of fox; from Spitzbergen. Specimens of birds and nine packages and ten bottles of dredgings; from Greenland.
- Ranger, Gustave.* Specimens of rock salt; from Petite Anse Island, Louisiana.
- Rathbun, Mrs. P.* Game of "Planchette."
- Rathbun, Richard.* Photographs of fishes (*Sudis gigas*, *Malthe*, *Epinephelus*, and *Trisotropis*).
- Rau, Dr. Charles.* Specimen of turquoise; from turquoise mine, New Mexico; and modern pipe made by the Catawba Indians of North Carolina.
- Rauchfuss, jr., C. F.* Specimens of fossil shells, etc.; from Illinois.
- Reed, George, paymaster, U. S. N. (through Col. M. McDonald).* Specimens of black bass (*Micropterus dolomieu* and *M. salmoides*); from Potomac River, near Great Falls.
- Reedman, Capt. F. M. (through E. C. Blackford).* Specimen of bluefish hooks, with piano-wire gaugings, used by New York and Southern New England fishermen.
- Remington, E., & Sons, New York.* Perfected type-writer, with head and case.
- Rhees, William J.* Specimens of bats; from Washington, D. C. Living specimen of lizard (*Sceloporus undulatus*); from Mount Pleasant, D. C.
- Rhode Island Horseshoe Company.* Exhibit of horseshoes; from Rhode Island.
- Rice, Clinton.* Specimen of concretion; from New Mexico.
- Rice, William T.* Large collection of marble and granite building stones; from Italy. (Purchased.)
- Richmond, Charles.* Specimens of common birds' eggs; from Washington, D. C.
- Richards, Rev. J. Havens.* Specimen of fossil shells; from Maryland.
- Rich, James W.* Specimens of fresh fish (*Lopholatilus chamaeleonticeps*).
- Ridgway, Robert.* Specimens of skin and nest of *Dendroica auduboni*; from California. Skins of birds; from Lower California. Specimen of *Passer domesticus*, nest and eggs of *Cardinalis virginiana*, alcoholic specimens of natural history, eggs of snapping tortoise (*Chelydra serpentina*), skin of martin and mole (*Putorius vison*, *Scalops argentatus*), living snake (*Ophibolus doliatus*), and salamanders (*Amblystoma opacum*, *Amblystoma microstomum*, and *Diemyctylus miniatus viridescens*), and one arrow-head; from Indiana.
- Rio de Janeiro National Museum.* Three boxes corals; from Brazil.
- Rivett, Carnac I. II. (through Dr. E. R. Meyer).* Two celts, two terracotta spindles and bat, and three Buddhist coins; from India.
- Roach, C.* Sample of earth paint (iron ochre); from Ohio.
- Robeson, Hon. George M.* Specimen of "snowy owl."
- Roberts, John N.* Specimen of Indian relics; from Louisiana.

- Roberts, William.* Specimen of harpoon-gun.
- Robinson, Goldsborough.* Samples of wood alcohol and pure spirits; from Kentucky.
- Robinson, G. S.* Specimen of ear-bone of sperm-whale calf.
- Robinson, General James S.* Specimens of copper and stone implements; from a mound in Ohio.
- Rockwell, Col. A. F.* Specimen, in flesh, of Baltimore oriole.
- Rockel, William, and M. Tandy.* Specimens of Indian relics; from Illinois.
- Rogan, James W.* Specimen of insect; from Tennessee.
- Rogers, Crueger & Munford.* Specimen of asbestos; from Virginia.
- Rogers, D. M. (through Hon. J. C. Clements).* Specimen of galena; from Tennessee.
- Rogers, John, New York.* Collection of statuary.
- Roosevelt, Theodore.* Collection of mammals, reptiles, and birds' skins.
- Roquet, Father (through Maj. J. W. Powell).* Bones from alligator-gar (*Litholepis spatula*); from Louisiana.
- Rosecrans, General W. S.* Specimens of rocks and ores; from Oregon and San José mine, Copala Sinaloa.
- Rowell, James T. (through Lieut. U. D. Sigsbee, U. S. N.).* Specimen of locust which came on board U. S. S. "Lightning," in latitude 12° north, longitude 46° west.
- Rowland, W. and Henry.* Exhibit of steel used in the construction of carriage and car springs.
- Ruby, Charles.* Skin and skull of puma, alcoholic specimens of reptiles, and collection of minerals; from Wyoming.
- Runyan, J. C.* Specimen of minerals and coal; from Washington Territory.
- Rusby, Henry H.* Specimens of prehistoric mining tools; and dried plants; from Arizona.
- Russell, Mr.* Ball from alkaline lagoon at the south end of Pyramid Lake, Nevada.
- Russell, Birdsale & Ward.* Series of objects made of iron used in the manufacture of carriages.
- Russell, D. E.* Specimens of minerals; from Texas.
- Ryder, John A.* Alcoholic specimens of fishes and eggs (*Clupea vernalis*, *Petromyzon marinus*, *Clupea sapidissima*, *Roccus saxatilis*, and *Perca americana*).
- Sage, Dean.* Specimen of lamprey eel (*Petromyzon marinus*, juv.), taken from salmon weighing 1½ pounds.
- Sampson, F. A.* Small box of fossils; from Texas.
- Sanborn, Captain.* Small specimen of asbestos cloth.
- Sandusky Tool Company.* Collection of tools used by hand in the wood-working industry.
- Sanford, Mrs. F. C.* Specimen of powder-horn used in 1757.
- Sankey, R. A.* Specimen of prylolusite; from Colorado.

- Sawyer, John A. Specimens of whaling apparatus. (Purchased.)
- Sayres, J. D. Two specimens of mineral; from Texas.
- Schanno, Joseph. Two leaves with larvæ of insects; from Washington Territory.
- Schieffelin, W. H., & Co., New York. Large and collective exhibit of American and foreign drugs.
- Schenck, Dr. J. Two living tortoises (*Chrysemys marginata*); from Illinois.
- Schönborn, Henry F. Egg containing embryo of *Strix nebulosa*, and double duck's egg; from Washington, D. C.
- Schuermann, C. W. Living specimen of snake (*Coluber obsoletus*) and specimen of duck (*Cairina moschata*); from Virginia.
- Sears, Henry H. Specimen of *Aphrodita aculeata*; from Massachusetts.
- Seidell, C. Two specimens of building stones, from Washington Territory.
- Seiple, Dr. W. G. M. Specimen of limonite or brown hematite; from Pennsylvania.
- Sennet, George. B. Three specimens of possum (*Didelphys virginiana*); from Texas.
- Shehan, Albert. One double hen's egg, $6\frac{1}{2}$ by $9\frac{1}{4}$ inches in circumference.
- Shannon, J. B., & Co. Collective exhibit illustrating artistic reproduction and original designs of furniture, and builders' hardware manufactured from nickel, brass, etc.
- Sharp, T. C. Box of oysters in shell; from Ocean View, N. J.
- Shepard, E. E. Three specimens of fresh-water shells; from White Water River, Indiana.
- Skockley, W. H. Four specimens of fossil shells; from Nevada.
- Shoemaker, George. Forty-three specimens of alcoholic reptiles, eighty-three specimens of birds' skins, seventeen bottles alcoholic insects, two bottles of shells; from District of Columbia, Maryland, and Virginia.
- Short, E. G. Piece of planking from war vessel "Oneida," sunk in the Saint Lawrence in 1812.
- Shufeldt, Dr. R. W. Collection of about eight hundred birds' skins, eleven specimens of birds' eggs; from Tongue River. Skin of squirrel (*Sciurus carolinensis*), head of antelope (*Antilocapra americana*); from Sweet Water Valley, Wyoming. One box alcoholic specimens of natural history; from Louisiana.
- Sibley, W. H. Specimen of silicious chalk; from Texas.
- Slack, John H. Specimen of fish (*Eupomotis aureus*); from New York.
- Small, Edgar A. Stuffed specimen of green heron (*Butorides virescens*); from Maryland.
- Small, I. A. Gun-harpoon; from Massachusetts.
- Smith, D. C. Bottle of water from artesian well at Pekin, Ill.
- Smith, Everett. Specimen of bird's skin (*Buteo borealis*); from Maine.
- Smith, Edward, & Co. Collection of fine varnishes.

- Smith, F. H.* Three specimens of native copper; from "Longfellow copper mine," Arizona.
- Smith, George H.* Two Smith's gun-harpoons, one cutting spade.
- Smith, Seth.* Darting-gun and harpoons, old-style lance with wooden head, dog-fish gear, hooks, chain, and one mackerel gaff; from Massachusetts.
- Sneed, J. R.* Specimen of galena in limestone; from Tennessee.
- Snow, A. J.* Specimen of mineral; from Tennessee.
- Snow, Loren, & Sons.* Specimens of whale-boat fittings. (Purchased.)
- Sommerfield, L.* Specimen of ruby-throated humming-bird (*Trochylus colubris*).
- South Side Club.* Living specimen of brook trout (*Salvelinus fontinalis*); from Long Island.
- Spinner, General F. E.* One box of marine shells; from Florida.
- Spray, S. J.* Four specimens minerals; from Colorado.
- Stabler, James P.* Specimen of black snake (*Bascanion constrictor*); from Maryland.
- Stallman, John.* One block building stone; from Massachusetts.
- Stanhorn, Pierson & Co.* Wooden wheels for light buggies and wagons.
- Starr, W. S.* Specimen of crystal of amethystine quartz; from South Carolina.
- Stassey, Frederick (through James Harrington).* Stone image; from Tampico, Mexico.
- Stearns, Robert E. C.* Thirty-five boxes of shells, two boxes of sample woods, alcoholic specimens of big clam (*Glycimeris*), one box of Indian relics, and specimen of *Pennatula*; from Pacific coast of United States.
- Stearns, Silas.* Large collection of alcoholic and fresh fishes, consisting in part of *Phyeis carlii*, *Dactylopterus*, *Stenotomus caprinus*, *Coryphæna equestris*, *Opisthognathus*, *Tylosurus*, *Rhinobatus*, *Narcine brasiliensis*, *Hemirhombus*, Gobioid, *Antennarius*, *Batrachus tau*, *Caulolatilus microps*, *Trisotropis stomias*, *Seriola*, etc., from Florida.
- Stearns, Winnifred A.* Two boxes alcoholic, one barrel of salted, specimens of fishes and vertebrates; from coast of Labrador.
- Steenstrup, Professor.* Three jars *Cephalopods*; from Denmark.
- Steere, Prof. J. B.* Sixty-six specimens (thirty-three species) of shells; from Philippine Islands.
- Steinway & Sons.* One grand upright piano, constructed to show interior workings.
- Stejneger, Dr. Leonard.* Three skins of swans, type-specimen of *Perisoreus canadensis nigricapillus*, from Labrador. Twenty large boxes of birds' skins, bones of whales and sea-cows (*Rhytina*); from vicinity of the Commander Islands, Kamtschatka.
- Stephens, Hon. Alex. H.* Specimens of malachite and melachonite; from Arizona.
- Stephens, L. A.* Specimens of mineral; from Texas.

- Stevens, Mrs. E. L.* Young specimen of alligator (*Alligator mississippiensis*); from Florida.
- Stewart & Co.* Collective exhibit of various sizes and kinds of wire.
- Stilwell, E. M.* Tin pump for aerating water in cans for transporting live fishes.
- Stone, Livingston.* Collection of photographs (50) showing United States Fish Commission hatching station and surroundings at Baird, Shasta County, California. Also copy letter written with the blood of a pauper.
- Stone, T. J.* Vertebra of whale; from marl bank on the Patuxent River.
- Story, William H.* Eight boat models.
- Stratton, C. L.* Box of stone and shell relics, with specimen of crania; from mound in Tennessee.
- Stribling, Will.* Specimen of shed skin of snake (*Pityophis melanoleucus*), specimen of clay, and skull of catfish; from Ohio.
- Stuart, H. J.* Five bottles of alcoholic snakes; from Guatemala.
- Stuart, Dr. Joseph G.* Specimens of wild flowers; from Colorado.
- Studer, Jacob H.* Bound volume of Studer's Popular Ornithology, for Museum library.
- Sullivan, Jeremiah.* Package of sprouted corn used by Moqui Indians in their ceremonies.
- Swan, Mrs. E. E.* Small box of minerals; from New York.
- Swan, James G.* Two boxes of Indian articles and ornaments. (Purchased.) Alcoholic specimen of salmon (*Oncorhynchus chouicha*); from Washington Territory.
- Sweeney, R. O.* One alcoholic specimen of fish (*Coregonus*); from Minnesota.
- Swift, Jeremiah.* Flint lance-head taken from a whale in Northern Pacific.
- Swift, Josiah.* Collection of whaling apparatus.
- Symmes, Francis M.* Cast of stone pipe and loan of stone pipe, "baby's foot," specimen of fresh water mussel; from Indiana.
- Syracuse Chilled Plow Company.* Exhibit of chilled plows and component parts.
- Laber & Gordon.* Specimens of whale boat fittings; broken whale-boat davit; one try-pot of one hundred and eighty gallons; cracked.
- Talbot, D. H.* Mounted skin of swallow-tailed kite (*Elanoides forficatus*); from Iowa.
- Tandy, M.* Specimens of Indian relics; from Iowa and Illinois.
- Tate, J. (through Dr. Timothy E. Wilcox).* One pair of mule-deer antlers (*Cervus macrotis*); from Idaho Territory.
- Taylor, B. F.* Specimens of Indian relics; from Maryland.
- Taylor, Dr. F. W.* Specimen, in flesh, of a golden pheasant (*Chrysolophus pictus*).

- Taylor, Martin S.* Specimens of minerals (galena in limestone); from Ohio.
- Taylor, Prof. William B.* Specimen of small pouch made of grasses.
- Taylor, William J.* Specimens of fossils; from Florida.
- Teague, Samuel J.* Specimens of plant bulbs; from Florida.
- Tegler, Henry.* Specimen of malformed hen's eggs; from Washington, D. C.
- Teiling, Charles.* Specimen of cow-fish (*Ostracion quadricorne*); from Georgia.
- Tennessee Historical Society.* Specimens of stone relics; from Tennessee. (Loaned.)
- Thayer, A. H.* Specimens of feathers of an American eider duck (*Somateria mollissima dresseri*); from Massachusetts.
- Thompson, Franklin.* Model of "Muscongus Bay lobster boat"; from Maine. (Purchased.)
- Thompson, H. H.* Specimens of fresh fish (*Coregonus artedi*), and fresh salmon (*Salmo salar* var. *sebago*); from New York.
- Thompson, John H.* Specimen of fish-hook made of pearl shell; from Fiji Islands. Idol and native gourd ornament; from an island southwest of New Guinea.
- Thomson, M. H.* Specimens of pottery from graves, and bottle of buffalo gnats; from Arkansas.
- Thurber, Prof. George.* Specimen, in flesh, of cinnamon bear; from mountains of Western Pennsylvania.
- Thurber, H. F. and F. B., & Co.* Exhibit of canned vegetables, samples of teas, coffees, spices, etc., and fruits.
- Todd, Aurelius.* Specimens of mammal skins (*Spermophilus Beecheyii*), with bones (*Sciurus fossor*, *Tamias Townsendii*, *Sciurus Douglassii*, and *Spermophilus Beecheyii*), etc.; from Oregon.
- Tooker, William Wallace.* Specimens of stone relics, sample of gravel, and pierced stone tablet, box of stone relics (loaned); from New York.
- Topliff, Ely & Co.* Specimens of wood-work used in the manufacture of buggies; from Ohio.
- Towne, F. H.* Pair of iron molds for casting old-fashioned pewter spoons.
- Townsend, Henry A.* Specimens of oysters; from Long Island.
- Tripp, Stephen A.* Six specimens of whale-boat fittings; from Massachusetts.
- True, F. W.* Specimens of seed necklace, models of agricultural implements, books and fan made from the palm, specimens of basket-work, and women's wearing apparel; from Ceylon. Tank of alcoholic fishes; from New York, and three Chinese representations of mammals and reptiles made from colored straw.
- Tuft, Richard.* Specimen of china tea pot (old English); from Massachusetts.
- Turner, J. H.* Specimen of insect (*Lucanus elaphus*); from Texas.

- Turner, L. M.* Specimens of birds' skins, natural history, and tank of alcoholic specimens; from Hudson Bay Territory.
- Turner, Otto A.* Specimens of building stones; from Illinois.
- Turner, Ross.* Model of ship "Il Sultana," built in Venice between the years 1850 and 1860. The vessel was lost at the battle of Lissa.
- Union Iron Company.* Collective exhibit of manufactured iron.
- United States Stamping Company.* Two boxes of stamped tinware.
- University of Alabama.* One box of Indian relics. (Loaned.)
- Upham, E. P.* Eight rude stone implements; from District of Columbia.
- Upton, George.* Collection of manufactured glue.
- Vail, Master Stevie.* Two living specimens of young alligators; from Florida.
- Vanderburg, Mrs. J. H.* Flint spear head; from Fort Ticonderoga, N. Y.
- Van Fleet, Dr. M. N.* Specimen of stone implement and specimen of gypsum from which was made the famous "Cardiff Giant"; from Nebraska.
- Van Sinderen, Adrian.* Section of meteorite.
- Vansant, H. H.* One box of shell oysters; from Somers Point, N. J.
- Vasey, Dr. George.* Specimens of agave paper; from Mexico.
- Verrill, Prof. A. E. (for U. S. Fish Commission).* Fourteen boxes, one tank of alcoholic invertebrates; from coast of New England.
- Von Berlepsch, Hans.* Collection of one hundred and thirteed European birds' skins.
- Von Epps, P. M.* One box of concretions; from New York.
- Vulcanized Fibre Company.* Seven samples of crude and manufactured vulcanite.
- Walke, E. H.* Alcoholic specimen (*Amblystoma opacum*); from Maryland.
- Walker, Hon. R. J. C.* Specimens of minerals.
- Walker, S. H.* Specimen of mineral; from Maryland.
- Walker, S. T.* Specimens of Indian relics and roots of the countie plant; from Florida.
- Wallace, John.* Specimen of baboon, in flesh.
- Ward, Prof. H. A.* Specimens of fossil erabs; from the Isle of Hainan, Gulf of Tonquin.
- Ward, Prof. L. F.* Specimens of anthracite coal; from Rhode Island.
- Ware, John D.* Specimens of a root; from vicinity of Hot Springs, Ark.
- Warren & Co.* Three specimens of *Caulolatilus microps*; from Florida.
- Washington, Charles H.* Specimen of red fox (*Vulpes fulvus*); from Virginia.
- Washington, D. C.:*
- Department of Agriculture.* One box of materia medica. (See under name of *Dr. George Vasey*.)
- Census Office.* Four hundred and seven specimens of building stones; from various States and Territories. See under name of *R. Pumphelly*.

Washington, D. C.—Continued.

Geological Survey, J. W. Powell, United States Geologist. Ninety-eight trays of fossils; from Rocky Mountains. Specimens of building stones; from Wyoming. Minerals; from Arizona and New Mexico.
General Land Office. Forty-six hand specimens of building stones. (See under names of *C. W. Holcomb, John Wasson, and Special Agent James Bell.*)

United States Commission of Fish and Fisheries, Prof. Spencer F. Baird, Commissioner. About 360 packages of zoological collections; from the Atlantic, Pacific, and Gulf Coasts, made by Prof. A. E. Verrill, Richard Rathbun, David S. Jordan, Charles H. Gilbert, G. Brown Goode, James E. Benedict, Col. Marshall McDonald, T. B. Ferguson, Dr. T. H. Bean, with large number of fishing and whale-boat fittings, collected by James Temple Brown, Joseph W. Collins, H. C. Chester, R. Edward Earll, and A. Howard Clark. (See also under names *G. Brown Goode, M. McDonald, James E. Benedict, H. C. Chester, Jos. W. Collins, A. Howard Clark, Frank N. Clark, Frank L. Donnelly, George H. H. Moore, John A. Ryder, Livingston Stone, James G. Swan and Prof. A. E. Verrill.* Also collection of several hundred specimens of Indian stone implements and relics made by the United States Fish Commission; from vicinity of Menemsha Bight, and Marthas vineyard, assisted by Willard Nye, jr., of New Bedford, Mass.

Navy Department. (See under names of *Commodore John G. Walker, Capt. T. M. Ramsay, J. R. Eastman, R. L. Newcomb, Dr. J. F. Bransford, Dr. Thomas C. Craig, D. William H. Jones, Paymaster George H. Reed, Ensign M. L. Wood, Ernest Wilkinson, Lieut. C. B. Sigsbee, F. C. Dale.*)

State Department. Four boxes of cotton samples; from the International Cotton Exposition at Atlanta, Ga., 1881.

Treasury Department, United States Revenue Marine. (See under names of *Lieutenant Elliott and Capt. J. C. Mitchell.*)

War Department, Signal service. One kayak, one bundle and nine boxes of ethnology. (See also under name of *John J. McLean and L. M. Turner.*)

Surgeon-General's Office. (See under names of *Drs. Jos. N. K. Corson and Elliott Coues.*)

United States Army. (See under names of *Capt. Chas. Bendire, Col. A. G. Brackett, Col. R. T. Burr, Capt. H. S. Hawkins, Acting Quartermaster S. B. Holabird, First Sergeant William H. Hudson, Major William A. Kobbe, General M. C. Meigs, Capt. R. H. Pratt, Col. A. F. Rockwell, Drs. R. W. Shufeldt, and Henry C. Yarrow, and Timothy E. Wilcox, Lieut. C. A. Williams.*)

Wasson, John. Specimens of minerals; from Arizona.

Watkins, J. M. Two dozen "original" Powhatan clay pipes; from Virginia.

- Watts, H. L. Model of reach boat; from Maine. (Purchased.)
- Weeks, P. B. Specimen of tertiary lignite taken from stump 30 feet below surface; from Louisiana.
- Weaver, George B., & Co. Specimens of fresh fish (*Amia calva*, *Lota maculosa*); from New York.
- Webb, W. H. Seven models of ships; from New York.
- Webster, W. W. Six papier-maché lay figures and one papier-maché head.
- Wcems, Rev. T. D. Specimens of Indian implements; from Illinois.
- Weidman, A., & Co. (through Thomas Donaldson). Two boxes of masks.
- Wells, J. G. Specimen of insect; from Grenada, West Indies.
- Wesleyan University. Five specimens of musical instruments, cornet, ophicleide, trombone, and clarinet. "Marimba;" from Venezuela.
- Wharton, Joseph. Specimen of cooking vessel made from rolled nickel on iron; manufactured in Germany. Samples of pure nickel rolled in sheets and on iron; from Pennsylvania. Also an exhibit of nickel ore and products; from New Jersey.
- Wheeler, Charles Le Roy. Collection of shells; from New Jersey.
- Whipple, S. C. Specimens of biotite granite and quartz porphyry; from Colorado.
- White, Dr. C. A. Box of land shells; from Indiana. Specimens of chalk; from Dakota. Fossil plants; from Colorado.
- Whittington, G. N. Specimen of ore.
- Whitman, J. L. Product of artificial planting of *Stizostedium vitreum* var. *Salmoneum*; from Kansas.
- Whitall, Tatum & Co. Two barrels, six hogsheads, and nine boxes, samples of glass bottles, etc.; also apparatus used in making.
- Wiggins, John B. Specimens of clay, fossils, stone pestle, slag, iron pipe or wrench, and living specimen of fox (*Vulpes fulvus*); from New York. Soapstone cup and tomahawk; from Virginia.
- Wilcox, Crittenden & Co. Box of fishing apparatus; from Connecticut.
- Wilcox, Joseph. Specimens of stone relics and implement; from Florida.
- Wilcox, Dr. Timothy E., U. S. A. Two pairs of antlers, alcoholic mammals (*Cervus macrotis*, *Alces americanus*, *Thomomys talpoides*), and two mice, piece of stone pestle and fossil bone, bag of kinnikinik made by the Cheyenne Indians, specimen of butterflies (*Papilio turnus*, *Dandus archippus*), pair of antelope prongs (*Antilocapra americana*), specimen of *Trochilus alexandri*, Juv.; from Idaho. One of skin of *Anpelis garrulus*; from Nevada.
- Wilcox, W. A. Specimen of fish basket, two currycombs for cleaning fish, used by New England fish dealers. One fresh specimen of eusk (*Brosmius brosmie*), and three negatives of warehouses and wharfs at Boston; from Massachusetts.
- Wild, George H. Specimens of alcoholic striped bass (*Roccus saxatilis*); from the headwaters of North Shrewsbury River, New Jersey.

- Wilder, Miss Mary.* Specimen of mineral; from Tennessee.
- Wilkinson, Ernest, U. S. N.* Specimens of rocks, lava, etc., and alcoholic specimens of star-fishes, sea-urchins, crustaceans, and mollusks; from Alaska and Greenland.
- Wilkins, Mrs. L. J.* Seventeen specimens of building stones; from various localities.
- Willard, S. W.* Specimen of bird skin (*Vireo Philadelphia*); from Wisconsin.
- Willets, James C.* Specimens of alcoholic fishes, (*Argyrosomus, sp.*); from New York.
- Williams, C. A.* Eleven specimens of whaling apparatus.
- Williams, Lieut. C. A., U. S. A.* Package of butterflies.
- Williams, Dr. Edward H.* Carved panel (dragon); from Buddhist temple in the interior of Japan.
- Williams & Page.* Specimens of railroad and steamship lamps; from Massachusetts.
- Williams, W.* Specimen of *Blepharis crinitus*; from Connecticut.
- Williamson, W. A.* Box of insects, with cells; from Toronto, Canada.
- Wilson, Mrs. Reiley (through John B. Wiggins).* Specimens of fossils; from New York.
- Wiltheiss, C. T.* Specimen of an inscribed stone; from Ohio. (Loan.)
- Wing, L. and W. R.* Fifteen specimens of whale-boat fittings, and one specimen of baleen; from Massachusetts.
- Wise, Morgan R.* Two specimens of gold-bearing quartz; from Virginia.
- Witherow, Jos. M. (through Edward Nichols).* Specimen of stone implement, boat-shaped; from North Carolina.
- Wolff, A.* Specimen of hematite; from California.
- Wolle, sr., A.* Mounted specimen of *Mareca penelope*, shot near Baltimore; eggs of *Callisittacus novæ-hollandiæ*, laid in confinement; specimen of *Pionias vioiæceus*; from Demerara; and birds' skins; from South America.
- Woltz, George.* Clarinet without mouth-piece, and one mouth-piece for A and B flat.
- Women's Silk-Culture Association, Philadelphia.* Frame and three samples of American grown and manufactured silk.
- Wood, Brightman & Co.* Two jacket-lamps, powder-horn, blubber-room lamp, blow-horn for whale-boat, boat and cook's lanterns, and deck-scoop, oil; from Massachusetts.
- Woode, E. and C.* Collection of hair and clothes brushes; from New York.
- Wood, George.* Exhibit of corrugated and creased leather.
- Wood, M. L., U. S. N.* Alcoholic specimens of fishes (*Batrachus tau*, *Hemirhamphus unifasciatus*, *Ocyurus chrysurus*, *Diabasis formosus*); from Florida.

- Wood, Sir William, Egypt.* One large mosaic lion, exhibited at the Centennial Exhibition at Philadelphia, Pa.; valued at \$25,000.
- Wood, W. M., U. S. N.* Specimens of fresh shad (*Clupea sapidissima*); from Potomac River.
- Woodbury, J. G.* Alcoholic specimens of striped bass (*Roccus saxatilis*), with parasites, (*Lironceca*); from California.
- Woodcard, W. Elliott.* Two stone mortars, and piece of cloth showing tracing of rock carving; from Massachusetts.
- Wooster, A. F.* Specimen, in flesh, of a bat; from Connecticut.
- Wooten Well Company.* Four demijohns of mineral water; from Texas.
- Wright, Harrison.* Specimen of sunfish (*Lepomis gibbosus*); from Pennsylvania.
- Wright, H. L.* Alcoholic specimen of fish; from Washington, D. C.
- Wright, Reuben.* Specimen of living horned-frog (*Phrynosoma cornutum*); from Texas.
- Yancey, B. M.* Package of rocks; from Virginia.
- Yarrow, Dr. H. C.* Two stone implements; from North Carolina.
- Yeates, W. S.* Three specimens of fossils; from New York.
- York, William E.* Collection of clay concretions; from beds along the headwaters of the Connecticut River.
- Zeledon, José C.* One box of stone images, pottery, celts, fragments of pottery, and one box of insects; from Costa Rica.
- Zoological Society, Philadelphia, Pa.* Specimen of vulturine Guinea-fowl (*Numida vulturina*); from West Africa.
- Zorn, George, & Co.* Two boxes of wood and clay pipes; over 300 styles.

ACTS AND RESOLUTIONS OF CONGRESS RELATIVE TO THE
SMITHSONIAN INSTITUTION, NATIONAL MUSEUM, ETC.

IN CONTINUATION FROM PREVIOUS REPORTS.

APPROPRIATIONS FOR FISCAL YEAR ENDING JUNE 30, 1882.

Furniture and fixtures, National Museum—To expedite the work of constructing the exhibition cases in the new building for the National Museum during the present fiscal year, thirty thousand dollars.

(Deficiency appropriation act, March 6, 1882. Statutes, xxii, p. 10.)

Fire-proof building for National Museum.—To pay Thomas J. Hobbs for disbursing the appropriations for the construction of the National Museum building, under appointment of the Secretary of the Treasury of March 28, 1879, two hundred and fifty dollars, in full satisfaction therefor.

(Deficiency appropriation act, August 5, 1882. Statutes, xxii, p. 274.)

APPROPRIATIONS FOR FISCAL YEAR ENDING JUNE 30, 1883.

Preservation of collections, National Museum.—For expense of heating, lighting, and telephonic and electrical service for the new Museum building, six thousand dollars; for the preservation and exhibition of the collections received from the surveying and exploring expeditions of the Government, and other sources, including salaries or compensation of all necessary employés, seventy-five thousand dollars; for expense of transferring to Washington the collections presented to the United States at the close of the Permanent International Exhibition, in Philadelphia, including necessary expenses already incurred for the purpose, ten thousand dollars. Total, ninety-one thousand dollars.

(Sundry civil appropriation act, August 7, 1882. Statutes, xxii, pp. 332, 333.)

Armory building.—For care of the Armory building and expense of watching, preservation, and storage of the duplicate collections of the Government and of property of the United States Fish Commission contained therein, including salaries or compensation of all necessary employés, two thousand five hundred dollars, and the distribution of duplicate specimens of the National Museum and Fish Commission may be made to colleges, academies, and other institutions of learning, upon

the payment by the recipients of the cost of preparation for transportation and the transportation thereof.

(Sundry civil appropriation act, August 7, 1882. Statutes, xxii, pp. 332, 333.)

Furniture and fixtures, National Museum.—For cases, furniture, and fixtures required for the exhibition of the collections of geology, mineralogy, natural history, ethnology, and the industrial arts, belonging to the United States, and for salaries or compensation of all necessary employés, sixty thousand dollars.

(Sundry civil appropriation act, August 7, 1882. Statutes, xxii, p. 332.)

North American ethnology, Smithsonian Institution.—For the purpose of continuing ethnological researches among the North American Indians, under the direction of the Secretary of the Smithsonian Institution, including salaries and compensation of all necessary employés, thirty-five thousand dollars.

(Sundry civil appropriation act, August 7, 1882. Statutes, xxii, p. 332.)

International exchanges, Smithsonian Institution.—For expenses of the international exchanges between the United States and foreign countries, in accordance with the Paris convention of 1877, including salaries and compensation of all necessary employés five thousand dollars.

(Sundry civil appropriation act, August 7, 1882. No. 217; Statutes, xxii, p. 332.)

War Department.—For the transportation of reports and maps to foreign countries, through the Smithsonian Institution, three hundred dollars.

(Sundry civil appropriation act, August 7, 1882. Statutes, xxii, p. 319.)

Naval Observatory.—For payment to Smithsonian Institution for freight on Observatory publications to be shipped to foreign countries during the fiscal year 1883, three hundred and thirty-six dollars and twenty-five cents.

(Legislative, executive, and judicial appropriation act, August 5, 1882. Statutes, xxii, p. 245.)

APPROPRIATIONS FOR FISCAL YEAR ENDING JUNE 30, 1884.

International exchanges.—For international exchanges, Smithsonian Institution: For expenses of the international exchanges between the United States and foreign countries, in accordance with the Paris con-

vention of eighteen hundred and seventy-seven, including salaries and compensation of all necessary employes, seven thousand five hundred dollars.

(Sundry civil appropriation act, March 3, 1883. Statutes, xxii, p. 603.)

International exchanges, Navy Department.—For payment to Smithsonian Institution for freight on Observatory publications sent to foreign countries, three hundred and thirty-six dollars.

(Legislative, executive, and judicial appropriation act, March 3, 1883. Statutes, xxii, p. 618.)

War Department.—For the transportation of reports and maps to foreign countries: For the transportation of reports and maps to foreign countries, through the Smithsonian Institution, three hundred dollars.

(Sundry civil appropriation act, March 3, 1883. Statutes, xxii, p. 555.)

Transfer of centennial collections, Treasury Department.—To complete the transfer and preparation of the Philadelphia collections presented to the United States at the close of the permanent international exhibition in Philadelphia, including necessary expenses already incurred, four thousand one hundred and twelve dollars and eighty-two cents.

(Deficiency appropriation act, March 3, 1883. Statutes, xxii, p. 584.)

Fire-proofing Smithsonian Institution.—For completing the reconstruction, in a fire-proof manner, of the interior of the eastern portion of the Smithsonian Institution, fifty thousand dollars.

(Sundry civil appropriation act, March 3, 1883. Statutes, xxii, p. 628.)

North American Ethnology.—For North American Ethnology, Smithsonian Institution: For the purpose of continuing ethnological researches among the North American Indians, under the direction of the Secretary of the Smithsonian Institution, including salaries and compensation of all necessary employes, forty thousand dollars, of which three thousand dollars shall be expended for continuing and completing the compilation and preparation of a statistical atlas of Indian affairs by C. C. Royce, under the direction of the Bureau of Ethnology, Smithsonian Institution which shall be immediately available.

(Sundry civil appropriation act, March 3, 1883. Statutes, xxii, p. 628.)

Furniture and fixtures, National Museum.—For furniture and fixtures of the National Museum: For cases, furniture, and fixtures required for the exhibition of the collections of geology, mineralogy, natural history, ethnology, and the industrial arts belonging to the United States, and for salaries or compensation of all necessary employes, sixty thousand dollars.

(Sundry civil appropriation act, March 3, 1883. Statutes, xxii, p. 628.)

Heating and lighting National Museum, etc.—For heating and lighting

the National Museum : For expense of heating, lighting, and telephonic and electrical service for the new museum building, six thousand dollars.

(Sundry civil appropriation act, March 3, 1883. Statutes, xxii, p. 629.)

Preservation of collections.—For the preservation of collections of the National Museum : For the preservation and exhibition of the collections received from surveying and exploring expeditions of the Government, and other sources, including salaries or compensations of all necessary employés, ninety thousand dollars.

(Sundry civil appropriation act, March 3, 1883. Statutes, xxii, p. 629.)

Armory building.—For the preservation of collections of the National Museum in the Armory building: For care of the Armory buildings and grounds, and expense of watching, preservation, and storage of the duplicate collections of the Government and of property of the United States Fish Commission contained therein, including salaries or compensation of all necessary employés, two thousand five hundred dollars. And the distribution of duplicate specimens of the National Museum and Fish Commission may be made to colleges, academies, and other institutions of learning, upon the payment by the recipients of the cost of preparation for transportation and the transportation thereof.

(Sundry civil appropriation act, March 3, 1883. Statutes, xxii, p. 629.)

INAUGURATION OF THE HENRY STATUE.

[No. 16.] Joint resolution accepting the invitation of the Regents of the Smithsonian Institute to attend the inauguration of the statue of JOSEPH HENRY.

Whereas, in a communication from Spencer F. Baird, Secretary of the Smithsonian Institute, 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 Smithsonian 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, xxii, p. 639.)

PRINTING CENTENNIAL EXHIBITION REPORT.

[No. 21.] Joint resolution to print five thousand copies of the report of the Board on behalf of the United States Executive Departments at the International Exhibition of eighteen hundred and seventy-six.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That there be printed and bound, in continuation of the series of volumes heretofore published by Congress under joint resolution of June twentieth, eighteen hundred and seventy-nine, containing the final report of the United States Centennial Commission on the International Exhibition of eighteen hundred and seventy-six, and uniform therewith, five thousand copies of the report of the Board on behalf of the United States Executive Departments at said Exhibition, being the report which was submitted to Congress by the President of the United States, by special message of February ninth, eighteen hundred and seventy-seven, and again in his annual message of December third, eighteen hundred and seventy-seven, of which number three thousand copies shall be for the House, one thousand copies for the Senate, two hundred copies for the Smithsonian Institution for distribution to such foreign governments and others as made contributions from such Exhibition to the National Museum, three hundred copies for the late members of said Board, and five hundred copies for distribution by the late president of the Centennial Commission, the printing to be done by the Public Printer, under the supervision of the late chairman of said Board, upon whose order may be allowed by the Public Printer to the late secretary of the Board not exceeding three hundred dollars for services to be performed, and incidental expenses to be incurred in connection therewith: *Provided,* That the photographic views of the Government exhibit accompanying the manuscript report shall not be printed or reproduced for the publication herein authorized.

(Approved March 3, 1883. Statutes, xxii, pp. 640, 641.)

SOUTHERN EXPOSITION AT LOUISVILLE, KY.

Chap. 99.—An act relative to the Southern Exposition to be held in the city of Louisville, State of Kentucky, in the year eighteen hundred and eighty-three.

Whereas ample means have been provided for holding, during the present year, in the city of Louisville, State of Kentucky, of an exposition of the products of agriculture, manufactures, and the fine arts; and

Whereas the objects of such an exposition should commend themselves to Congress, and its success should be promoted by all reasonable encouragement, provided it can be done without expense to the general public: Therefore,

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That all articles which shall be imported for the sole purpose of exhibition at the Southern Exposition at Louisville, Kentucky, to be held in the year eighteen hundred and eighty-three, shall be admitted without the payment of duty, or of customs fees or charges, under such regulations as the Secretary of the Treasury shall prescribe: *Provided,* That all such articles as shall be sold in the United States, or withdrawn for consumption therein, at any time after such importation, shall be subject to the duties, if any, imposed on like articles by the revenue laws in force at the date of importation: *And provided further,* That in case any articles imported under the provision of this act shall be withdrawn for consumption, or shall be sold without payment of duty as required by law, all penalties prescribed by the revenue laws shall be applied and enforced against such articles, and against the persons who may be guilty of such withdrawal or sale.

SEC. 2. That medals, with appropriate device, emblems, and inscriptions, commemorative of said Southern Exposition, and of the awards to be made to exhibitors thereat, be prepared at some mint of the United States, for the board of directors thereof, subject to the provisions of the fifty-second section of the coinage act of eighteen hundred and seventy-three, upon the payment of a sum not less than the cost thereof; and all the provisions, whether penal or otherwise, of said coinage act against the counterfeiting or imitating of coins of the United States shall apply to the medals struck and issued under this act.

SEC. 3. That with the approval of the director of the National Museum, any portion of the collections thereof may be exhibited at said Southern Exposition, permission to remove the same from the National Museum being hereby granted: *Provided,* That said removal can be made without loss or expense to the Government. And upon the same conditions permission is also granted for the exhibition of articles in charge of other Bureaus and Departments of the Government.

SEC. 4. That upon the passage of this act the Secretary of State shall notify the consuls, consular agents, and other representatives of our Government in foreign countries of the time and place of holding said Southern Exposition, together with the fact that all articles intended therefor will be admitted free of duty, as provided herein.

(Legislative, executive, and judicial appropriation act, March 3, 1883. Statutes, xxii, pp. 481, 482.)

LONDON FISHERY EXHIBITION.

[No. 49.] JOINT RESOLUTION concerning an International Fishery Exhibition to be held at London, in May, eighteen hundred and eighty-three.

Whereas the Government of the United States has received official

intimation from that of Great Britain that it is proposed to hold an International Exhibition of Fish, Fisheries, and Fish Products at London in May, eighteen hundred and eighty-three, whereat the representation of the United States is invited; and

Whereas, also, by its action as a Government, and by the active enterprise of merchants, fishermen, and inventors and the researches of men of science in this country, the United States has attained and holds a prominent place in all that relates to the development of the great fisheries industries, the extension of the great commercial relationship with other countries based on the exportation of prepared fish products; which now forms an important factor in the national wealth, the artificial propagation of food fishes, and the re-stocking of depleted fishing waters, and it is expedient that the industries and interests thus concerned should be adequately represented on the occasion: Therefore,

Resolved, by the Senate and House of Representatives of the United States of America in Congress assembled, That the invitation of the British Government be accepted, and that, under the auspices of the Department of State, the United States Commissioner of Fish and Fisheries be, and he hereby is, instructed to prepare or cause to be prepared a complete and systematic representative exhibition of the fisheries of the United States, in which shall be shown the following: A series of fishing grounds; a full series of the principal sea and fresh-water fishes, shell-fish, sponges, and so forth, and other useful inhabitants of the waters of the country (either as specimens, casts, or illustrations); specimens of models of the various kinds of gear, apparatus, boats, and so forth, used in their capture; a full collection of articles showing the commercial and economic uses of the fishes and other water animals, which shall include, besides the samples and specimens, models and other representations of appliances used in their preparation and preservation for food as well as for purposes of use and ornament, such as dried, smoked, and canned fish, and so forth; oils, fertilizers, manufactured shells, corals, sponges, and so forth; also a full series of articles, or models thereof, showing the economic condition of our fishermen, such as clothing and other personal outfit, models of dwelling houses, and so forth; a collection of documents showing the present condition of fishery legislation; also specimens, models, and illustrations of the apparatus used in artificial hatching and breeding of fish, oysters, and so forth; models of hatcheries, ponds, fishways, transportation cars, vessels, and so forth; statistical maps showing the range, abundance, and so forth, of our fishes, and so forth; also such other facts, apparatus, models, specimens, and so forth, as may be needed to convey a correct idea of this branch of the nation's industries.

SEC. 2. That with the approval of the Director of the National Museum, any cognate portion of the collections thereof may be used in the preparation of the exhibit herein provided for, permission to remove

the same from the National Museum being hereby granted. And the Commissioner of Fish and Fisheries is hereby authorized to obtain, by exchange or otherwise, such procurable objects from other exhibits in London as may tend to perfect the permanent fishery exhibit of the United States National Museum.

SEC. 3. That it shall be the duty of the United States Commissioner of Fish and Fisheries to present to Congress a detailed report of the present condition of the European fisheries, with information as to any methods by which those of the United States can be modified or improved, as well as any suggestions he may deem pertinent in regard to increasing the exportation of fishery products from the United States to foreign countries.

SEC. 4. That the United States Commissioner of Fish and Fisheries is hereby authorized to represent the United States at the exhibition in question, either in person or by a deputy to be appointed by the President of the United States, together with such assistants as he may recommend as useful in carrying out the proposed participation of the United States at the exhibition.

SEC. 5. That in order to defray the expenses of the collection, preparation and packing of the exhibit authorized, its transfer from and to the United States, its installation and supervision, in London, and such other incidental expenses as may of necessity arise, there is hereby appropriated, out of any money in the Treasury of the United States not otherwise appropriated, the sum of fifty thousand dollars, or so much thereof as may be required, to be immediately available, and to be expended by the United States Commissioner of Fish and Fisheries, under the direction and regulations of the Department of State.

(Approved July 18, 1882. Statutes, xxiv, pp. 387-389.)

WITHDRAWAL OF SMITHSONIAN DEPOSIT.

CHAP. 481. An act for the relief of Mary E. Thomson.

Be it enacted, &c., That Mary E. Thomson, mother of Passed Assistant Paymaster Curtis H. Thomson, United States Navy, deceased, be, and is hereby authorized to accept, first, a portrait, in frame, of Her Royal Highness, the Princess of Siam; second, a silver enameled cigar case; third, a match-box and tray of Siamese work, the same being presented to said Curtis H. Thomson, in his lifetime, by the King of Siam, and now on deposit in the Smithsonian Institution.

(Approved August 8, 1882. Statutes, xxii, p. 738.)

DISTRIBUTION OF PUBLIC DOCUMENTS.

Resolution of the House of Representatives, August 8, 1882.

Resolved, That the Librarian of Congress, the Secretary of the Smithsonian Institution, and the Superintendent of Documents, Department of the Interior, be and they are hereby requested to compile the laws and regulations now in force governing the printing and distribution of public documents; to prepare a tabulated statement showing the number of documents printed by order of Forty-sixth and the first session of the Forty-seventh Congress, and under general laws now in force, and the disposition directed to be made of the same; and to report what reductions should be made in the number of such documents, and to present such other information at their command relating to public documents as will tend to promote judicious legislation and submit the draft of a bill to provide for the printing and distribution of documents, and they shall report to the House at the beginning of the next session.

GENERAL APPENDIX

TO THE

SMITHSONIAN REPORT FOR 1882.

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 1882.

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 had not been carried out on any very systematic plan. 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 was followed in the report for 1881, excepting the account of geologic progress, which was necessarily omitted in consequence of the illness and lamented death of Dr. G. W. Hawes, to whom the subject had been referred. In the record for the present year, Dr. T. Sterry Hunt, of Montreal, Canada, has supplied very acceptably this deficiency. A sketch of geographical progress during the years 1881 and 1882 has also been furnished for the present report by Commander F. M. Green, U. S. N. The account of progress in chemistry has been undertaken by Prof. H. Carrington Bolton, of Trinity College, Hartford. The résumé of progress in mineralogy, likewise unfortunately omitted in the report for 1881 (owing to the death of Dr. Hawes, as above mentioned), has this year been supplied by Prof. Edward S. Dana, of Yale College, New Haven. The remaining contributors have continued their work, as heretofore.

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, and in 1881 extended to 330 pages, has this year reached 400 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 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.

This record of astronomical progress during the year 1882 is in continuation of that of preceding years and is presented in the same form. Abstracts of some of the most important papers of the year are given, arranged under appropriate heads. To the professional astronomer they may serve as a convenient collection of reviews and notes. But their chief aim is to convey to the large and increasing class of those interested in astronomy, and having some acquaintance with it, an idea of its annual progress. This object might be more directly attained by writing a connected account of the year's work without referring to separate papers. It is, however, conceived that the present plan really serves its purpose better.

While the progress of astronomy in general, as well as that of other sciences, is even and sustained if viewed from a distance, yet this progress is really made by steps and irregularly. It is of value to be able to follow these steps one by one.

The writer has made free use of reviews which have appeared in scientific periodicals, and especially of abstracts which he has himself written.

NEBULÆ, ETC.

Nebula in Orion.—The Naval Observatory has recently published a monograph of the Central Parts of the Nebula of Orion (quarto, 230 pp., 42 illustrations), by Professor Holden.

Part I gives a history of the various researches on the nebula of Orion, in chronological order, from Cysat, 1618, to the observations of the author in 1882. With this are given 38 wood-cuts, which are engraved from photographs of the principal published (and unpublished) drawings. A very fine drawing of Lassell is here given for the first time.

Part II (pp. 108–197) gives the observations made by Professor Holden at Washington and Madison in the years 1874–1882.

Part III is a summary of *all* the observations arranged for comparison.

Part IV gives the conclusions to be reached with regard to possible variations in the shape or brilliancy of its parts. These are, in brief, that there have certainly been changes in the relative brightness of some

of the parts, but that no evidence exists of any changes of form other than those which might be due to changes in relative brightness. These changes in brightness have been examined by the author by photometric measures by means of an instrument devised by Prof. Charles S. Hastings.

An *addendum* gives a magnificent photograph of the nebula made by Dr. Henry Draper, his last published work. The frontispiece is Bond's beautiful steel engraving of the nebula, which was kindly furnished by Professor Pickering.

Spectrum of Nebula in Orion.—Dr. Huggins has succeeded in photographing the *spectrum* of the nebula of Orion (March 7, 1882), and "in addition to known lines" a strong line in the ultra-violet is shown. The same thing had also been done by Dr. Henry Draper, and from a private letter we learn that he had made four such photographs, which show that two knots of nebulosity in the bright mass just preceding the trapezium have a continuous spectrum, and that there are traces of the same in other parts of the nebula.

Dr. Huggins has obtained a fine photograph of the spectrum of this nebula, which shows a *new* line λ 3730, in addition to the four which he has located in the visible spectrum.

In this connection it may be worth while to correct a common, although a natural, error with regard to the question of the discovery of the discontinuous nature of the spectra of nebulae.

In August, 1864, Dr. Huggins investigated the spectra of nebulae before any other observer, and communicated the results to the Royal Society on September 8, 1864.

Secchi's observations of the spectra of nebulae are published in the *Comptes Rendus* of 1865, and appear to be the record of an independent discovery; certainly they are usually so considered. That they are not independent, may be seen from the fact that the results of Dr. Huggins were communicated to P. Secchi by Director Otto V. Struve, who was at the time on a mission to Rome. Secchi received the announcement with incredulity, but as Struve insisted on its correctness Secchi pointed on a nebula and saw the gaseous spectrum for the first time in consequence of this announcement. This may not seem important now, but it is a portion of the history of astronomy, and if recorded at all, it should be stated correctly.

FIXED STARS.

Dr. Gould's southern zones.—The second volume of the Cordoba observations is at last printed. (Vol. I was the *Uranometria Argentina*.) It contains the places of some 460 southern stars for the large catalogue of 30,000 southern stars, and also 128 zones, containing some 13,000 stars. This is the first installment of a very important work undertaken by Dr. Gould in 1870-'71; which was to prepare a zone catalogue of the region of the sky from (and overlapping) Argelander's southern

zones (which end at -31°) to (and overlapping) Gilliss' zones, yet unreduced, which extend from the south pole to 25° S. P. D. and contain some 27,000 stars.

All the observations (1871-1881) are now reduced, and they make a grand showing.

	Observations.
For the catalogue.....	121,000
Fundamental stars.....	14,000
In the zones.....	105,000
Total.....	240,000

About half of these were made by Dr. Gould himself. The total number of individual stars is about 73,000 in the zones and 30,000 in the catalogue. The individual observations of the same star made in different years agree well, the average discordance being below $0^s.10$ in R. A. and $2''$ in Declination.

One great obstacle to the rapid publication of these volumes is the printing, which has to be done in Buenos Ayres. A meteorological volume (Vol. II) has also just been issued. Dr. Gould may be congratulated on the amount of work which he has accomplished in his ten years of exile. His uranometry, his catalogue of fundamental stars, his large catalogue of 30-35,000 stars, and his zones make a showing of which any observatory would be proud.

The state of our knowledge of the southern sky, so long an unknown region, is becoming satisfactory. The years 1870-1880 have seen great advances. At the Cape of Good Hope, the late Royal astronomer, Mr. E. J. Stone, has printed three catalogues of first-rate importance.

1st. The Cape catalogue of 2,892 stars (epoch 1840) from Maclear's observations (1834-'40).

2d. The Cape catalogue of 1,159 stars (epoch 1860) from Maclear's observations (1856-'61).

3d. The Cape catalogue of 12,441 stars (epoch 1880) from observations by Mr Stone (1870-'80). Nearly all of Lacaille's 9,766 stars have been reobserved for this last catalogue.

From Melbourne we have a fine catalogue (epoch 1870) of 1,227 stars, from observations made by Mr. White (under the direction of Mr. Ellery, Government astronomer) since the observatory was moved from Williamstown.

Lamont's catalogue of 5,563 stars (many in southern declination) was published in 1874 and Yarnall's, which contains some 6,000 southern stars, in 1878. The next ten years will see the complete publication of Schoenfeld's *Durchmusterung* from -2° to -23° ; its extension from -23° southwards by Prof. O. Stone, the publication of Gilliss' zones (from 0° to 25° S. P. D.) by Professor Harkness at Washington, and of Gould's 80,000 zone stars, and very possibly the publication in catalogue form of the Washington zones (1846-'49), containing 38,000 observations.

Zone observations.—In Bessel's southern zones ($+15^{\circ}$ to -15°) and northern zones ($+15^{\circ}$ to $+45^{\circ}$) there are 75,011 observations of 62,000 stars. The actual time spent in observing was 868 hours, 18 minutes, so that on the average a star was observed every $41^{\text{s}}.7$, or at the rate of 83.64 stars per hour. Two observers participated, Bessel and Argelander. In Argelander's northern zones ($+45^{\circ}$ to $+80^{\circ}$) there were 26,424 observations of 22,000 stars. The actual time required was about 320 hours, and an observation was made every $43^{\text{s}}.6$ on the average, or at the rate of 82.56 per hour. In Argelander's southern zones (-15° to -31°) there were 23,250 observations of 17,600 stars. The time employed was about 281 hours. On the average an observation consumed $43^{\text{s}}.5$, or the rate was 82.75 stars per hour. In Argelander's, as in Bessel's zones, two observers participated.

In the Washington zones (1846-49) only one observer was employed at each instrument. The rates are as follows: Meridian Circle Zones, 1846, 4,137 observations were made in $178^{\text{h}} 19^{\text{m}}$, or at the rate of 23.20 per hour; Meridian Circle Zones, 1847, 1848, and 1849, 7,388 observations were made in $227^{\text{h}} 30^{\text{m}}$, or 32.52 per hour; Transit Zones, 1846-49, 12,029 observations were made in $395^{\text{h}} 55^{\text{m}}$, or at the rate of 30.37 stars per hour; Mural Circle Zones, 1846-49, 14,792 observations were made in $500^{\text{h}} 27^{\text{m}}$, or at the rate of 29.55 stars per hour. It thus appears that two observers working together will do one-third more work than working separately.

At the Strasburg meeting of the German Astronomical Society (September, 1881) reports were made of the progress of the zone observations as usual. These are epitomized as below:

Kasan: Observatory: Zone 80° - 75° . This zone is nearly finished.

Dorpat: Zone 75° - 70° . All the declinations are reduced to 1875.0 and the observations of R. A. partly reduced. The zone is almost completed.

Christiania: Zone 70° - 65° . This zone is also nearly completed.

Helsingfors-Gotha: Zone 65° - 55° . The observations are done and are now being printed.

Cambridge (U. S.): Zone 55° - 50° . The observations were completed in January, 1870, and required 633 nights for about 20,000 observations. The reductions will be finished in 1882.

Bonn: Zone 50° - 40° . The final catalogue is complete as far as 3^{h} .

Lund: Zone 40° - 35° . The observations will be finished in 1882.

Leyden: Zone 35° - 30° . The zones are printed, and the definitive catalogue is in preparation.

Cambridge (England): Zone 30° - 25° . Eight hundred and twenty-eight stars are yet to be observed.

Berlin: Zone 25° - 20° . This zone is observed by Dr. Becker, and 80 per cent. of the observations are made.

Berlin: Zone 20° - 15° . This zone is observed by Dr. Auwers, and is nearly completed.

Leipsic: Zone 15° - 5° . The zone 15° - 10° has been completed for some

time. The zone 10° - 5° , lately undertaken, will not be finished before 1885.

Albany: Zone 5° - 1° . Some 600 observations are yet to be made, 17,000 having been made.

Nikolaief: Zone $+1^{\circ}$ - 2° . No reports were received.

We learn from a recent letter of Prof. O. Stone, director of the McCormick Observatory, that his *Durchmusterung* (or zone observation of all the stars from the first to the tenth magnitude inclusive), from -23° southwards, is progressing rapidly. The zones are 1° wide, and four zones are nearly finished, so that printing may commence this year. Schoenfeld's *Durchmusterung* (from -2° to -23°) is also nearly ready for publication.

Definitive positions of the red stars.—Part IV. of the *Astronomical Observations and Researches made at Dunsink, the Observatory of Trinity College, Dublin*, contains the mean places of 321 red stars, deduced from observations made with the meridian circle at Dunsink by Dr. J. L. E. Dreyer.

The work contains about 1,140 observations of the 321 stars, each of which has been observed on the average three and a half times. Of these observations, 445 were made by Dr. Copeland in 1875-'76, and the remainder by Dr. Dreyer in 1878-'80.

The epoch of the catalogue is 1875.0, and the system is that of the *Astron. Gesell.* zones, so that subsequent comparisons will be easy. The work begins with an account of the Pistor & Martins meridian circle. Its aperture is 6.38 inches, focus 8 feet. The power used has been 180. This circle is similar in design to those of Ann Arbor, Albany, Copenhagen, Leyden, Washington, and Leipsic. The standard clock by Dent is mounted in the observing room. The observations have been made by eye and ear over wires only $3^{\text{a}}.2$ apart, and Dr. Dreyer says, what is tolerably clear, that this interval is too small.

The pointing in declination is done by means of two threads 14 inches apart.

There is a difference in the size of the (exactly cylindric) pivots equal to $-0^{\text{ins}}.10$. The *collimation* has been determined over mercury. The *equator-point* has been determined from the zero stars of the *Astron. Gesell.* The latitude is not definitively determined, but is taken at $53^{\circ} 23' 13''.0$.

There is a difference in the horizontal flexures of the instrument, Cl. E. and Cl. W., but the absolute flexure is small. Both circles are finely divided, and the division errors of each are given. The eight micrometer screws have been twice investigated. The constants of the instrument have been investigated by all the various methods, and the results by the various ways agree well.

Dr. Dreyer would confer a favor if he would describe in detail his plan for getting the exact position for the counterpoise weights referred to on page 7 of his work. It would be interesting to know how much

weight is allowed to remain on the Ys in the various meridian circles of the world. The *reductions* are purely differential, as has been said. The refraction is computed by Bessel's tables, with the Greenwich modification.

The probable error of a clock correction derived from one star is $\pm 0^s.052$, and of a single determination of the equator-point $\pm 0''.55$, or from four stars $\pm 0''.28$. The resulting *p. e.* of a single declination is, above -10° , $\pm 0''.63$, and from -10° to -26° , $\pm 0''.73$.

For comparison with this work we can refer to the Ann Arbor declinations of 195 stars, made with a circle of exactly the same size as that of Dublin, and also by the same makers, published by the Washburn Observatory (1881).

This catalogue was observed by Mr. Schæberle in 1879, and the *p. e.* of a single night in declination is $\pm 0''.55$; in R. A. $\pm 0^s.040$ sec. δ . Schjellerup at Copenhagen (10,000 stars, p. xvi), found between 0° and $+15^\circ$ *p. e.* in Dec. $\pm 0''.69$, and between 0° and -15° , $\pm 0''.95$.

The magnitudes of the stars have been assigned on Argelander's scale, and a note of the color of each star is given for each observation.

The main object of the work is to bequeath good determinations of position of a large number of red stars, which may serve hereafter to show if the red stars as a class have any peculiarities of proper motion.

Besides this object, another has been attained, in that 321 red stars have been observed for color and magnitude on three or four nights each on the average.

Dr. Dreyer has now undertaken the observation of a large number of zero stars for Schoenfeld's *Durchmusterung* with this circle, which, like the large refractor of the observatory, is not destined to be idle.

Double stars.—No. 6 of "Publications of the Cincinnati Observatory" has been issued. It contains micrometrical measures of double stars made with the 11-inch refractor in 1879-80, consisting partly of observations preliminary to the formation of a general catalogue of known double stars situated between the equator and 30° south declination, and partly of observations of objects which Mr. Burnham has found to need re-observing. The cases of notable differences from previous measures are collected in the introduction. The refractor appears to have been much improved since the object-glass was refigured by Messrs. Alvan Clark & Sons.

The double star observations of Baron Dembowski are to be published in the *Atti della R. Accademia dei N. Lincei*. They will fill three to four of the (quarto) volumes, or about 1,500 pages in all, and are to be edited by Professor Schiaparelli.

Variable stars.—Prof. E. C. Pickering, of Harvard College Observatory, has prepared and published in pamphlet form a plan for securing observations of the variable stars. It is well known to astronomers that this observatory is doing systematic work in the study of the variable

stars, and this plan has been devised to bring this interesting branch of astronomy to the attention of observers generally, and to secure desirable and needed co-operation in it. The work is easy but very useful, and the plan is so minutely developed as to offer a delightful field of study to amateurs for observation with the naked eye, the common opera-glass, or the small telescope. Correspondence is desired with any persons who wish to undertake this work.

Mr. G. Knott, writing from Cuckfield on May 29, states that he had caught a maximum of the apparently capricious variable star "*U Gem-inorum*" on May 27 or 28; on both nights it was about $9^m 9$. This, compared with the previous maximum noted by the same observer on February 28, gives a period of eighty-eight days.

Professor Schoenfeld finds that a star R. A. $16^h 13^m 36^s$., Decl. $-7^\circ 21'.0$ for 1855 is variable.

A star in R. A. $19^h 17^m 33^s$., Decl. $-21^\circ 32'.3$ for 1850, must be variable to a great extent—6.5 to 9.0 at least.

Mr. S. C. Chandler has made the very interesting discovery that the period of the star, D. M. $+1^\circ$, No. 3408, is not $5\frac{1}{4}$ days as was at first supposed, but considerably less than one day, viz, $20^h 7^m 41^s.6$. The error arose from the star having been visible for some time only in the early evening. The minimum could therefore only be observed at intervals of 5.03 days, *i. e.*, 6 periods, or sometimes 5.87 days, *i. e.*, 7 periods. A combination of these resulted in the period assigned. All the variations from maximum to minimum, and back to maximum, are accomplished in about four hours, the maximum brightness being maintained for sixteen hours. This star therefore has the shortest period known, and is the most remarkable for the rapidity of its changes. The duration of increase and of decrease appears to be exactly equal, and the range is about seven-tenths of a magnitude, from 6.0 or 6.1 to 6.7 or 6.8.

The star D. M. $+8^\circ$, 4899, was observed by Dr. Krueger (1853, August 29) as 9.5 magnitude and by Dr. Schoenfeld (1854, September 20) as 9.5 magnitude, and it was not seen by Schoenfeld in a zone observed 1854, September 16. Dr. de Ball calls attention to the fact that, on August 13, 1882, it was barely visible in the eleven-inch refractor of the Bothkamp Observatory.

In a recent paper presented to the Saint Petersburg Academy of Sciences, Dr. Lindemann, of Pulkova, has investigated the effect of the red colors of stars on estimates of their magnitudes. His observations have been made with a Zoellner's photometer, and he has compared the results of Rosen and Wolff with his own. This is not the place to indicate his methods, which indeed are laid down in Zoellner's well-known work; but we may quote his general conclusion, to the effect that in matching an artificial star produced by the photometer, with a red star, the accidental errors are very great compared to similar comparisons with white stars, and that in general the sensibility of the eye to red rays is three or four times less than to blue. The errors may amount to

at least one magnitude, and he concludes that we should look with doubt upon red variable stars where the variability is less than a magnitude or so.

Parallax of the star Bradley 3077.—Dr. Gylden has lately published the results of his micrometric comparisons of this star with neighboring ones. His memoir gives the parallax as $0''.28 \pm 0''.045$. Professor Bruenow found by a similar method the parallax to be $0''.07 \pm 0''.02$.

In this connection a recent paper by Dr. Backlund, of Pulkova, is interesting, as it gives the reduction of some observations begun by Dr. Wagner on the same star. These observations were made by means of differences of R. A. with the transit instrument, and they were discontinued as the comparison stars were too faint to observe during the whole year. From the incomplete series Dr. Backlund has obtained the following results:

Twenty-seven comparisons with star *a* give $+ 0''.20 \pm 0''.080$.

Thirty-two comparisons with star *b* give $+ 0''.21 \pm 0''.078$. This star has thus a small parallax.

Parallaxes of Alpha Lyrae and of 61 Cygni.—During 1800 and 1881 Professor Hall, of the Naval Observatory, observed for the parallaxes of these two stars on 77 and 66 nights, respectively, using the 26-inch equatorial and micrometer I, with an eyepiece magnifying 383 times. The results have been printed in the Washington observations for 1879. The observations are of extreme precision, the probable errors of a single distance in the case of *Alpha Lyrae* being $0''.075$ and in that of *61 Cygni* $0''.081$.

A temperature coefficient was found for the screw from observations of Δd made during the series. The range of temperature was 42°F . If this coefficient be used to reduce the 900 observations of transits made in 1875, in which the range of temperature was 47° (Wash. Ast. Obs. 1877, App. I), the probable error of the resulting R_0 is $\pm 0''.0020$. If the temperature coefficient is omitted, the probable error is less than this. As far as this goes, it would indicate that the coefficient is doubtful.

At any rate, its introduction will not affect the values of the resulting parallaxes, which are:

<i>Alpha Lyrae</i>	$0''.180 \pm 0''.006$
<i>61 Cygni</i>	$0''.478 \pm 0''.014$

It will be interesting to compare these results with preceding ones.

For *61 Cygni* we have—

Bessel	$0''.357$
Bessel & Schlüter	0.536
Johnson, 1st	0.526
Johnson, 2d	0.192
Struve	0.511
Auwers	0.564
Peters	0.349
Ball	0.465

For *Alpha Lyrae* we have—

Struve	0".261
Main	0 .154
Brunnow, 1st	0 .131
	etc., etc.

Professor Hall's work is especially interesting from the uniformity of the measures and from their great precision, as well as showing the fitness of the large telescope for such work.

At the Dublin Observatory, Professor Ball has nearly completed his investigation of the parallax of *Mu Cephei* and of *Struve* 2486. The meridian circle is to be employed in determining the positions of about 1,000 stars between -2° and -23° for Dr. Schoenfeld.

Parallaxes of southern stars.—*Alpha Centauri*, *Beta Centauri*, *Epsilon Indi* and *Sirius* are being observed at the Cape of Good Hope for parallax. Two observers, Mr. Gill and Dr. Elkin, are making independent series on the four stars. Dr. Elkin's observations will be completed in September, 1882, and Mr. Gill's in March, 1883. The work is done with Mr. Gill's heliometer. Mr. Gill expresses his admiration for the new heliometer just made by the Repsolds for the Yale College Observatory, which he regards as the most perfect micrometric apparatus in the world.

At the Cape of Good Hope much time was spent in 1881 on the determination of the longitude Aden-Cape, which is now completed. The Cape catalogue for 1850, containing 4,715 stars, will shortly be published.

Over 600 occultations, observed since 1834, have been reduced (by means of Newcomb's standard stars) and will be compared with Hansen's tables by Professor Newcomb.

Under date of May 11, Professor Stone, of Cincinnati, writes: "In observing one of our D. M. zones (-23° Dec.) a remarkable vacuity was found in the region between $16^{\text{h}} 17^{\text{m}}$ and $16^{\text{h}} 25^{\text{m}}$ right ascension. In this region there is no star brighter than 9.5 mag., and only one of that magnitude."

Stellar Spectra.—From the report of the Astronomer Royal for 1882, we extract the following account of his spectroscopic observations of stars: "During the twelve months ending May 20, 1882, the sun's chromosphere has been examined with the half-prism spectroscope on 36 days, and on every occasion prominences were seen. On one day a detailed examination of the whole spectrum of the chromosphere was made at 24 points on the sun's limb. Several prominences have shown great changes in the course of two or three minutes, and large displacements or contortions of the bright lines, indicating very rapid motions of approach or recession, have been noted. In particular, a prominence examined on May 13, 1882, was observed to rise through a space of about $30'$ in less than two minutes, being at the rate of about 110 miles a second, whilst the C line showed a displacement towards the red gradu-

ally increasing from 1.25 to 11.4 tenth meters, corresponding to a motion of recession increasing in two minutes from 36 to 330 miles a second. Thirteen sun-spots have been examined on 20 days with reference to the broadening of the lines in their spectra. The strong black lines or bands in the part of the spectrum between *b* and F, first noticed in the spectrum of a spot on November 27, 1880, have been generally observed to be present in the spectra of spots during the last twelve months, besides several fine lines in the same region of the spectrum to which there is nothing corresponding in the solar spectrum.

For the determination of motions of stars in the line of sight, 177 measures have been made of the displacement of the F line in the spectra of 41 stars, 68 of the b_1 line in 19 stars, and 9 of the b_4 line in 5 stars. Of the 61 stars observed, 15 had not previously been examined, and the total number of stars of which the motions have been spectroscopically determined is now 106. In the case of three of the stars observed in the last year, a dispersive power equivalent to that given by sixteen prisms of 60° has been used. A comparison of the successive determinations of the motion of Sirius indicates a progressive diminution from about 22 miles a second, in 1877 and 1878, to about 7 miles a second or less this year, and as other stars do not show anything similar, it appears likely that the change is due to the orbital motion of Sirius. Further observations will, however, be required to settle the point."

THE SUN.

Solar radiation.—Prof. S. P. Langley has submitted to the Chief Signal Officer an abstract of the results of the Mount Whitney Expedition to determine the amount of heat the sun sends to the earth; in technical terms, the solar constant. Mount Whitney, in Southern California, was selected for the observation because it combined the advantages of great elevation, extreme dryness of atmosphere, and abrupt rise from the plain. The party of observation consisted of Capt. O. E. Michaelis, United States Army; two non-commissioned officers of the Signal Service, six soldiers acting as an escort, four civilian assistants, and Professor Langley. Systematic work did not commence until the last days of August, 1881. Professor Langley summarizes the results obtained as follows:

"The approximate estimate of the solar constant is from 2.6 to 3.0 calories, by which is meant that the direct solar radiation before absorption by the earth's atmosphere would in falling for one minute, normally, upon an area of a square centimeter, raise the temperature of one gramme of water 20.6 or 3° centigrade. This implies its ability to melt annually a crust of ice covering the whole earth over 150 feet thick. This amount is one-half greater than the received value of Pouillet, and greater than the latest determinations of Messrs. Crova and Violle."

On the summit of Mount Whitney an ordinary black-bulb thermom-

eter, *in vacuo*, rose 130° Fahrenheit, while the temperature in a blackened copper vessel, covered by two sheets of common window glass, rose above the boiling point. With such a vessel water could be boiled among the snow-fields of Mount Whitney by the direct solar rays.

While the influence of the atmosphere is to shut off from the earth's surface a considerable portion of the sun's heat by absorbing it, the capacity of the air to store heat and prevent its radiation into space serves to make the earth habitable. Otherwise, the surface temperature, even under the tropics, would be lower than the lowest recorded degrees of Arctic cold. Another effect of the selective absorption of the atmosphere is to change the apparent color of the sun. In a transparent atmosphere the now golden sun would appear blue.

Subsequently to this report, Professor Langley read a paper to the Brit. Assoc. A. S., giving an outline of the results he has reached. It is impossible to condense this paper, which is itself a highly condensed account of work extending over several years and covering a varied field.

Solar parallax from observation of minor planets.—Mr. David Gill, H. M. astronomer at the Royal Observatory, Cape of Good Hope, has arranged with a number of observatories in both hemispheres for corresponding observations of the minor planets *Victoria* and *Sappho* about the time of their oppositions in the present year. *Victoria*, in opposition on August 24, will be distant from the earth 0.89 of the earth's mean distance from the sun; and *Sappho*, which comes into opposition in R. A. on September 24, will be within 0.85; so that we have in each case a favorable opportunity of applying the method of determining the sun's parallax which was advocated and also applied by Professor Galle, the director of the observatory at Breslau. In a communication to the *Astronomische Nachrichten*, Mr. Gill states that the necessary extra-meridian observations will be made in the southern hemisphere at the Cape, Natal, Melbourne, and Rio de Janeiro, and in the northern hemisphere at Dunsink (Dublin), Strasbourg, Berlin, Bothkamp, Leipsic, Upsala, Moscow, Clinton, U. S., and probably at Kiel. From the clearer skies of the southern hemisphere, he believes that a fully corresponding number of observations will be secured there, notwithstanding the smaller number of observatories, and he invites co-operation from other establishments in the northern hemisphere on this ground. A list of the proposed stars of comparison is given in his letter.

Maskelyne's value of the solar parallax.—Several inquiries have been lately made with regard to the authenticity of a value of the sun's parallax, attributed in many works to Maskelyne, the former Astronomer Royal. These are answered as follows in *Nature*:

“This value ($8''.723$) was deduced by Maskelyne in an application of what he calls a new method of determining the effect of parallax on transits of the inferior planets, and is given in an article which appears to have communicated to Vince, Plumian Professor of Astronomy

at Cambridge, who published it both in his large work, 'A Complete System of Astronomy,' and in his elementary treatise intended for the use of students in the university. We have not been able to consult the earlier editions of these works to ascertain whether, as is probably the case, the article was published in Maskelyne's lifetime, but it is found in Vol. I of the 'System of Astronomy,' which appeared in 1814, and is dedicated to Maskelyne, and also in the fourth edition of the 'Elements of Astronomy,' Cambridge, 1816. The article is entitled 'A new method of computing the effect of parallax, in accelerating or retarding the time of the beginning or end of a transit of Venus or Mercury over the sun's disk, by Nevil Maskelyne, D. D., F. R. S., and Astronomer Royal.' After explaining his method and how an approximate value may be corrected, as a numerical example he compares the duration of the transit of Venus in 1769 as observed at Wardhus and Otaheite, assuming as an approximate value of the mean horizontal parallax $8''.83$ (nearly that found by Du Séjour), and concludes: 'Hence the mean horizontal parallax of the sun = $8''.83 \times (1 - 0.0121) = 8''.72316$.' In the 'Elements of Astronomy' there is the additional sentence: 'We assume, therefore, the mean horizontal parallax of the sun = $8\frac{3}{4}'$;' but this does not appear in Vince's larger work, nor is it quite clear whether it is an addition of Maskelyne's or his own.

"Lalande says the first edition of Vince's 'Elements of Astronomy' was published in 1790, and Vol. I of the larger work in 1797. Probably some of our readers may be able to refer to the earlier editions."

Solar eclipses.—The British scientific expedition sent to the banks of the Upper Nile to make observations of the total eclipse of the sun, June 17, was every way successful. The chief members of the party were Norman Lockyer, Arthur Schuster, Mr. Woods, assistant, Mr. Lawrence, and Mr. Black. The special correspondent to the London *Daily News* summarizes the results as follows:

"This eventful morning was the finest we have yet had, cool and without a cloud. A great crowd of natives in picturesque costumes lined the road and the hill between the camp and Sohag. The shore of the Nile, except before the observatories, was packed with dahabiyehs bringing the governors of the provinces and other notables to observe the eclipse and do honor to the strangers. Thanks to Moktar Bey, in charge of the camp, and a force of soldiery, there was no confusion. Along a line of three hundred yards the French, English, and Italian observers were left in undisturbed possession of tents and observatories. Nevertheless, while the sky darkened and assumed a leaden hue, the hills bounding the Nile bathed in purple, the great silence gave way, and from the river and palm-shaded slope arose a shout of wonder and fear, which reached its climax at the moment of the sun's disappearance; nor ceased then, for in addition to the horror of an eclipse (which the natives here in Africa attribute to the act of a dragon) there appeared

in the heavens on the right of the sun an unmistakable scimitar. The eclipse had indeed revealed the existence of a new comet. Despite the short totality (one minute and twelve seconds) many valuable results have been obtained. I am permitted to send a copy of the collective telegram sent to the various Governments, showing many new facts touching the sun's atmosphere, though matters have not become much simpler, which means more work. The layer to which much absorption has been ascribed seems vanishing from existence. The band **K** in the spectrum of the corona fully explains the eclipse coloring.

"Among the results, the most satisfactory are photographs of the corona, and a complete spectrum obtained by Schuster on Abney's plates. H and K are the most intense lines. A study of the red end of the spectrum of corona and protuberances was made by Tacchini. A comet near the sun was a striking object; it was photographed, and was observed by the naked eye. Bright lines were observed before and after totality at different heights by Lockyer, with intensities differing from Fraunhofer's lines; by Lockyer and Trepied an absolute determination was made of the place of the coronal line 1474 in Kirchhoff's scale; by Thollon and Trepied the absence of dark lines from the coronal spectrum was noted. Tacchini and Thollon, with very different dispersions, noted many bright lines in the violet. Thollon observed the spectrum of the corona, and Schuster photographed it. The hydrogen and coronal lines were studied in the grating spectroscope of Buisieux, and with direct-vision prism by Thollon. Rings were observed in the grating by Lockyer, of the first, second, and third order. The continuous spectrum is fainter than in 1878, stronger than in 1871. An intensification of the absorption lines was observed in group B, at the moon's edge, by Trepied and Thollon. The whole spectrum, with blue lines on a continuous background, has been photographed. The prominences were photographed with the prismatic camera (showing, of course, ring spectrum). Three photographs were taken of the corona. The comet close to the sun was photographed with the prismatic and also with ordinary cameras."

Solar eclipse of May, 1883.—The following is a summary of a paper prepared by Mr. C. H. Rockwell, New York, and read at the meeting of the American Association:

"The great astronomical event for 1883 will be the solar eclipse to occur on the 6th day of May. At the points of greatest obscuration the totality will last nearly six minutes. Unfortunately, the line of totality is almost exclusively a water track, running from a point about 200 miles back of the east coast of Australia, going northeasterly to 9° south latitude, 130° west longitude, thence toward the coast of South America, terminating about 500 miles from the coast.

"The only island crossed by this line is a small coral reef called Caroline Island; this was discovered by Captain Nares, the Arctic explorer, in 1874, who gave its length at nine miles and width at one mile.

“This point is in 10° south latitude, 150° west longitude, and is probably the only point where the eclipse could be observed. To reach this island a schooner or steamer would have to be chartered especially for the voyage; the expense of such a vessel suitable for the purpose would be about \$6,000.”

It is now probable that this eclipse will be observed by an expedition sent out under the auspices of the National Academy of Sciences and the United States Coast Survey. The party will probably consist of Professor Holden, of the Washburn Observatory, Professor Hastings, of Johns Hopkins University, of Mr. Roekwell, and Prof. C. S. Peirce, of the Coast Survey. Two photographers sent by the Royal Society of London will also join the party.

Solar spectrum.—A new map of the solar spectrum, containing a much larger number of lines than are shown in Angstrom's normal spectrum, has been published by Dr. H. C. Vogel, of Potsdam. Particular attention has been given by Dr. Vogel to the *characters* as well as to the positions of the lines.

Transit of Venus, December 6, 1882.—It is yet too soon to speak of the success of the various observing parties sent out to observe this transit. From reports already received, it appears that the observations were, on the whole, quite successful, although the weather in Europe was bad. Mr. Stone, director of the Radcliffe Observatory, regards the contact observations as alone sufficient for the solution of the problem of the solar parallax, and it is certain that enough photographs have been secured by the United States Government parties and by the Lick Observatory party to insure a good determination by this means also.

The following are the stations of the different parties:

Cape of Good Hope:

Chief astronomer, Prof. S. Newcomb, U. S. N.

Assistant astronomer, Lieut. T. L. Casey, jr., U. S. Engineers.

Additional assistant astronomer, Engineer J. H. L. Holcombe, U. S. N.

Photographer, Mr. Julius Ulke.

Santa Cruz, Patagonia:

Chief astronomer, Lieut. Samuel W. Very, U. S. N.

Assistant astronomer, Mr. O. B. Wheeler.

Photographer, Mr. William Bell.

Assistant photographer, Mr. Irvin Stanley.

New Zealand:

Chief astronomer, Mr. Edwin Smith, United States Coast and Geodetic Survey.

Assistant astronomer, Mr. Henry S. Pritchett.

Photographer, Mr. Augustus Story.

Assistant photographer, Mr. Gustav Theilkuhl.

Santiago de Chile :

Chief astronomer, Prof. Lewis Boss.

Assistant astronomer, Mr. Miles Rock, assistant astronomer,
United States Naval Observatory.

Photographer, Mr. Theo. C. Marcean.

Assistant photographer, Mr. Charles S. Cudlip.

San Antonio, Tex. :

Chief astronomer, Prof. Asaph Hall, U. S. N.

Assistant astronomer, Mr. R. S. Woodward.

Photographer, Mr. D. R. Holmes.

Assistant photographer, Mr. George H. Hurlbut.

Cedar Keys, Fla. :

Chief astronomer, Prof. J. R. Eastman, U. S. N.

Assistant astronomer, Lieut. John A. Norris, U. S. N.

Photographer, Mr. George Prince.

Assistant photographer, Mr. George F. Maxwell.

Fort Thorn, N. Mex. :

Chief astronomer, Prof. George Davidson, United States Coast and
Geodetic Survey.

Assistant astronomer, Mr. J. S. Lawson.

Second assistant astronomer, Mr. J. F. Pratt.

Photographer, Mr. D. C. Chapman.

Assistant photographer, Mr. T. S. Tappan.

Washington, D. C. :

Chief astronomer, Prof. William Harkness, U. S. N.

Assistant, Mr. Joseph A. Rogers.

Assistant, Prof. A. H. Buchanan.

Assistant, Lieut. Comdr. C. H. Davis, U. S. N.

The following is the list of stations selected for the observation of the transit of Venus by English parties, with the observers appointed to each by the executive committee of the Royal Society, acting under the authority of the treasury :

For retarded ingress and accelerated egress :

Jamaica.—Dr. Copeland, Captain Mackinlay, R. A., Mr. Maxwell Hall.

Barbadoes.—Mr. Talmage, Lieutenant Thomson, R. A.

Bermuda.—Mr. J. Plummer, Lieutenant Neate, R. N.

(The Canadian Government will have three observers with six-inch instruments, besides others with smaller telescopes. These observers are acting in direct concert with the British expeditions.)

Accelerated ingress :

Cape Observatory.—Mr. David Gill (H. M. astronomer), Mr. Maclear, second assistant.

Montague Road, Cape Colony.—Mr. W. H. Finlay (first assistant at the Cape), Mr. Pett.

Accelerated ingress—Continued.

Aberdeen Road, Cape Colony.—Mr. Burton, Mr. C. M. Stevens.

Madagascar.—Father Perry, Father Sidgreaves, Mr. Carlisle.

Durban, Natal.—A telescope has been provided by the colonists.

Mauritius.—Mr. Meldrum.

Retarded egress :

New Zealand.—Lieutenant-Colonel Tupman, R. M. A., Lieutenant Coke, R. N.

Brisbane.—Captain Morris, R. E., Lieutenant Darwin, R. E., Mr. Peek.

Melbourne.—Mr. Ellery and staff.

Sydney.—Mr. Russell and staff.

Professor Young has prepared the following table, which gives the results of the observations of the transit of Venus at the time of writing.

The figures 1, 2, 3, 4 denote that the corresponding contacts were observed; *P* denotes that photographs were made on the same plan as those of the Government parties; *P**, photographs on some different plan; *h*, heliometer measures; *h**, measures for the same object as heliometer measures, but made with a different instrument, more or less completely equivalent; *s*, spectroscopic observations; *p*, photometric observations; *m*, micrometer measures of the planet's diameter :

1. Ottawa, Canada—1, 2, 3, 4.
2. Kingston, Canada—2, 3, 4.
3. Cambridge, Mass.—1, 2, 3, 4, *s*, *p*, *m*; several observers.
4. Providence, R. I.—2, *P**, (23).
5. Amherst, Mass.—3, 4.
6. South Hadley, Mass.—3, 4, *s*.
7. Hartford, Conn.—2, 3, 4, *h*, *m*; German party.
8. New Haven, Conn.—1, 2, 3, 4, *P** (150), *h*, *m*; several observers.
9. Helderberg Mountain, N. Y.—1, 2.
10. West Point, N. W.—1, 2, 3, 4.
11. Poughkeepsie, N. Y.—3, 4, *P** (9).
12. Brooklyn, N. Y.—1, 2, 3.
13. Columbia College, New York City—2, 3, 4.
14. Western Union building, New York City—1, 2, 3, 4.
15. University City of New York, New York City—1, 2, 3, 4.
16. Elizabeth, N. J.—2, 3, 4.
17. Princeton, N. J.—1, 2, 3, 4, *P* (188), *s*, *m*; several observers.
18. Philadelphia, Pa.—1, 2, 3, 4.
19. Easton, Pa.—1, 2, 3, 4.
20. Allegheny, Pa.—1, 2 (?), *s*, *m*.
21. Pittsburgh, Pa.—2, 3.
22. Wilmington, Del.—1, 2.
23. Baltimore, Md.—2, 3, 4; several observers.
24. Annapolis, Md.—2, 3, 4.

25. Washington, D. C., Naval Observatory.—1, 2, 3, 4, *P* (53), *m*;
several observers.
26. Washington D. C., Coast Survey.—2, 3, 4; several observers.
27. Washington, D. C., Signal Service.—1, 2, 3, 4.
28. Charlottesville, Va.—2, 3, 4.
29. Aiken, S. C.—3, 4, *h*, *m*; German party.
30. St. Augustine, Fla.—1, 2, 3, 4, *h**, *P** (200), *m*; French party.
31. Cedar Keys, Fla.—2, 3, 4, *P* (180), *m*; Government party.
32. Chicago, Ill.—1, 2; several observers.
33. Madison, Wis.—1, 2.
34. Northfield, Minn.—3, *m*.
35. Iowa City, Iowa—1, 2.
36. Ann Arbor, Mich.—1, *m*.
37. San Antonio, Tex.—3, 4, *P* (204), *m*; Government party.
38. San Antonio, Tex.—3, 4, *h**, *m*; Belgian party.
39. Fort Selden, N. Mex.—1, 2, 3, 4, *P* (216), *m*; Government party.
- Potsdam, Prussia—1, 2, *P**, *s*, *m*.
- Jamaica—1, 2, 3, 4.
- Puebla, Mexico—1, 2, 3, 4, *h**; French party.
- Chapultepec, Mexico—No contacts; *P** (13).
- Cape Town, South Africa—1, 2, *P*; (?) American Government party.
- Durban, South Africa—1, 2.
- Tasmania—3, 4, *P*; (?) American Government party.
- Melbourne, Australia—3, 4, *P** (33).
- New Zealand—3, 4, *P* (236); American Government party.
- Santiago, Chili—Completely successful; *P*; (?) American Government party.
- Santiago, Chili—Completely successful; *h**, *m*; Belgian party.

COMETS.

Comet-seeking.—That the search for comets may be systematic and as general as possible in this country, the following provisional arrangements have been suggested by the *Science Observer*, and almost universally commended by observers interested in the study of comets:

"1. It is proposed to divide the sky into zones of declination, of which each observer has selected or been allotted one or more.

"2. Each observer has expressed his intention to sweep carefully once at least during each month the region selected by him, and some will sweep their zones several times each month. It is to be clearly understood that no observer is in any way confined to his zone, but is allowed to sweep anywhere, according to his judgment or circumstances.

"3. As there are at present in the country three observers who are constantly engaged in comet-hunting as their principal work, it is proposed to secure the complete covering of the sky once during each month by these observers, they having selected the following regions:

Swift, $+ 90^{\circ}$ to $+ 45^{\circ}$; Brooks, $+ 45^{\circ}$ to $+ 15^{\circ}$, and Barnard, $+ 15^{\circ}$ to $- 45^{\circ}$.

"4. To the other observers, who, from college duties or other regular work, can devote a varying part only of their time to comet-seeking, smaller zones have been allotted, as follows: Tiffany, $+ 45^{\circ}$ to $+ 30^{\circ}$; Wendell, $+ 30^{\circ}$ to $+ 15^{\circ}$; Sharpless, $+ 15^{\circ}$ to 0° ; Larkin, 0° to $- 15^{\circ}$, and Rebasz, $- 15^{\circ}$ to $- 45^{\circ}$.

"5. Other observers will keep a record of their observations, but cannot agree to sweep regularly enough to take charge of a zone.

"6. This arrangement of zones secures the sweeping of the sky twice during each month, and their relation to each other provides, as well as possible at present, that the same storm, unless very extensive, will not be likely to interfere with both observers in the same region at the same time.

"7. One of the important results of an organization will be the accumulation of data concerning comets and comet-seeking. It has accordingly been agreed upon by all observers that records of their work will be kept. These will include a statement of the weather, the clearness of the sky, the time spent in search, the region covered, and any matters of general interest that may be of value. Blanks will be furnished to each observer, including a duplicate set for his own use, and these blanks, being returned on the first of each month, will be regularly published in such detail as may be necessary in the *Science Observer*."

Daylight observations of Wells' comet.—At the Dudley Observatory, Albany, this comet was observed on the meridian as early as June 5, just before noon, and again on June 11 and 12, 1882. The aperture of the object-glass of the transit-circle is 8 inches; the focal length of the telescope 10 feet. A detailed description, with engraving of the instrument with which these notable observations were made, will be found in Vol. I of the Annals of the Dudley Observatory. On June 5 the comet was not perceived until forty seconds after transit, and was observed with difficulty on a single wire, but the positions obtained on the subsequent dates were considered very satisfactory. The true nucleus was seen at the observation of June 11, made about sixteen hours after the perihelion passage, and the estimated diameter of the disc was $0''.75$. The nebulosity of the coma was uniform and faint, about $10''$ in diameter. It is stated that "while the nucleus was observed for position, the coma was scarcely noticed at all." The atmospheric conditions on this day were such as are well known to conduce to easy vision of objects in daylight. "The sky was sparsely covered with cumulus clouds, while the intermediate clear spaces were exceedingly transparent." On June 12 the nebulosity had increased in brightness, but the image was very unsteady, and "either for that reason, or because of the increased brightness of the nebulous screen, the nucleus proper could not be seen."

We are not aware that any complete observation of a comet on the meridian at noonday has been made since the year 1744. The grand comet in the early part of that year, first remarked by Klinkenberg at Harlem on December 9, 1743, attained an extraordinary degree of brilliancy towards the end of February. We find Bliss writing on February 12 (O. S.) to Lord Macclesfield, who had fitted up an observatory at Shirburn Castle, thus: "The comet appeared so very bright last night, equaling the light of Venus, that Dr. Bradley agrees that it may be seen on the meridian, and being engaged himself, has desired me to request your lordship to try to observe it. The elements which he left at Shirburn appear, to our last night's and former observations, to give the place true within 2' of longitude and latitude." As a matter of fact the comet was observed on the meridian near noon at Shirburn on the 28th and 29th of February, and at Greenwich on the 29th; these observations will be found reduced in Mr. Hind's paper on the comet of 1744. (*Astron. Nach.*, vol. XXVII.)

Photometric observations of Wells' Comet.—Exact photometric observations of comets have been rare; but Dr. Muller, of Potsdam, has succeeded in obtaining a good series of observations of Comet Wells with a Zollner's photometer, attached to one of Steinheil's refractors. Having found considerable difficulty in measuring the brightness of a comet with this photometer, owing to the great difference in appearance between the comet and the artificial stars, he removed the disk that bore them and substituted an artificial nebula; and the observations from April 21 to May 19, 1882, were conducted with this latter. But as the brightness of the comet increased he reverted to the original disk. Thus his observations form two series which are not exactly comparable. The entire series of observations, which were obtained on 21 days, from April 21 to June 6, showed that the comet increased in brightness much more rapidly than was to be expected from theoretical considerations and calculations, so that it must be concluded that a very remarkable development of the comet's own light took place. The time when this growth of intensity commenced was in the latter half of May, about the time that the bright lines of sodium were discovered in the spectrum. The photometric observations by themselves would have justified the conclusion that in the middle of May extraordinary changes took place in the physical condition of the comet, and this conclusion was thus fully confirmed by the revelations of the spectroscope. From the comparison of the nucleus of the comet with the stars D. M. 49°, No. 3062, and D. M. 49°, No. 3059, it was found that the nucleus of the comet was equal in brightness to a star of the third magnitude on June 6, whilst on May 19 it only equaled one of the eighth or ninth.

Daylight observations of comet 1882 a.—Prof. Julius Schmidt writes to the *Astronomische Nachrichten* that on June, 10, after 3 p. m., in an exceptionally clear sky at Athens, he observed the comet, though with difficulty, in the 6-foot reflector of that observatory.

The great comet of 1882.—It is very seldom that any discovery unites in itself so many and such important points of interest as has been the case with the great comet now engaging so much attention. The report of the discovery by M. Cruls of a new naked-eye comet was in itself enough to arouse a keen degree of interest; for as three such objects had already been observed within the last twelve months, that a fourth should follow in such quick succession was quite an unprecedented event. M. Cruls' discovery had scarcely been published in England before a yet more unusual observation was made. Mr. Common, of Ealing, who ever since the accidental discovery of the comet "Tewfik," during the total eclipse of May 16 last, had persistently examined the neighborhood of the sun with what might well have appeared to be the forlorn hope of detecting some comet wandering there, was at length rewarded, on Sunday, September 17, by the sight of a splendid comet close to the sun, of which he obtained observations.

In the extreme south of Europe more favorable conditions prevailed; and the comet was seen on September 18 at a large number of places in Italy, Spain; and Algeria in full daylight, when only 4° from the sun. And, indeed, Mr. Common was not the only person who was fortunate enough to see it on September 17, before perihelion; for a dispatch from Reus, near Tarragona, announced that there the inhabitants were astonished to see a comet close to the sun, so that, though only $1^{\circ}.5$ distant from it, it was bright enough to catch the eye of casual gazers. Indeed, it was so bright that it could be seen even through light cloud. Its tail could readily be detected by means of an opera-glass furnished with a dark glass. On the following day, however, M. Thollon, at Nice, was able to detect some portion of the tail without even this assistance, for he says: "The coma and part of the tail visible to the naked eye were nearly $20'$ in length. Their outer contour took the shape of a half-ellipse of eccentricity about 4, and the fairly large and very brilliant nucleus occupied a position intermediate between the apex and the focus."

The same cloud-bank which baffled English observers on this and the following days covered the north of France likewise, and in despair of its breaking up, M. de Fonvielle resolved to rise above it, and on Friday, September 22, prepared for a balloon ascent. Fearing, however, that his own sight was not sufficiently good, he resigned his place in the car to M. Maurice Mallet, whom he duly instructed as to the observations to be obtained. The small dimensions of the car greatly hampered the adventurous astronomer, who, however, succeeded in making a sketch, and in obtaining a rough estimation of the distance from the sun and position-angle of the comet.

The cloudy weather rendered it difficult to obtain sufficient observations to form an orbit; but Mr. S. C. Chandler, jr., of Harvard College, at

length succeeded in deducing approximate elements, which showed a remarkable resemblance to those of comet I, 1880, and I, 1843.

Per. pass. = 1882, September, 17.38, G. M. T.	
Long. (Per.—node) = $60^{\circ} 45'$	} Mean equinox, 1882.0.
Long. node..... = 342 29	
Inclination = 140 17	
Log. q = 7.54407.	

The resemblance of the orbit of the great comet of 1880 to that of the still finer one of 1843 had attracted the earnest attention of astronomers at the time, and most had been led to consider them one and the same body.

And now the appearance of a third magnificent object on the same, or nearly the same, track revived the discussion which took place in 1880. Then three leading theories had been started.

The first, of least probability and but little received, saw in the comet of 1843 a return of the comet of 1668, and supposing the comet of 1702 to have been another return of the same object, considered that we had here a comet with a period of about 35 years, which had been apparently slowly increased to one of 37 years. But this theory rested on but very slender foundations; and, if true, it is obvious that our present visitor can claim no identity with his predecessors in the same path. Professor Weiss, of Vienna, holding a somewhat similar view, ascribed to the comet a constant period of about thirty-seven years, and identified it with those of 1106, 1179, 1363, 1511, and 1695, but not with that of 1668.

A second theory suggested that the comets of 1843 and 1880 might now be independent comets traveling on the same track, the original parent comet having suffered disruption at some much earlier visit, and the fragments having become so widely separated that an interval of thirty-seven years now takes place between their perihelion passages. In any case it was felt that the hypothesis that so brilliant an object could have frequently returned without any observation having been made of it was quite incredible.

A third and more popular theory regarded, indeed, the comets of 1668, 1843, and 1880 as one and the same object, but supposed that its period was gradually being shortened through the resistance experienced by the comet whilst passing through the solar atmosphere at perihelion. M. Meyer went further back, and regarded Aristotle's comet, B. C. 371, as the next earlier appearance to that of 1668. This theory seemed to receive strong confirmation by the apparition of the present comet, and further information seemed to lend it greater force.

The great comet which had borne the names of Thollon, Common, and Cruls, who had each in turn discovered it independently, now proved to have been still earlier discovered by Mr. Finlay, first assistant at the Cape Observatory, who remarked it at five o'clock in the morning

of September 8, and who obtained the following place for it on the following day:

Cape mean time.	R. A.	Decl.
September 8, 17 ^h 23 ^m 58 ^s	144° 59' 51".4	-0° 45' 30".0

Mr. Finlay had been more fortunate than the subsequent discoverers, not only in thus anticipating them by several days, but in being able to retain his hold on the comet right up to its conjunction with the sun; and Mr. Gill was able to inform the Astronomer Royal that, "on Sunday, September 17, the comet was followed by two observers with separate instruments, right up to the sun's limb, where it suddenly disappeared at 4^h 50^m 58^s Cape mean time." This observation is wholly unprecedented in the history of astronomy, and proved most valuable as showing how exceedingly unsubstantial the comet was, for the sun's brilliancy could not, as some have supposed, account for the disappearance. Had it been so bright as to have become invisible, neither bright nor dark, in the center of the sun's disk, it would have appeared as a bright object when seen against the comparatively dull background of the regions near the limb. Had it harmonized with the degree of splendor of the limb, it would have looked dark on the disk. There was not, therefore, enough solid matter, or that matter was not sufficiently aggregated, for it to appear as a spot or a cloud, bright or dark, whilst in transit.

Mr. Hind had meanwhile computed an orbit, which compares as follows with those which Mr. Tebbutt obtained for the 1880 comet, and those of Professor Plantamour for the comet of 1843:

	Comet 1843.	Comet 1880.	Comet 1882.
Per. pass			Sept. 17. 2169
π	278° 18' 3".0	277° 22' 53".4	*276° 14' 36"
Ω	0 51 4.1	358 22 48.6	*346 6 58
i	35 45 39.0	36 41 41.9	*57 58 59
q	0.005807	0.0067243	0.0080656
Motion	Retrograde.	Retrograde.	Retrograde.

* App. eq., Sept. 25.

Sun's radius 0.004664 (sun's mean distance = 1).

But this orbit would give the comet's distance from the center of the sun at the time of Dr. Gill's remarkable observation, on September 17, as only 10'.9; that is to say, it should have been far on the disk, and fully 5' from the limb at the time when it was actually seen to be only just entering the limb. Mr. Hind cannot think this discrepancy due to faults in the elements, for they represent the middle position within 1', and the first observation was taken only twenty hours after the one at the Cape with which the elements are in so little accord. There is, therefore, strong reason to believe that the comet's speed received considerable alteration whilst in the immediate neighborhood of the sun, and Mr. Hind suggests the probability of its return in October, 1883.

Mr. Chandler, using the above-mentioned Dun-Echt observation, with one made at Washington, September 23, and Cambridge, United States, September 30, found that a parabolic orbit gave considerable deviations in the middle place, and deduced therefore the following elliptic elements. The elliptic elements obtained by Professor Plantamour, for the comet of 1843, and by M. Meyer, for that of 1880, are given for comparison:

	Comet 1843.	Comet 1880.	Comet 1882.
Per. pass			Sept. 17, 1880, G. M. T.
Ω	355° 46' 48".4	356° 16' 43".2	346° 51' 58"
w	77 43 57.9	77 53 55.9	71 39 3
t	143 1 31.2	143 7 46.8	142 35 51
Mean eq.	1880.0	1880.0	1882.0
Log. q	7.8394780	7.7720495	7.943416
e	0.999117	0.999467	0.997898
a	7.82165	11.08090	4.17535
Period	21.875 years.	36.91 years.	8.532 years.

A comparison of the orbit with whatever observations were available seemed to Mr. Chandler to confirm the periodical nature of the comet, although further observations will be necessary to fix the period with precision.

The physical appearance of the comet which, like that of 1843, and unlike that of 1880, showed at first a decided nucleus, together with the above intimation of a period very considerably greater than that of the internal from 1830, January 27, the date of perihelion of the 1880 comet, suggest that perhaps the 1843 comet suffered disintegration when at its nearest approach, and that the 1880 comet was a portion of its less condensed material, whilst the body of the comet, with the principal nucleus, suffering less retardation than the separated part, has taken two and a half years longer to perform a revolution. The remarkable discovery made by Professor Schmidt, of Athens, on October 8, of a second comet only 4° S. W. of the great comet, and having the same motion, would seem rather to confirm this view.

The spectroscopic observations of the comet have only been less interesting than the questions of its orbit and identity. M. Thollon, who examined its spectrum on September 18, with a Steinheil spectroscope, having one prism of 60° of dense flint, in conjunction with a horizontal telescope of 9 inches aperture, into which the light of the comet was reflected by means of a siderostat, gives the following description of it:

“Although working in full daylight, the spectrum of the comet was very bright; its leading characteristic was the presence of the bright lines of sodium. We at once saw in the field of the instrument a tolerably distinct spectrum, due to the scattered light of our atmosphere, in which the dark Fraunhofer lines could be distinguished. Upon the background of this spectrum a narrow and much more brilliant continuous spectrum, given by the nucleus of the comet, was seen clearly detached. From the height of the spectrum we estimated the apparent

diameter of the nucleus as about $15''$. This spectrum stretched very far into the violet. The bright lines of sodium D_1 and D_2 were given at the same time both by the nucleus and by the neighboring regions. From their length we estimated the apparent diameter of the part of the comet which displayed them at 1.5 . They were neither diffused nor broadened, but narrow and perfectly separated, and exceedingly bright, especially in the spectrum of the nucleus. They were nearly of the same brilliancy, however, the most refrangible seemed a little the brighter, and they were, in short, exactly like the lines given by a flame moderately charged with sodium, both in brightness and in their essential characteristics. Of their identity there can be doubt, for besides the characteristics which we have just pointed out, we compared their positions with those of the Fraunhofer lines D_1 and D_2 , given by the spectrum of the diffused daylight. We ascertained that the bright lines of the comet were not exactly superposed on the Fraunhofer lines, but were both displaced towards the red by a very small amount, the same in each case, equal perhaps to $\frac{1}{2}$ or $\frac{1}{3}$ of the interval between D_1 and D_2 . We therefore concluded that the comet was traveling away from the earth at that moment. We intended to measure this displacement the next day, and prepared a more powerful spectroscope for this purpose; but the state of the sky did not give us the opportunity. No part of the comet showed us the bands of carbon, nor any band or line other than those of sodium, perhaps on account of the diffused light, which would be able to mask bands of small brilliancy.

"The singular analogy between the spectrum of this comet and that of comet Wells, observed some months ago, will doubtless appear the more remarkable, as preceding comets have never shown the lines of sodium."

But as the comet has receded from the sun, the ordinary cometary hydrocarbon bands have made their appearance, and the ordinary yellow, green, and blue bands had become very conspicuous on October 1, whilst the sodium lines were very much fainter. M. Ricco, at Palermo, observing up to October 11, found the spectrum of the tail perfectly continuous, and could trace it right to the end. The three hydrocarbon bands were only given by the nucleus and a region of some $5'$ radius round it.

These changes in the spectrum, as the comet recedes from perihelion, combined with the reverse changes witnessed in that of comet Wells as it approached it, seem to render it not unlikely that sodium would appear in the spectrum of any comet which should approach the sun sufficiently nearly; that it is, in fact, an indication of excessively high temperature, as the hydrocarbon bands are of one not quite so great. An intermediate spectrum of which no definite details have yet been supplied seems to have been observed at Dun-Echt and elsewhere. M. Ricco speaks of having seen many lines up to September 27, a band in the red, a line in the yellow near and after D_1 , two others in the green,

and an enlargement of the continuous spectrum in the green and blue, but was able to make no measures. Had determinations of the positions of these lines been possible, we might have had much very interesting information.

The tail of the comet has throughout resembled that of the 1843 comet, it being nearly straight and very brilliant. M. Cruls represents it as being about 30° long about ten days after perihelion. M. Ricco gives its breadth as varying on different days from $1^\circ 48'$ to $2^\circ 28'$. The southern edge has appeared stronger and brighter than the northern, sometimes remarkably so, and, though nearly straight, it is slightly convex towards the south. The nucleus, circular at first, has shown a strong tendency to lengthen, and M. Ricco has observed it as double.

Astronomers will continue to seize on every possible opportunity of watching this most remarkable and interesting object as long as it remains within our view, even without the stimulus afforded by the expectation of seeing it plunge into the sun, as it has been confidently prophesied it will shortly do. If it should turn out as here suggested, that the present is but its second return, in modern times at least, we may have to wait longer for the final catastrophe than is perhaps generally expected; and the present behavior of the comet would perhaps seem to indicate that its fate will be accomplished rather by a gradual disintegration than by a sudden headlong plunge into the solar orb.—*Observatory*, 1882, November.

The comet of May 17, 1882.—M. Trépiéd, in an account of his observations made in Egypt during the total solar eclipse of May 17, which was communicated to the Academy of Sciences on the 19th instant, has the following interesting note:

“Towards the middle of totality, I perceived to the right of the sun, a streak of light, slightly curved at the lower part, having a singular appearance and in evident discordance with the rest of the corona. I did not for an instant suppose that it could be a comet, and only recognized its nature an hour after the eclipse on comparing my sketch with one of the photographs obtained by Dr. Schuster. That photograph plainly showed the nucleus at a distance from the edge of the sun a little greater than the diameter of that body; the direction of the tail agreed well with what I had drawn, but I had stopped the streak at much too short a distance from the edge. I did not, however, believe that it would be allowable for me to change anything in my drawing.”

The sketch referred to is copied in the *Comptes rendus* of the above sitting of the Academy. M. Trépiéd further remarks:

“The brightness of the comet appeared to me the same as that of the external parts of the corona.”

The position of the observing station, as provisionally determined by M. Trépiéd, is in longitude $1^h 57^m 40^s$ east of Paris, and latitude $26^\circ 33' 21''$, where the middle of totality occurred at $8^h 31^m 53^s$ a. m. local mean time. M. Trépiéd says in the week following the eclipse he searched

for the comet many times before sunrise and after sunset, but without detecting it.

The comet has been sought for elsewhere, though unfortunately without success.

The refractive power of comets.—The great comet 1881, III, passed near to faint stars on several occasions, so near that the stars were certainly shining through the cometic substance. During three such opportunities, Dr. Meyer, at the Geneva Observatory, made a series of micrometer measures on the relative positions of the star and the comet's nucleus. This last was sharp and well defined like a star.

The preliminary reduction of these measures showed that the light of the star suffered a refraction in its passage through the comet's head. The whole question of such a refraction was examined by M. Cellierier (Archives des Sciences, etc., de Genève, October, 1882) under the supposition of a variable density to the cometic matter, which was further supposed to act like a true gas. The theoretical solution of the problem is given in a simple form. Dr. Meyer has applied the theory to the cases in hand, and obtains from the three stars the following values of e , which is the refractive power of the cometic matter (supposed gaseous):

$$29 \text{ June, } 1882, e = 0.00000916; 14''.3 = d_1.$$

$$13 \text{ July, } 1882, e = 0.0000299; 25''.3 = d_2.$$

$$1 \text{ August, } 1882, e = 0.0000317; 24''.6 = d_3.$$

The numbers d_1, d_2, d_3 , are the shortest distances of the stars from the comet's nucleus, reduced to what they would have been if seen all from a distance 1. Supposing the density of the gas to be proportional to the square of the distance, and the refractive power of the gas to be directly proportional to the density, the three values of e above can be reduced to the following three numbers which express (on this hypothesis) three different determinations of the refractive power of the gas at a distance of $14''.3 = 102,000$ kilometers.

$$29 \text{ June, } e_0 = 0.00000916.$$

$$13 \text{ July, } = 0.0000936.$$

$$1 \text{ August, } = 0.0000938.$$

Dr. Meyer epitomizes his results as follows:

“The substance which composed the head of comet 1881, III, behaved optically like a gas, and its refractive power at a distance of 102,000 kilometers from the head was 0.0000093. This refractive power, and hence the density of the gas itself, varied as the square of the distance from the comet's nucleus.”

Professor Bredichin has issued the first part of Vol. VIII of *Annales de l'Observatoire de Moscou*, which, in addition to meridian observations, contains a continuation of his researches upon the tails of comets, the present publication including the comets 1881 *b* and *c*, and the fourth or great comet of 1825. Professor Bredichin has reprinted the long series of physical observations on the latter body made by Dunlop at

Paramatta, N. S. W., which originally appeared in Brewster's *Edinburgh Journal of Science*, 1827, and which have been a good deal overlooked, that periodical, on the Continent at least, not being easy of access, Dunlop's drawings are reproduced, and there are several figures of the two bright comets of 1881. With regard to his investigations generally, Professor Bredichin concludes:

“My researches on all the comets of which I have been able to find observations in astronomical literature (33 comets), place me now in a condition to calculate in advance, for each great comet that appears, the positions and the figure of its tails of all three types. It is evident that the relative amount of matter in tails of different types cannot be determined in advance, and, consequently, observation alone can show us the relative brightness of the types and the possible absence of one or another of them. But, in every case, the positions and the general form of such of the tails as become visible will be in accord with the positions and figure calculated beforehand.”

PLANETS.

Vulcan.—In the report of the director of the Washburn Observatory for 1882, is given an account of experiments with the Watson Solar Observatory. This we give in full, as it probably will not be published elsewhere, and on account of the general interest in the success of this experiment.

The solar observatory was devised for the purpose of seeing a planet or stars in the daytime.

It consists essentially of a covered cellar large enough to contain an observer and a six-inch telescope. From the north wall of this cellar a tube 12 inches in diameter and 55 feet long is directed to the north pole. At the upper (north) end of this tube a heliostat, or mirror driven by clock-work, is to be placed. The idea is that the images of stars will be reflected down the tube by the mirror and seen by an observer in the cellar through the telescope. When I took charge of this observatory the building was entirely incomplete, and no instruments were available for trying the experiment. I have borrowed from Professor Langley, director of the Allegheny Observatory, a heliostat suitable for the purpose, and the regents of the university have bought from Mr. Burnham, of Chicago, his six-inch Clark telescope; and the building has been completed. Six weeks have been spent in thoroughly trying the experiment. The trial is now concluded, and the result is that the solar observatory is not suitable for showing stars as faint as the third magnitude in the daytime, even when they are distant from the sun.

Therefore there is no use in proceeding further with this means in the search for Vulcan, which was estimated by Professor Watson to be of the four-and-a-half magnitude, and which, from the nature of the case, must always be near the sun. The details of the experiment are given in the following extract from the annual report:

"The solar observatory was destined by Professor Watson for two purposes: First, spectroscopic and photographic observations of the sun itself; and, second, for observations of the immediate neighborhood of the sun for the detection of a planet (Vulcan) interior to Mercury.

"The magnitude of Vulcan was estimated by Professor Watson at four and one half, that is, it has a light about one-twentieth as brilliant as that of an average first-magnitude star—Alpha Lyra, for example. If seen at all, it must be seen in the daytime, and close to the sun.

"During the months of June and July experiments were made to determine the fitness of the observatory for the detection of Vulcan. In these experiments the six-inch telescope bought by your Board from Mr. Burnham was mounted in the cellar of the solar observatory on June 8—its objective and eyepiece having been carefully adjusted previously. To get an idea of the advantage gained by the inclined tube of the solar observatory I reduced the aperture of the fifteen-inch telescope in the dome to six inches, and put on an eyepiece similar to that used on the small refractor. Both telescopes were then pointed to the north pole. Two observers, one at each telescope, noted times of the first appearance of the small stars about the north pole as evening twilight disappeared. A map had been prepared previously giving these stars. If the fifty-five-foot dewcap gave a material advantage, then these stars should have been first seen with the solar observatory telescope. In fact, they were first seen by this, but only by about two minutes on the average. This experiment was tried on June 8, 11, and 12.

"The excellent heliostat lent by Dr. S. P. Langley, director of the Allegheny Observatory, was placed on its pier June 12, and adjusted. This instrument was exactly fitted for the purpose, and was in perfect order.

"Observations were made to find stars in the daytime every clear day between June 15 and July 12, without result. The place in the sky to which the heliostat mirror was pointed was fixed by setting on the sun at a given hour; and the fact that this setting was not changed by accident was established by observing the position of a small pointer which was added to the heliostat.

"The latter trials were made with a heliostat mirror, set for the place of the brightest star in the Pleiades, and on three days this group was looked for about the time of its passing the meridian. Forty or fifty minutes were thus spent daily.

"There must have been in the field of the telescope (30 degrees) the following stars:

"*a* Eta Tauri—3.4 mag. (twice as bright as Vulcan).

"*b* Pleiadum—4.5 mag. (as bright as Vulcan).

"*d* Pleiadum—5 mag. (fainter than Vulcan).

"*f* Pleiadum—4.5 mag. (as bright as Vulcan).

"*h* Pleiadum—5.6 mag. (fainter than Vulcan).

"At this time the sun was some 50 degrees east of the Pleiades. No stars were seen at any time. The position of the mirror for the Pleiades was verified by finding a group of stars at night-time in the predicted place. The original setting was made through the sun.

"I am satisfied, therefore, that there is no use in prosecuting this particular experiment further. The instruments employed were as perfect as possible. Every conceivable precaution was taken, and it was shown that this apparatus was not suitable for seeing stars of the magnitude of Vulcan, even distant from the sun. It would, therefore, be a waste of time to look for such stars close to the sun.

"It is to be noticed that no evidence has been collected in regard to

the existence or non-existence of Vulcan. It has simply been shown that this device is not suitable for detecting such a planet.

"I may mention that, during the summer of 1881, this same experiment was tried by Dr. Langley, with far more satisfactory arrangements than those of the solar observatory, and that it was a failure with him also, and that Professor Harrington, of Ann Arbor Observatory, also failed to find any material advantage with a (horizontal) tube 150 feet long."

The Earth.—We extract from the *Academy* the following review (by G. F. Rodwell) of an important book entitled *The Physics of the Earth's Crust*, by the Rev. Osmond Fisher:

"The author in twenty-one chapters discusses the principal facts connected with the interior heat of the earth, the elevations and depressions of its surface, and the causes and effects of volcanic action. He shows that the rate of increase of temperature, as the distance beneath the earth's surface is augmented, is, on the whole, an equable one, and may be taken to average about 1° F. for every fifty-one feet (misprinted degrees, p. 267) of descent. And thus at a depth of about thirty miles all known rocks would be in a state of fusion. As to the condition of the interior of the earth, we are first led to a discussion of the density. The surface density is between 2.56 and 2.75, while the mean density of the whole earth is 5.5. Thus the density considerably increases as we approach the center of the earth. Everything points to the conclusion that the earth has once been in a molten condition; the main question for consideration is whether it is still molten within, or whether this condition has passed away, and it is now solid. It has been thought by some, however, that the interior of the earth may be 'potentially hot'—that is to say, really solid, on account of the enormous pressure to which it is subjected, but ready to become fluid at any moment when the pressure is diminished or removed. Having discussed the arguments of Hopkins and of Sir William Thomson, the author asserts that the requisite great rigidity which the earth must possess in order to enable it to resist the deforming influence of the attraction of the sun and moon does not require that the earth should be absolutely solid from the center to the circumference. A rigid nucleus nearly approaching the size of the whole globe, covered by a fluid substratum of no great thickness in comparison with the radius, with an outer crust of less density floating upon it, would meet the difficulty. 'This is the supposition,' says the author, 'as to the condition of the earth, which appears, on the whole, to satisfy best the requirements both of geology and of physics.' Thus the solid nucleus would owe its solidity to the great superincumbent pressure, while the outer crust would owe its solidity to having become cool through radiation, while the fluid substratum would remain in that condition because it would not be submitted to sufficient pressure to render it solid, while it would retain sufficient heat to render it molten. As to the density, von Waltershausen has calculated that

the density at the center of the earth is 9.59 under a pressure of 2,500,000 atmospheres, and he thinks it probable that the magma beneath the outer crust consists of felspathic materials, passing lower down into augitic, and finally, at the center, into a magnetic magma.

"The next problem to be discussed relates to the manner in which the heat and the gravitation of the earth have produced the elevations and depressions, and puckerings of the surface. To explain this it is generally thought that, as the cooling of the earth proceeded, the interior retreated from the solidified crust, and that the latter became crumpled and contorted by the lateral pressure. The author has calculated that the pressure available for this purpose would be equal to that of a column of rock of the surface density, having the same section as the stratum, and 2,000 miles in length—a pressure equal to 830,200 tons on the square foot, and more than sufficient to perform the operations assigned to it.

"Volcanic eruptions probably arise from liquid masses of the substratum gaining access to the surface, and we must conceive that the water which accompanies all volcanic phenomena must be present in the magma of the substratum. 'We may look upon the state of igneoaqueous solution,' observes the author, 'as one in which the water-substance is in a gaseous state, and the combination between the water-substance and the rock is probably of that kind which has been termed "occlusion" of gas by a liquid. An examination of the amount of contraction which would have produced the existing inequalities of the earth's surface shows that the ocean basins are not the result solely of depressions in the upper surface only of a crust of uniform density, but that they are due to the greater density and general depression of the suboceanic crust.'

"According to the author, volcanic energy is the cause of the compression of the earth's crust. Thus he reverses the theory of Mallet, which makes volcanic energy the result rather than the cause of compression, and he shows that the utmost conceivable amount of heat capable of being obtained by his theory is inadequate to the purpose assigned to it. He considers, moreover, that the geographical distribution of volcanoes is better explained on the supposition of a thin crust and fluid substratum than upon any other.

"Their linear arrangement points to their being situated along great systems of fissures; and such systems of fissures are indicative of a thin crust. Fissures which run for long distances in nearly straight courses point either to a movement perpendicular to the fissured surface or else to a rending pressure within the fissure itself; while on the other hand fissures which are caused by contraction in a direction parallel to the earth's surface would divide up an area into polygonal fissures. The former arrangement of the fissures accords best with the distribution of volcanic ranges and suggests a thin crust.'

"Volcanic regions are either oceanic or appertaining to the coast, and

it is probable that the latter are closely connected with elevations of the continents which they skirt, while the oceanic volcanoes are not concerned with true elevatory action. The great volcanic chain of the Pacific approximately divides the earth into two parts, one of which contains the chief proportion of land, while the other contains Australia and nearly all the ocean. And perhaps the area of Australia has been elevated within the ocean hemisphere on account of the deflection of the great Pacific line of action by the northwest line, which passes through Sumatra and the Malay Archipelago, and which meets it at the southeast corner of Asia.

“Although many of the subjects discussed by Mr. Fisher must remain open questions until we are far better acquainted with the conditions of volcanic action, we think that he has cleverly argued his points, and, by the frequent application of a rigid mathematical treatment, has removed his opinions from the domain of those pure speculations which are too often applied to the explanation of obscure phenomena connected with the physics of the earth.”

Geodesy of Europe.—Two very interesting charts have just been distributed as supplements to the proceedings of the sixth general conference of the European Geodetic Survey (held at Munich, in 1880). One of these gives all the telegraphic determinations of *differences of longitude*, and the other gives all the determinations of *latitude* and *azimuth* (separately). Such charts for the United States would be most valuable.

Atmospheric refraction.—An important memoir on refraction has been lately published by M. Radan, who, after a discussion and comparison of previous theories, gives formulæ and tables for refraction, in which allowance may be made for difference in the rate of decrease of temperature with the height above the earth's surface at different seasons of the year. M. Radan also discusses the case in which the surfaces of equal temperature in the atmosphere are inclined to the earth's surface.

The Moon.—Selenography has lately received a valuable contribution by the publication of the sketches of portions of the moon's disk which were made by Tobias Mayer, at Gottingen, in the middle of the last century. Mayer was the first observer who constructed a general map of the moon in which the positions of the chief lunar spots were laid down from actual measurements, and not from mere eye-drafts. The intended publication of his lunar sketches at the end of the last century was frustrated by the death of Lichtenberg, who had undertaken it, and Mayer's smaller general map remained the only accessible result of his selenographical labors. To the discussion of any questions referring to physical changes on the moon's surface, the evidence which may be derived from trustworthy sketches made at an early period is obviously of considerable importance, and the publication of Mayer's old sketches is therefore a welcome addition to the available sources of information. There are forty sketches made between June, 1748, and

June, 1750, and these are reproduced by photoheliography, so that the copies are faithful representations of the originals. They are accompanied by a copy of Mayer's large general map, of nearly fourteen inches diameter; and thus the results of his old selenographical observations, obtained with humble means, have at last become available, and a debt long due to him has been paid by the Gottingen observatory.

Mr. Henry Harrison, of New York, has published a colored lithograph representing the moon as the "three-days-old crescent," or as it appears three days after the time of new moon. As the ordinary lunar maps are constructed with the object of exhibiting the general topography of the whole visible surface, they do not represent, and are not intended to represent, the real aspect of the moon at any time; and it is necessary to have special maps for special phases of illumination if they are to show the shadows and other variable features which are so strikingly characteristic of the moon's appearance at different hours of the lunar day. Mr. Harrison's lithograph is such a special representation, and, as regards general resemblance and artistic effect, may be called a success. Though it does not show more than a small portion of the innumerable details which the telescope reveals, it gives a good notion of the telescopic appearance of the young moon as seen with a comparatively low power. The moon's image is eighteen inches in diameter, the phase represented corresponding to the time when the crater Messier has emerged into the light of the rising sun.

The plate is accompanied by a little descriptive hand-book and an outline map. Its publication will be followed by that of five more plates containing similar representations of five of the most interesting phases.

Experiments have repeatedly been made with the object of producing natural imitations of the craters and inequalities visible on the moon's surface, and it has been found that the figures of the lunar inequalities can be closely imitated by throwing pebbles upon the surface of a smooth, plastic mass such as mud or mortar. Mr. Meydenbauer, of Marburg, uses a basis of dextrine for the purpose and drops small quantities of the same material from a moderate height upon that basis. A photograph of various figures which are thus produced show a remarkable resemblance to the various inequalities visible on the moon's surface. (A. Marth, in the London Academy.)

The topography of the planet Mars.—Professor Schiaparelli has published a second important memoir, entitled "Osservazioni Astronomiche e Fische sull' Asse di Rotazione e sulla Topografia del Pianeta Marte - - ." (*Reale Accademia dei Lincei*, anno cclxxviii, 1880-'81.) By combining his observations at the opposition 1879-'80 with those made at the favorable opposition of 1877, he finds the position of the equator of Mars referred to the earth's equator as follows: Ascending node (1880), in $48^{\circ} 7' .8$ inclination $36^{\circ} 22' .9$ —figures differing little from those provisionally adopted by Mr. Marth.

Schroeter's observations.—The University of Leyden having acquired in 1876 the manuscripts and copper plates of Schroeter's great unpublished work on *Mars*, "Areographische Beitrage zur genauern Kenntniss und Beurtheilung des Planeten *Mars*," Professor Bakhuyzen is about to bring it out. Schroeter had all but completed it at the time of his death, and had, indeed, it would appear, thoroughly revised the greater portion of it. Professor Bakhuyzen states that having reduced Schroeter's observations for the position of the axis of *Mars*, he finds its longitude $352^{\circ} 59'$ and the latitude $60^{\circ} 32'$.

Asteroids.—The following is a list of the Asteroids discovered in 1882:

Discovered.	No.	By—	Discoverer's No.
Jan. 18	221	Palisa	30
Feb. 9	222	do	31
Mar. 10	223	do	32
Mar. 30	224	do	33
April 19	225	do	34
July 19	226	do	35
Aug. 12	227	Prosper Henry	8
Aug. 19	228	Palisa	36
Aug. 23	229	do	37
Sept. -2	230	L. de Ball	1
Sept. 10	231	Palisa	38

The mass of Jupiter.—Dr. Schur has made a new determination of the mass of *Jupiter* from heliometer measures of the satellites, an equal number of observations being made on each satellite. His results are:

From satellite I, $m = 1 \div (1050.918 \pm 1.667.)$

From satellite II, $m = 1 \div (1046.026 \pm 1.425.)$

From satellite III, $m = 1 \div (1047.665 \pm 0.646.)$

From satellite IV, $m = 1 \div (1046.818 \pm 0.484.)$

so that having regard to the weights, the mass of *Jupiter* is $1 \div (1047.232 \pm 0.365)$, the sun being taken as unity. Bessel's published result by the same method was $1 \div (1047.879)$, but Dr. Schur has reduced Bessel's work anew, having regard to the corrections proposed by Auwers to the constants of the heliometer (periodic error of screw, temperature coefficient, etc.), and finds, in the mean for Bessel, 1048.629 ± 0.198 , and combining by weights, the final mass of *Jupiter* from observations of the satellites by Bessel and Schur is, $1 \div (1048.311 \pm 0.174)$.

Dr. Schur brings up some interesting questions in regard to the personal errors of observations of the satellites, for an account of which reference must be made to the original paper.

Various other series of measures of the satellites are discussed, but no changes are made in the concluded mass of *Jupiter*.

The mean motions and the periods of the satellites require only extremely small changes.

The disk of Jupiter.—Prof. G. W. Hough's annual report as director of the Dearborn Observatory at Chicago, for the year 1882, is mainly devoted to the reduction and discussion of the numerous series of observations on the spots upon the disk of the planet Jupiter, made with the 18½ inch refractor, including measures for position of the great red spot, of equatorial white spots and other markings, and angles of position of the equatorial belt. The observations extend over the period from September, 1879, to March, 1882. Those made in 1879 and 1880 showed that the red spot was retrograding with accelerated velocity, and this drifting has continued with such uniformity that Professor Hough considers "the position of the spot at any future period can be very accurately computed." It was found that all the observations could be fairly represented by a period of rotation, varying directly with the time, and the discussion leads to the following formula: (1879, September 25 + $t \times 0.00209s.$), which gives 9^h 55^m 35^s.9 for the mean period between September 25, 1879, and March 29, 1882, comprising 916 days, or 2,214 rotations of the planet.

Hence, it is inferred that the apparent rotation-period has increased about four seconds since the opposition of 1879, showing a total drift of the red spot in longitude of 40,000 miles; and Professor Hough regards his observations as evidence that the great red spot is not the solid portion of the planet. "An immense floating island," nearly 30,000 miles in length, and more than 8,000 in breadth, has "maintained its shape and size, without material change, during more than three years." He has failed to recognize any fading of the color of the spot, which, on February 2 in the present year, he judged to be a light pink, as formerly. Although the dimensions of the spot may not be said to have materially changed, the micrometrical measures do indicate a diminution in length to the extent of 0".95 between the oppositions of 1879 and 1881, at which latter epoch it was 11".30 (reduced to Jupiter's mean distance).

The direction of the south edge of the equatorial belt was nearly parallel with the planet's equator, as given in Marth's ephemeris; the north edge of this belt was found to be slightly concave.

The elliptical white spots were more numerous in 1882 than previously, but, with the exception of two situated south of the red spot, they were seen with difficulty, and were only measurable under the best vision. The two spots named were observed systematically during the three months from November 21, 1881, to February 23, 1882. The following of the two appeared to be at rest relatively to the red spot from November 22 to December 6, and subsequently to drift in the direction of rotation to the extent of about 41°; the average drift during the last two months was at the rate of fifteen miles per hour. The preceding spot also did not retain the same relative position in longitude with respect to the great red spot. Professor Hough adds: "The observations of the small white spots during 1880 and 1881 prove that the

whole surface of the planet outside the margin of the equatorial belt rotates with nearly the same rate." The approximate rotation-period for the principal white spot between the edges of the great equatorial belt was $9^{\text{h}} 50^{\text{m}} 9^{\text{s}}.8$ from observations over more than eight months, which is the same as for the second spot observed during 1880: Hence, these equatorial white spots drift in the direction of the planet's rotation, at about 260 miles per hour, or through a complete revolution in about 45 days.

Twelve tinted drawings of the appearance of the disc of Jupiter accompany the report. The first of two made on July 3, 1880, shows the second satellite just entering on the great red spot at $15^{\text{h}} 43^{\text{m}}.5$, and the other, made nine minutes later, shows it nearly over its center. A notch was formed so soon as the satellite touched the end of the red spot, and when completely entered it appeared as white as when outside the planet's disk.

OBSERVATORIES.

Observatories of the United States.—It will be remembered that at the accession of Professor Pickering to the directorship of the Harvard College Observatory he obtained by the subscription of some 70 persons in Boston the sum of \$25,000 (\$5,000 a year for five years). A pamphlet report on the scientific work accomplished has just been published, which shall be summarized here. The work is spoken of under the headings of the various instruments employed.

Large equatorial: This has been chiefly devoted to photometry and many new (successful) forms of photometers have been devised. The brightness of the satellites of *Mars*, *Jupiter*, *Saturn*, *Uranus* (two only) and *Neptune* has been determined. Some 200 double stars and about 100 bright stars with faint companions have been measured in the same way. All the planetary nebulae have been similarly measured and several new ones have been discovered by their spectrum only.

Many variable stars have had their light curves determined photometrically, and several new ones have been discovered. Fifty points on the moon have also been determined. Bond's zones of faint stars near the equator are shortly to be revised.

Meridian circle: The zone (50° to 55° N.) has been finished. It contains 8,300 stars from 1 to 10th mag., each of which has been observed twice. Two hundred and fifty-eight stars have been observed, each 6 times, for the Coast Survey. One hundred standard stars are regularly observed with the sun. This work has continued for 3 years, and will require 2 more. The graduation errors of one circle have been determined.

Meridian photometer: Every star visible to the naked eye has had its light determined photometrically on at least three nights, many on more; over 100,000 observations were made in 3 years, and this work is now completed. Other similar work is planned. Other miscellaneous

work of importance has been done, but is not mentioned here. This brief summary will be sufficient to show the extraordinary amount of the work which has been accomplished during the 5 years by the aid of the additional endowment. The reasons for this Professor Pickering summarizes as follows, and they deserve careful attention :

“It will be noticed that the increased work is quite out of proportion to the increase of income. This is to be expected, since a large part of the expense is the same in either case, and the increase is directly available for the attainment of scientific results. The formation of a corps of skilled assistants also requires time, and a delay in securing a continuation of our present income would seriously reduce our capacity for attaining results with the greatest economy both of time and money.

“As an increased expenditure was undertaken before the completion of the subscription, it is deemed best not to limit the present report to a period of exactly five years, but to include all the work undertaken since my first connection with the observatory in February, 1877.

“The effect of the subscription may be summarized in a few words. Without it only one instrument, the meridian circle, was kept actively at work, the large telescope being comparatively idle. The reductions even of this one instrument could not be kept up, but every year fell more and more behindhand. With the subscription, the large telescope, the meridian circle, and the meridian photometer are in constant use. A large number of the old observations have been published, while the remainder have been reduced, and before long will be ready for publication. One volume of the recent observations with the large telescope has already been published; another volume of meridian photometer observations is now passing through the press. The unfinished volumes of *Annals* were completed, so that, as is shown below, our work is now known through twelve quarto volumes, while in 1876 but four had been given to the public. Eight more volumes of *Annals* will be needed to complete the publication of the observations already made. The increased rate of work ensues simply because the corps of assistants has been more than doubled.”

Willets Point.—A very interesting report is published by General H. M. Abbot, of the Corps of Engineers, U. S. Army, on the astronomical work which has been done during 1881 at the engineer post of Willets Point, New York Harbor. It is to this school of application that young officers of engineers are sent to learn the practical application of their studies at West Point. They are taught the practice of military surveying, mining, torpedo service, etc., and also the application of astronomy to military and boundary surveys. Each year a general order is issued, giving the results of the past year's work. The order for 1882 may be summarized as below:

For local time, each officer makes a long series of determinations with various instruments, and in various ways. Using the portable transit, the time of transit is at first recorded by an assistant, at the word given

by the observer; next, the observer records his own time by the *relay beat* of a chronometer every 1 second; next by the chronographic method, and lastly by the beat of the chronometer itself (every 0.5 second). Beginners use these methods in succession in the order named.

Personal equation is studied by means of Eastman's machine (see Wash. Ast. Obs., 1875), and an interesting table of results by the second method of marking time (the relay beat) is given.

The time determinations are given for each day of observations, with the probable errors.

Time determinations by sextant observations are also given, and by means of the (known) correction of the standard chronometer the error of each observation and observer is determined.

We quote below the errors of the sextant *Delta t*'s so determined. (Usually 10 altitudes of an east star and 10 of a west were employed.) 4^s.0; 1^s.0; 1^s.5; 13^s.7; 8^s.2; 24^s.1; 1^s.7; 0^s.4; 1^s.8; 0^s.7; 3^s.3; 2^s.8; 5^s.6; 5^s.0. These are the observations of students.

The latitude is determined, first by zenith telescope, and the first process is the evaluation of the level division. This is done by each student, and of the set for 1881 the largest probable error is $\pm 0''.008$.

The observations for latitude are given in detail. From 326 observations of 84 pairs in 1880, the latitude was found to be $+40^{\circ} 47' 21''.59 \pm 0''.082$. From 591 observations of 104 pairs in 1881, it was found to be $+40^{\circ} 47' 21''.47$, a difference of about 12 feet only. Sextant observations for latitude were also made. The errors of the several determinations were 1^{''}.1; 30^{''}.5; 14^{''}.8; 7^{''}.4; 0^{''}.9; 0^{''}.5, respectively.

The longitude is determined—

1st. By lunar culminations. The errors were found to be (of one night's observations), 7^s.01; 6^s.99; 3^s.14; 15^s.97; 3^s.74; 21^s.06; 14^s.29; 24^s.84; 20^s.58; 25^s.04; 4^s.06; 2^s.28; 1^s.81. The errors of each limb of the moon are separately shown.

2d. By Jupiter's satellites. Errors: 21^s.02; 29^s.48; 25^s.95.

3d. By lunar distances (sextant). Errors: 4^s.0; 25^s.0; 40^s.6; 13^s.7; 34^s.7; 6^s.4; 5^s.7.

The value of a revolution of the micrometer screw of the small (five-inch) equatorial was twice determined, as follows:

$$R = 19''.362 \pm 0''.018 \text{ Polaris.}$$

$$= 19.287 \pm 0.057 \quad "$$

The displays of the aurora have been regularly noted since 1870, February 1. The number for each year is as below:

1870, 99; '71, 104; '72, 94; '73, 92; '74, 35; '75, 27; '76, 17; '77, 13; '78, 4; '79, 16; '80, 2; '81, 44.

What has been given as an abstract of one year's work in one department only of this school of application for young engineer officers is sufficient to show that we have at present no better school of practical astronomy in America.

Halstead Observatory.—The new telescope at Princeton is now at last in position and nearly ready for work. It was made by A. Clark & Sons, of Cambridge, the glass disks being furnished by Feil, of Paris.

The diameter of the object-glass is 23 inches, and the focal length within an inch or two of 30 feet. At present its only superiors in the United States are the 26-inch telescopes of the Naval Observatory, at Washington, and of the University of Virginia. In Europe the 27-inch refractor of the Vienna Observatory and the 25-inch telescope of Mr. Newall surpass it. Five other instruments of larger dimensions are indeed now constructing, two in Paris, and three in Cambridge; but it will be some time before any of them are finished.

In the Princeton telescope the lenses which compose the object-glass are separated by a space of nearly seven inches, allowing a free circulation of air between them, and securing a rapid equalization of temperature. This construction also prevents the "ghosts" (formed by reflections between the lenses), which are very troublesome in some large instruments.

The spherical and color corrections are very fine in the Princeton telescope, and the performance of the object-glass, so far as can be judged from a few nights' use, is entirely satisfactory. It is intended to devote the instrument for the present mainly to spectroscopic observations of the stars. The spectroscope is of Christie's direct vision form, which has been successfully used at Greenwich for several years. Mr. Christie (Astronomer Royal) very kindly supervised its construction (by Hilger, of London), and there is every reason to hope that it will prove a magnificent instrument. It is much larger and more powerful than anything ever used before in stellar work; it is nearly six feet long, and admits through the prisms a beam $2\frac{1}{4}$ inches in diameter.

A four horse-power gas-engine works the dome and shutters. It also drives one of Edison's dynamo machines, which furnishes a powerful current for purposes of illumination, and for producing the spectra of metals or gases to be compared with those of the stars.

Yale College Observatory.—From a late report of Prof. H. A. Newton, director of Yale College Observatory, we learn that the Board of Managers are to proceed at once to erect suitable buildings on the observatory grounds for the new heliometer just received from Messrs. Repsold, of Hamburg, and the new equatorial telescope, purchased of Howard Grubb, of Dublin, last summer. The towers for these instruments are now being erected, and the heliometer is expected to be in place by the first of August, that the observers may have ample time to prepare for the best use of the instrument at the transit of *Venus* in December, 1882. The new equatorial of eight inches aperture is expected from the makers about the middle of August, and it will also be ready for use early in the autumn. The domes for these instruments were made by Mr. Grubb. The longitude of the transit house of this observatory was recently determined by exchanges of telegraphic sig-

nals on four nights by Prof. W. A. Rogers, of Cambridge, and Dr. Waldo, an exchange of observers being made on two nights. The difference of longitude between the meridian circle of Harvard College Observatory and the transit of Yale College is $0^h 7^m 10^s.353 \pm 0^s.0091$.

This report also contains the second annual statement of Dr. Waldo, astronomer in charge of the horological and thermometrical bureaus of the observatory. This kind of work has not been undertaken anywhere else in this country; and the manner in which it is done reflects credit on all concerned.

Lick Observatory.—The Lick trustees have ordered from Messrs. Repsold, of Hamburg, a 6-inch meridian circle of the design of that of the Strasburg Observatory. The objectives of the instrument and of the north and south collimators are of six inches aperture, and will be made by Alvan Clark & Sons. The objective and eye end of the circle are interchangeable. There are two divided circles, A and B. A is fixed on the axis and divided to 2'. B is movable on the axis and is divided to 2' at four points 90° from each other. Every degree of each circle is numbered with an engraved figure. There are four microscopes to each circle, one revolution of their micrometers being 1', and one part being 1". The setting is done by a reflecting microscope with two eye-pieces, one north, the other south. The axis of the circle is itself a telescope, and a collimator east or west is used to rectify its position. The hanging level is so arranged that it can be applied while the instrument is pointed to the nadir.

The flint disk for the 36-inch objective to be made by Alvan Clark & Sons for the Lick Observatory has arrived in this country. Its diameter is 97^{cm} (38.19 inches), its thickness 55^{cm} (21.65 inches), and its weight 170 kilograms (375 pounds). A month was required in the cooling. A crown disk has also been cast by M. Feil (fils) who made the flint.

A sidereal clock ordered by the Lick trustees, from A. Hohwu, of Amsterdam, has arrived in this country. It is in all respects similar to the normal clock of the Washburn Observatory, described in its publications, Vol. I, 1881, p. 12; and to a clock just delivered to the Pulkova Observatory. Its cost is about \$447. Similar clocks are mounted at the observatories of Upsala, Leyden, Strasburg, Brussels, and Tashkent. This clock bears the number 33.

West Point Academy.—Alvan Clark & Sons are making a 12-inch equatorial for the observatory of the United States Military Academy at West Point.

The following list of dates may have some interest :

The collimating eye-piece was first proposed (by Bohnenberger)	
in the <i>Astronomische Nachrichten</i> , Vol. IV, p. 330 in.....	1825
Used at Madras Observatory	1834
Tried at Königsberg	1837
Used at Edinburgh for nadir	1840
Used at Oxford for nadir	1843

Used at Cambridge	1845
Used at Washington	1845
Used at Greenwich	1847

McCormick Observatory.—Prof. Ormond Stone of the Cincinnati Observatory, has been appointed director of the Leander McCormick Observatory of the University of Virginia. The institution is already in possession of the great refracting telescope made by the Clarks a few years ago for Mr. McCormick, who generously presented it to the university in 1877. It cost nearly \$50,000. The friends of the university have contributed \$75,000 to endow the chair of astronomy.

Warner & Swazey, of Cleveland, have completed arrangements with the director of this observatory (Prof. O. Stone) by which they are to build a 45-foot iron and steel dome to contain the 26½-inch Clark refractor.

The dome is to turn on a live ring, on Grubb's plan, but the rolls are to be mounted in an ingenious manner which does away with most of the friction, and allows of the most accurate placing of the ring on the track. It is guaranteed that the dome (45 feet) will revolve with a direct pressure of fifty pounds.

Foreign observatories.—The last number of the *Vierteljahrsschrift der Astronomischen Gesellschaft* contains reports of the proceedings of some twenty of the observatories in Europe during the year 1881. At Berlin observations for the zone + 20° to 25°, were actively continued, upwards of 10,000 being made in the year. The 9 inch refractor was employed for comets and small planets, etc., the physical appearances of the comet 1881 III, receiving special attention. With the Declinograph 1,200 small stars were observed, making, up to the end of 1881, 12,329 stars, mostly from the eleventh to the thirteenth magnitudes, thus determined in connection with the identification and observation of the small planets. At Bonn the southern "Durchmusterung" furnished observations of upwards of 14,000 stars, so that rapid progress is being made with this work under the direction of Professor Schoenfeld. At Brussels astronomical physics, as well as meridian observations, have been attended to; the meteors of the August period were extensively observed over Belgium; Christiania was mainly occupied, under Dr. Fearnley, with the zone 65° — 70°, and the curious circumstance of the existence of four variable stars in this zone within a radius of 1° is recorded; the first, in 20^h 59^m 20^s + 66° 8' 5", has been estimated by various observers from 5m. (Lalande) to 9m. (Argelander); the second is in 20^h 59^m 48^s + 67° 35'.9; the third in 21^h 7^m 33^s + 67° 54'.4, and the fourth in 21^h 11^m 49^s + 66° 0'.9, for 1855.0. Baron v. Engelhardt, at Dresden, has zealously observed the various comets of the year, and has made 111 observations of 19 minor planets. The principal instrument in the Baron's observatory is an equatorial refractor by Howard Grubb, of Dublin; aperture 306^{mm}. A new physical observatory has been erected at Herény, Hungary, by Eugen and Alexander von Gothard, the posi-

tion of which is $12^m 49.8^s$ east of Berlin, in latitude $47^\circ 16' 37''$. The observatory is provided with a $10\frac{1}{2}$ -inch equatorially-mounted reflector by Browning, of London. Observations were commenced in the second week of November, and chiefly consisted of the examination of star-spectra. At Keil an 8-inch refractor by Steinheil has been received. Meridian observations here were largely devoted to circumpolar stars $+ 79^\circ$ to 82° , but according to the present plan the observations will be continued to the pole. Leipsic is now under the direction of Prof. H. Bruns. At Lund the zone undertaken by the observatory was continued, more than 5,200 stars being determined. From the observatory of Brera, Milan, Professor Schiaparelli makes the welcome announcement that the late Baron Dembowski had confided to him all his astronomical manuscripts, with the condition that they were to be utilized to the best advantage for the science. His measures of double stars, upwards of 20,000 in number, will be published under the auspices of the Accademia Reale dei Lincei; they are to form four volumes, of which the first will contain the measures made by Dembowski at Naples with his Plössl Dialytic in the years 1852-'58; the second and third, the observations made at Galarate on stars of the Dorpat Catalogue, and the fourth, the measures of stars in W. Struve's appendix, the Pulkowa Catalogue, and double stars discovered by other astronomers, more especially by the eminent American observer, Mr. Burnham. The first volume is in course of preparation. At Plonsk Dr. Jedrzejewicz continues, in his private observatory, measures of double stars as his principal work. The passages of the red spot on Jupiter, by the middle of the disk, were micrometrically determined from November 25, 1880, to February 5, 1881, from 174 rotations. The period was found to be $9^h 55^m 34.41^s \pm 0.13^s$, and at the same time the jovicentric latitude of the center of the spot was found $- 22^\circ.8$, and its length in degrees of the parallel $26^\circ.4$; the third and fourth comets of 1881 and Encke's comet were also observed for position. The physical observatory at Potsdam was in full activity, and, in addition to the more special subjects of observation undertaken by this important establishment, an extensive series of observations of variable stars was secured in 1881. From Stockholm Dr. Hugo Gylden notifies his determination of the parallax of the star Bradley 3077, or No. 240 in Argelander's Catalogue of 250 stars, forming part of the seventh volume of the Bonn observations. The resulting value is $0''.283 \pm 0''.0468$. This star has considerable proper motion. Prof. R. Wolf communicates from Zurich the monthly number of days with and without sun spots, and the relative numbers. In the whole year's observing days the sun was free from spots on five days and exhibited spots on 297.

From the report of the director of the Paris Observatory, we extract the following: The asteroids, which have been observed at Paris and at Greenwich for the past fifteen years, are now to be observed at Paris only. It has been found at Greenwich that the bad weather seriously

interferes with the progress of the work; and Admiral Mouchez has therefore undertaken the whole of this labor at Paris.

The observation of the stars of Lalande has been going on at Paris for some years, as is well known. During the past three years this task has been made the chief work of the meridian service, and it is hoped that the whole of these observations will be finished in 1882. The catalogue will be published in Paris, and it is expected that part 1, comprising 23,640 stars, will be sent to the printer during the year.

This will be the most important contribution to stellar astronomy that could be rendered.

The eighteen observers of the meridian service have made 28,747 observations during the year. The observations of the sun, moon, planets and comets amount to 1,018. These are reduced by the Bureau des Calculs. The equatorials are employed as before in observations of planets, comets, and asteroids. The large reflector will be resilvered and devoted to photographic and spectroscopic work.

The meteorological observations, the time-services, and the astronomical school of Montsouris continue as formerly.

Visitors are admitted (by the written permission of the director) once a month. Four hundred persons come on the average, and the uses of the various instruments are explained to them by four of the astronomers, in regular turn.

The observatory is about to undertake an investigation of the variations of the vertical, which have been remarked by Messrs. D'Abbadie and Darwin. From the terms in which this research is spoken of in the report, it is evident that it is not considered to be one which promises to be very fruitful in results. The large refractor is still in process of construction. It will be clear, from the brief *résumé* here given, that the observatory of Paris is engaged in work fully worthy of its great name and of its past services to astronomy.

The commission appointed by M. Ferry to report on the construction of the rotating dome for the large refractor of the Paris Observatory has held numerous meetings at the Conservatoire des Arts et Métiers, Colonel Laussedat, director of the establishment, being in the chair. Only two projects have been reserved for final choice. M. Eiffel proposes to use a saline solution in a horizontal circular channel placed on the wall to diminish the weight of the rotary roof.

Owing to the exertions of Admiral Mouchez, magnetical observations will soon be resumed at the Paris Observatory, in subterranean chambers which have been excavated in the newly annexed grounds. These observations will be self-registering by photography, in conformity with the instruments established by M. Mascart at the College de France. Direct observations will also be conducted with the old instruments which were used by Arago, which were famous for his prognostications of auroræ, at a period when, the electric telegraph not having been

invented, many days must elapse before the arrival in Paris of news from the northern parts of Europe.

A credit of 96,000 francs (\$19,200) has been granted by the Chambers of Belgium to found an observatory at the University of Liége. It will be chiefly devoted to the instruction of students in geodesy and geographical surveying.

A new observatory has been founded at Tashkent, under the direction of Lieutenant Pomerantzeff. The principal instruments are—

1. A Repsold meridian circle of 4.82-inch aperture and 55.27 focus, with a circle divided to 2' and read by 4 microscopes.
2. A Merz equatorial of 6.34 inches aperture.
3. A sidereal clock by Holwu.

The geographical position is :

Latitude, $40^{\circ} 18' 32''.2$.

Longitude, $2^{\text{h}} 35^{\text{m}} 52^{\text{s}}.15$, east of Pulkova.

From two letters, printed in *l'Astronomie*, we learn that Don José Gonzales has built and equipped and also endowed a small observatory in Bogota, Colombia. Its principal instruments are a 4-inch equatorial, a small meridian circle, spectroscopes, &c. The façade bears the inscription: "Observatoire Flammarion.—A la France.—A Flammarion.—"

ASTRONOMICAL BIBLIOGRAPHY.

The fourth and last fascicule of the second volume of *Bibliographie de l'Astronomie*, by J. C. Houzeau, director of the Royal Observatory of Brussels, and A. Lancaster, librarian of the same, has lately appeared. The authors have tabulated the number of astronomical papers by the dates of publication, from 1600 to 1880, and have plotted the results in a curve of astronomical works, which illustrates with striking effect the rapidity with which the number of these articles is increasing with time. Political revolutions have but slightly affected this progressive activity—excepting only the great wars of the first French empire, which occasioned a remarkable decrease in the number of papers, the epoch of greatest depression being the year 1815. Important astronomical discoveries and events have had the most marked effect in stimulating the production of astronomical works; for example, the last transit of Venus, 1874, and the discovery of Neptune, 1846. Of some 1,800 articles indexed in this volume of the *Bibliographie*, 6,000 are written in the French language, 5,800 in English, 4,400 in German, 800 in Italian, and 600 in Latin, the remaining 400 being divided unevenly among nine other languages. The four most prolific names are those of Secchi, Lalande, Zach, and Bessel, while those who have averaged the greatest number of papers per annum during the period of their activity are Flammarion, Secchi, and Proctor. The sections of this volume are nine in number, and relate to the History of Astronomy, Astronomical Biography, Spherical Astronomy, Theoretical Astronomy, Celestial Mechanics, Astronomical Physics, Practical Astronomy, Mon-

ographs on the principal bodies of the Solar System, and Stellar Astronomy. The first and third volumes, being thought of less pressing importance than the second, will be published subsequently, and will relate, the first to works (or separate publications), and the third to observatories and the observations made at them.

This work has been epitomized in the *Vade-mecum de l'Astronomie*, 8vo, 1 vol., 1882.

The Greenwich Observatory, always prompt in its publications, is this year even more prompt than usual. The volume of 1879 has been distributed; parts of the volume for 1880 have also been sent out, and the whole volume is nearly printed; and at the date of writing, the volume for 1881 is nearly ready for the printer.

Professor Folie, director of the new observatory at Luttich, has published new tables for computation of the precession, nutation, etc. These are more complete than Coffin's and Hubbard's tables in the Washington observations for 1847, and according to the account of them in *V. J. S. der Ast. Gesell.*, 1881, p. 291, they are also more convenient, as the argument (R. A.) does not vary uniformly, as in the Washington tables, but is varied so as to make the interpolation easy.

The German Astronomical Society is about to issue another volume of its publications (the quarto series). It has for title, *Syzygien-Tafeln für den Mond, nebst ausführlicher Anweisung ihres Gebrauchs, von Th. von Oppolzer*.

The publication (by Scribners) of Trouvelot's "Astronomical drawings of the sun, planets, comets, and nebulae" gives us a work never attempted before on such a scale, and only recently made possible.

The plates represent to the general student and the public, with accuracy and beauty, the chief celestial objects and phenomena, almost exactly as the power of modern instruments now presents them to the trained eye of the astronomer. Not only are the general appearance and relative positions of the different objects accurately given, but their peculiar and delicate colorings are reproduced with excellent effect—a result which photography is wholly inadequate to secure.

The fifteen years' study of which this is the fruit has involved the preparation of about seven thousand larger and smaller drawings, in which telescopes of all powers have been used, from the great 26-inch equatorial in Washington to instruments of $6\frac{1}{2}$ inches aperture. The whole series consists of 15 large plates.

New astronomical journal.—M. Flammarion has recently founded a new popular astronomical journal, having for title: *L'Astronomie, revue mensuelle d'Astronomie populaire, de Météorologie et de Physique du Globe*.

No. I is dated March, 1882, and contains a good account of the observatory of Paris, with wood-cuts of its appearance in 1672 and at present. A list of the instruments now in use is given, which we copy:

	Aperture inches.
Gambey transit	5. 91
Gambey mural circle	4. 74
(1) Eichens meridian circle	9. 48
(2) Eichens meridian circle	7. 48
Lerebours equatorial	14. 96
Secretan equatorial	12. 20
Secretan equatorial	9. 44

A short and interesting history of the administrations of the various directors is given, most attention being naturally paid to the present one. The salaries paid are :

	Francs.
Director	15, 000
Vice-director	12, 000
Astronomers	7, 000 to 10, 000
Adjunct astronomers	3, 500 to 7, 000

The meridian observations are to-day chiefly devoted to a reobservation of the Lalande stars, some 48,000 in all. Probably the places of some 23,000 Lalande stars will be printed in 18^c2. The ten observers obtain some 28,000 observations yearly.

The six observers with the equatorials are engaged on the observation (and discovery) of asteroids, double stars, &c. The reflector of 47 inches aperture is not in use. The large refractor of 29.13 inches aperture will be mounted shortly.

It is announced that with the year 1883 a new journal, *Science*, will be published in Cambridge, Mass., with Mr. S. H. Scudder as editor and the principal scientific men of the country as coadjutors. It is intended to fill a corresponding place to the English *Nature*, and certainly it starts with the fairest prospects, and occupies a field in which there is much to do.

MISCELLANEOUS.

Standard time.—The two following papers (which do not exhaust the subject, however,) may be taken to show the general interest in the question of a standard or of many standards of time. For America the question should be settled after careful discussion and general consent, and not be allowed to drift to its solution :

“In response to the circular of the general time convention, asking for communications bearing upon the matter of a standard time for the railways of the United States and Canada, Admiral Rodgers, late Superintendent of the United States Naval Observatory, wrote the following :

“The various countries of the world generally have their own prime meridian, as Greenwich, Paris, Pulkova, etc., and the national maps are drawn to the respective national prime meridians. The maps of the United States are drawn with reference to the meridian of Washington. The observatories of Europe—Pulkova, Greenwich, Paris, etc.—give time to their respective nations. In England the differences of longitude are not great, and all England uses Greenwich time. But the

extent of the United States renders a single time impracticable, for by the hour at any place is only sought an expression for the relative position of the sun in regard to that place. At the noon of any locality the sun is on its meridian; at 1 o'clock it is one hour past the meridian; at midnight it is on the lower meridian, or just under the feet, and at 1 o'clock at night it is one hour past the lower meridian. All this is very elementary, and is known to every one.

“By local time man must live, move, and have his being. Other standard for his daily avocations is chimerical, fit for speculation, but utterly impracticable. Sailors have for a long time kept on board ship, for their practical purposes, two times—namely, local time, for the daily uses of life, and the time of the national meridian, for astronomical purposes. This is Greenwich, Paris, Pulkova, or other, according to nationality. This arrangement at sea is in constant use by a community far from a learned one, according to shore standards. The system must be plain and practical to landsmen, since it is plain and practiced by seamen.

“The plan of time zones seems to me a plan for legalizing diversity. It is against diversity that the country protests, as applied to railroad service. Two neighbors, separated by a fence, may live in different zones, or two villages near one another may have different zones and different legal times, in which case business will be carried on between them with more difficulty than with natural time, by which people dwelling near one another will have, substantially, agreement in their watches. Two railroads on different sides of a river may have different zones, and trains collide for want of agreement. Except in towns of some size, no one would know his zone, for the zones cannot be marked. The State lines are too irregular in shape to serve for a guide, nor have we custom-houses on the borders to inform travelers of the name of the State into which they enter.

“Learned societies may recommend artificial time for the use of man, but it is to be apprehended that the community may refuse to accept it. When the laborer, who has worked from sunrise until noon, is gravely told that noon comes at 1 o'clock, will he not object? In short, men will continue to keep natural time for their daily uses, whatever different practice conventions may recommend.

“In conclusion, I beg leave to recommend that in the railroad guides the time of Washington, the national meridian of the United States, be published opposite to the movements of through trains, leaving, the trains to run on Boston time, or Ogden, or San Francisco, or such other time as the directors may prefer. This plan invades no right now enjoyed; it changes no practice; it only adds to the tables a few columns of figures. I would also recommend that the clocks at railroad stations be furnished with two sets of hands, gilt hands for Washington time, and black hands for local time. These hands, separated by a constant difference equal to the differences of longitude, will always show at a glance the time required, whether local or Washington.”

The second paper referred to, is an essay read by Dr. Ulbricht, at a convention of engineers, which met at Dresden last winter, and is as follows:

“In most of the European countries the inconvenience of various local times has been partially done away with, by accepting the true time at the capital city for the standard time for the rest of the country, as has been partly done by the railroad companies in the United States; whole

trains arrive at and leave the intermediate stations by New York or Chicago time.

“Dr. Ulbricht then spoke with approbation of the ingenious plan proposed by President Barnard, of Columbia College, New York, at the convention held recently at Cologne to discuss some of the debated points of international law. President Barnard’s scheme is to have the earth divided by twenty-four meridian lines corresponding to the number of hours in a solar day, and to have the inhabitants of each spot on the globe reckon time by the true time at the nearest meridional line. By this plan, all places would register minutes and seconds simultaneously, all over the world, the name of the hour only being different at each meridian line. If this much could be secured, it would be a vast improvement on the present irregular system, but it would necessitate perfect standards and exceedingly careful and accurate distribution of time from the appointed centers or standard clocks.

“The ‘time ball’ on the Wartberg (a mountain near Heilbrunn), which was set up more than a hundred years ago by that many-sided genius, Goethe, is a primitive mode of distributing time from a central station to the surrounding stations, and modern science is rapidly perfecting this system, so that the complete unison between all the clocks of a country is only a *question of time*.

“The pneumatic system gives unqualified satisfaction in Vienna, where it has been thoroughly tested, and other places are introducing it; but the most infallibly accurate means for distributing time either long or short distances, is electricity. Simultaneous action in clocks, no matter how widely separated they may be, is insured by the Hipp system of electric communication, or the Jones system, which is in successful operation at Greenwich, Berlin, and several other places. In this latter system the pendulums receive their impulse by the opening and closing of the electric circuit, so that all have a simultaneous vibration. Of course, this system makes no allowance for the difference between the time of different localities.

“The Siemens and Halske electrical clocks are provided with a simple little apparatus which allows the minutes and seconds to be recorded on each clock in unison with the central clock, but as the hour strikes it moves the hands back or forward to the place where they belong according to the true time of the place.

“The system invented by Dr. Ulbricht himself, and in use in many of the principal depots in Germany, requires the pendulum-rod to be somewhat shorter than usual, so that the clock will gain a trifle each hour. This is remedied by an automatic arrangement that, as the hour strikes, stops the motion of the pendulums in all the secondary clocks until the center clock has caught up with them, when all vibrate again in unison.

“President Barnard’s proposition for ‘cosmopolitan time,’ as he calls it, comprehended still further changes in the system now in use, which can be briefly summed up as follows: After having decided upon the location of the twenty-four meridional lines, the whole world should reckon time from a certain one of these lines. For general convenience (and to avoid showing undue partiality to any special country, probably), President Barnard suggests the meridian passing through Behring Strait and the Pacific Ocean, for the starting point, and the time midnight.

“The hours of the day should be counted from one to twenty-four, inclusive, doing away with the unnecessary annoyance of dividing the solar day into P. M. and A. M. He suggests also that the hours might

be designated by the twenty-four letters of the alphabet (leaving out J and W).

“By the general adoption of this system, or even a modified form of it, all the countries in the world would thus be brought into harmony, and ‘cosmopolitan time’ would be recorded simultaneously on the faces of all the clocks in the world, the incalculable advantages of which must be seen to be fully appreciated.

“A convention of geographers lately held in Venice passed resolutions expressing their approbation and admiration of President Barnard’s plan, prophesying that the present zealous agitation of this subject will before long bring about a radical change in the systems now in use.”—(From the *Allg. Jour. der Uhrmacherkunst*.)

Astronomical prizes, salaries, &c.—The French Academy of Sciences has recently awarded the Lalande prize to Dr. Lewis Swift, of Rochester, N. Y., for his discovery of seven comets in four years. One of them, Comet E, 1880, which is identical with Comet III, 1869, discovered by Tempel, is a short-period comet. The Valz prize was awarded to Dr. D. Gill, astronomer at the Cape, for his researches on the solar parallax, especially for his observations of Mars, at Ascension, in 1877.

From the British navy estimates for 1881–82, the following items of interest are extracted: “*Greenwich Observatory*, total, £5,144. The salary of the Astronomer Royal (to be reconsidered on the appointment of a successor to Sir G. B. Airy), £1,200; of the chief assistant, £600; two first-class assistants, £787; four second-class assistants, £1,017; expenses for repairs, apparatus, &c., £2,639. *Cape of Good Hope Observatory*, total estimate for salaries, apparatus, &c., £2,703. *Nautical Almanac*, £3,203, including salary of the superintendent, £550. The average annual sale of the almanac for the last five years is estimated at 16,749 copies. The chronometers of the royal navy cost £1,432; and the expenses of the compass department are £2,146.”

GEOLOGY.

By Prof. T. STERRY HUNT, LL. D., F. R. S.

EOZOIC ROCKS.

The study of the Eozoic, or, as they are often called, the Archæan rocks—the Primary rocks of older writers—continues to occupy more and more the attention of geologists. It is now generally understood that these rocks, like those of Secondary and more recent periods, are capable of subdivision into great stratified groups, the relations between which, in the absence of organic remains, must be determined by stratigraphical and lithological characters. Of these, three great groups—first established in North America, and named Laurentian, Huronian, and Montalban—are now recognized in many parts of the old World.

The existence in the Alps of an older granitic gneiss, corresponding to the Laurentian, and a younger gneissic series, the representative of the Montalban, has long since been recognized by Gerlach, Gümbel, and others, and the relations of the former to the great greenstone or *pietre verdi* series of northern Italy, rightly referred by Gastaldi to the Huronian, has attracted attention. It should, however, be said here that this series, as defined by him, included also the younger gneisses. Geological studies of the Simplon, with reference to the proposed railway-tunnel through the mountain, made by Renevier, show the existence there of an older gneiss, called by Gerlach the gneiss of Antigorio, which is well seen in the Val de Vedro, where it is brought up by an anticlinal from beneath a mass of younger gneisses, with micaceous and hornblendic schists and crystalline limestones. This latter series has a great thickness, and is probably, like the upper gneiss of the St. Gothard, Montalban, here resting directly upon Laurentian.

The careful geological studies of Stapff, the director of the St. Gothard tunnel, show at the base a granitoid gneiss (veined granite of other observers), to which belongs the Finsteraarhorn, overlaid by a great series of gneisses and mica-schists, with serpentine and hornblendic rocks, through which the greater part of the tunnel passes. These form the southern slope of the St. Gothard, as well as the basins of Unseren on the north and the Ticino on the south side. They have, according to Stapff, an aggregate thickness of not less than 15,000 meters, but the possibility of repetition by faults and undulations should not be lost sight of. Von Hauer has recognized two similar series of

gneisses in the Austrian Alps, besides an intermediate group, which he compares with the Huronian. Hunt, from his recent observations, announces that the upper gneissic series, as examined by him on the southern slope of the St. Gothard, and in the Ticino, are clearly of the type of the Montalban of North America, seen in the White Mountains of New Hampshire, and near Philadelphia. The tunnel of the St. Gothard passes through about 2,000 meters of the older gneiss, on the north, and 13,000 meters of the younger series, the strata of this along the line being generally at a very high angle, and much contorted and faulted, but often lying at low angles in the Ticino. The typical *pietre verdi*, or Huronian series, is here wanting, though seen over large areas in northern Italy, with its serpentines, argillites, chloritic, steatitic, epidotic, hornblendic, and feldspathic rocks, including so-called gabbros and euphotides. Hunt has given in this connection an account of his recent observations near the foot of Mont Viso, in the vicinity of Biella, in the province of Novara. Here he found the older gneiss highly contorted, having the characters of the Laurentian, and including bands of granular limestone, with graphite, pyroxene, quartz, and other characteristic minerals. This is overlaid to the westward by an area of the *pietre verdi* or Huronian series, which is immediately succeeded on the west by Montalban gneisses and mica-schists. The southward course of the eastern border of this series is such as to rapidly reduce in this direction the considerable breadth of the Huronian, and if continued for a mile or two beneath the superficial deposits in the valley of the Cervo would bring the newer gneisses in juxtaposition with the Laurentian, as in the St. Gothard section.

The gneisses and mica-schists of the Saxon Erzgebirge have, according to the same observer, the lithological characters of the Montalban or younger gneiss series (and the same is true of the Granulitgebirge of Saxony), with their included beds of gabbro and serpentine. It may be here remarked that the characteristic Montalban gneisses in America pass into granulite or leptinite on the one hand, and into gneiss and quartzose mica-schist on the other.

Sauer has found in several localities in the gneiss and mica-schist series of the Erzgebirge, conglomerates holding, in a crystalline gneissic matrix, pebbles occasionally of quartzite or granular limestone, but more often of gneiss. These rolled masses, often several inches in diameter, represent different varieties of gneiss common to the older series of the Alps, and in the opinion of Hunt, who has examined them, are doubtless pebbles derived from Laurentian strata. He has noticed a similar occurrence of granular limestone pebbles in a hornblendic gneiss in the White Mountains. Pebbles of gneiss are also found in like conditions in gneisses in Sweden and in southeastern France.

The age of these Saxon gneisses is, according to Credner, clearly pre-Cambrian. The late researches of the geological survey of Saxony have shown that this is also true of the gneissic area formerly supposed by

Naumann to be of Paleozoic age, which is found to be continuous with the other gneisses.

Marr has lately noticed the crystalline rocks which underlie the Cambrian strata in Bohemia, and has compared the older or basal series of gneisses with limestones to the Dimetran of Wales (Laurentian). They are succeeded unconformably by a newer crystalline series of greenish schists, with conglomerates, &c., which, according to him, resemble the Pebidian of Wales (Huronian). These constitute the stage A of Barrande, and are succeeded, after a stratigraphical break, by fossiliferous Cambrian and Silurian rocks.

The crystalline rocks of the Taunus were regarded by Dumont as altered Devonian, a view also defended by Lossen, but Gosselet and Koch have shown on stratigraphical grounds that they must be older, and are, in part at least, Huronian. Hunt had already examined the continuation of these rocks in the Ardennes, which, from their association with *Oldhamia*, must be at least at the base of the Cambrian, and had compared them with Huronian. The question of the development of crystalline minerals in sedimentary rocks will be discussed elsewhere.

Von Richthofen has examined the crystalline rocks of northern China, where they occupy a great area, and are divided by him into two groups, which he compares with Laurentian and Huronian, respectively. The first of these is again subdivided into two parts; the older is a gneiss, often granulitic, with steep dips and a prevailing northwest strike. Resting unconformably upon it are newer gneissic rocks, sometimes hornblendic and chloritic. Both of these Richthofen would refer to the Laurentian. Reposing in discordance upon these is a third division, described as a series of green schists with micaceous and hornblendic beds, quartzites, and crystalline limestones, presenting many variations in different districts, but regarded by Richthofen as the probable equivalents of the Huronian, and having a thickness of at least 10,000 feet. These crystalline strata, after having been folded, faulted, and penetrated by intrusive rocks, were subjected to great erosion before the deposition of the succeeding series, called by Richthofen Sinisian, to be noticed below. With reference to the twofold division of the Chinese gneisses, it will remain for further studies to determine whether we have here the representative of two great divisions of the Laurentian, and whether we have also to do with newer gneisses, which occasionally, in the Alps, as in parts of North America, rest directly on the pre-Huronian gneisses.

The rocks to which Richthofen has given the name of the Sinisian system are developed with similar characters over wide areas, and have an aggregate thickness of from 12,000 to 20,000 feet. They are described as consisting of three groups in concordant succession: A lower one of reddish sandstones and quartzose breccia, a middle group of limestones, sandstones, and argillites, and an upper of limestones, in

which organic remains appear for the first time. These forms are Cambrian, and are compared with the Potsdam of North America.

The late publications of its geological survey enable us to arrive at some general views with regard to the Eozoic rocks of India. In the peninsular region of that country we find, stretching from Ceylon to the mouth of the Ganges, a broad area, almost unbroken, of granitoid gneissic rocks, having the general lithological characters of the Laurentian, and in many parts accompanied by crystalline limestones, whose mineralogical resemblances to those of our older gneissic system are well known. The Bundelkhand gneissic area, lying a little to the northwest of the great belt, is conjectured by the Indian survey to be distinct from and older than the latter. To these gneisses succeed a great unconformable series of what are described as transition or submetamorphic strata. These include quartzites, crystalline limestones, jasper-like rocks, which, in some cases at least, have the composition of petrosilex and are porphyritic; beds of specular iron-ore, hornblendic and micaceous schists, sometimes with garnet, staurolite, and andalusite. It is probable, as supposed by the Indian geologists, Medlicott and Blanford, that these transition rocks include two or more distinct groups. They are of great but undetermined thickness.

To these succeed what is called the Vindyhan series, which, though generally unconformable, seems, in some parts of its wide distribution, to exhibit such transitions from the series just described as to lead to the conjecture that some of the strata included in the former are really parts of the lower division of the Vindyhan series, to which is assigned a minimum thickness of 2,000 feet. It includes limestones, quartzites, argillites, and, in some parts, crystalline schists, recalling some of those referred to the older transition series. It contains diamonds, of which it has been conjectured to be the parent rock. The upper division of the Vindyhan series is supposed to be unconformable to the lower, and has a thickness of 20,000 feet, consisting of sandstones, limestones, and argillites. No organic remains have as yet been observed anywhere in this great series, which is consequently classed by the Indian survey with Azoic rocks. It is well argued that such a great succession of varied sediments would seem to offer the conditions for the preservation of the remains of ordinary Paleozoic life, had such existed in the wide Vindyhan area. This series suggests a comparison with the Sinisian rocks in northern China, lying below the Cambrian (Potsdam) beds. In peninsular India the Vindyhan is unconformably overlaid by the Gondwana system, the base of which is upper Paleozoic. While these ancient Vindyhan rocks of the peninsula are very little disturbed, we find in northern or extra-peninsular India, to the north of the great Indo Gangetic plain, a mountain-region in which even the Tertiary strata bear evidence of the great disturbing forces that were displayed in the elevation of the Himalayas. The gneissic rocks of this region are distinguished from the reddish syenitic gneisses of the peninsula by

being white or gray in color and are associated with much mica-schist. Other observers have described, in the region of the Upper Himalayas, syenitic gneisses resembling those of the peninsular type, succeeded by various crystalline schists, with greenstones and soft talcoid slates.

The Eozoic rocks, to which Hicks, in Wales, gave the name of Pebidian, were some years since compared lithologically with the Huronian. Hunt, in pointing this out, after his comparative studies in the British Islands, referred certain crystalline schists in eastern Ireland to the Montalban series, which, as he had previously shown, is represented in Donegal and in the Scottish Highlands, where Pebidian rocks are also largely displayed. Hicks has since found there a series of crystalline strata, which succeed the Pebidian, and which he has called Upper Pebidian. These, as they are the predominant rocks in the Grampian Hills, he proposes to designate the Grampian series. They consist in large part of tender gneisses or granulites, with mica-schists, and according to Hunt have the lithological characteristics of the Montalban series, as seen in the Alps and in North America.

Callaway has contributed important observations to the question of the age of the younger gneisses found in northwestern Scotland, in Dunness, where they are found in close association with an older gneiss recognized as Lewisian (Laurentian), a quartzite, a limestone with a lower Paleozoic (Arenig) fauna, and a younger flaggy gneiss. This latter, regarded by Nichol and others as pre-Cambrian, has been by Murchison and his followers supposed to overlie the fossiliferous limestones, and to consist of more recent or so-called Silurian strata in an altered condition. Callaway has shown that the evidence of this superposition is defective, and that on the contrary we are forced to conclude that the flaggy gneiss belongs to an older series which underlies unconformably the limestones. The conclusion to be deduced from all the observations up to this time seems to us to be that the crystalline strata of the Scottish Highlands, regarded by the geological survey of Great Britain as altered Paleozoic strata, include representatives of various pre-Cambrian groups, including Montalban (Grampian), Huronian (Pebidian), and Arvonian, to which series Hicks refers the *hällflinta* series found in Glencoe.

Callaway has also described the pre-Cambrian rocks of county Wexford in Ireland, and finds beneath the argillites of the Longmynd group with *Oldhamia*, rocks which he compares with the Pebidian and Dime-tran of Wales and Anglesea. He maintains that there is here no evidence whatever of a gradual passage, such as had been asserted, from the crystalline to the uncrystalline series, either in Wexford or in other localities examined by him, and elsewhere says: "every case of supposed metamorphic Cambrian or Silurian has been invalidated by recent researches, and we are driven to the conclusion that within the English and Welsh area there is a presumption in favor of the suppo-

sition that any district of altered rocks that may be discovered is of Archæan age."

Bonney, continuing his studies in the vicinity of the Lizards, in Cornwall, has described the crystalline schists of the region, of which he has as yet published only a preliminary note. These rocks, once regarded as altered Paleozoic, are shown to be Eozoic, and are by him divided into three groups, the first or lowest of which consists of greenish, often micaceous schists, with hornblendic minerals, which he compares with the Pebidian of North Wales and Anglesea; the second group is characterized by black hornblende, and the third or uppermost is described as a granulitic group with bands of quartzo-feldspathic rock, the last two groups being remarkable for their display of bedded structure, and the three apparently forming one continuous series, with a general northwest strike. The upper portions recall the Montalban series. We shall notice further on the serpentines found in these Eozoic rocks, both in Cornwall and Anglesea, together with those of the Alps.

W. O. Crosby has rendered a service to comparative geognosy by resuming the facts known with regard to the Eozoic rocks of eastern South America, where they occupy two great areas, the one north of the Amazonas, extending east to the Orinoco, which includes the various districts known by the name of Guiana; and the other, and still larger region, to the south of the Amazonas, which forms the highlands of Brazil. This area, extending through thirty degrees of latitude and twenty-five degrees of longitude, is separated from the Andean region by a broad expanse of newer rocks, stretching down to the mouth of the La Plata. Hartt has shown that these crystalline areas of Guiana and Brazil were above the sea in the earliest Paleozoic times. They may be compared both geographically and geognostically with the Laurentides and the Atlantic belt of North America. The older observations of Darwin, Pissis, and Liais with regard to these rocks are confirmed by the later ones of Hartt and of Derby. The basal rocks of the Brazilian highlands are gneisses, often granitoid, with crystalline limestones, occasionally serpentinic, with Eozoon. To these succeed a fine-grained gray gneiss or leptinite, often schistose, followed by mica-schists and gneisses, with subordinate beds of quartzite. The two types correspond to the Laurentian and Montalban, respectively. Elsewhere in southern Brazil are found large areas of petrosilex rocks, and of others having the characters of Huronian. These same great types are also recognized in the Andes, from Peru to Patagonia.

In Guiana, in like manner, there is found a series of granitoid and gneissoid rocks, compared by Jannetaz to the older gneisses of Brazil. To these succeed a great series described as felstones and quartziferous porphyries, which are probably the same with the petrosilexes of southern Brazil. Accompanying these in Guiana is a series of hornblendic and schistose rocks having the characters of the Huronian, succeeded by a newer series, described as resting in different places upon

the preceding groups, and consisting largely of gneisses with hornblendic and micaceous schists, the latter often abounding in garnet and staurolite, and including great veins of endogenous granite, the whole resembling the upper gneisses of Brazil, which appear to belong to the Montalban series.

It would thus seem that the great series of crystalline rocks marked by distinct mineralogical characters, which were first defined and named in eastern North America, are repeated with the same stratigraphical relations in the British Isles, in central Europe, in Asia, and in South America.

THE TACONIC ROCKS.

Under the name of the Taconic system, as is generally known, have been described the quartzites and sandstones, with granular limestones and intercalated crystalline schists and argillites, found in eastern North America, which were by Eaton, and subsequently by E. Emmons, assigned to a horizon between the older crystalline series and the lower Paleozoic strata, a portion of which, under the name of Upper Taconic, was at first included in the Taconic system. The Lower or true Taconic (Taconian), first recognized in the Taconic range of western New England, includes the Primal and Auroral of Rogers in eastern Pennsylvania, and the Itacolomite series of Lieber in the Carolinas.

The granular limestones or marbles of the Taconian have been by different geologists referred to various horizons more recent than that assigned to them by Emmons. They have been regarded as infra-Trenton (Calceiferous, Chazy, or Quebec group), Trenton, and (Upper) Silurian or Devonian. Each of these views has been sustained by specious arguments from stratigraphy, and by others based on organic remains found in rocks supposed to belong to the limestones in question, and found within the limits of the Taconic belt. That fossils characteristic of each of these horizons occur in such associations is certain, but whether the great mass of the limestones belongs to any one of these three, or, as supposed by others, to a still older Taconic horizon, is a question which many geologists, unacquainted with the whole of the facts in the case, regard as unsettled. Hunt has maintained the view of Eaton and of E. Emmons, that these rocks belong to a series older than the Potsdam sandstone of New York, and has endeavored to show that they are represented in their geognostical and lithological relations by the Hastings series of the geological survey of Canada, which, a little to the north of Lake Ontario, rests upon the Huronian, and is overlaid unconformably by the Trenton limestone.

Crosby has pointed out that the resemblances already traced between the geognosy of eastern North and South America are further shown in the development of a great series of rocks resembling the Taconian, alike in Brazil, Guiana, and the island of Trinidad. In Brazil these have been described as a newer series, resting, according to Derby, un-

conformably upon the older crystalline rocks, and consisting in great part of quartzites, often granular and sometimes flexible, constituting the so-called itacolumite, with unctuous talcoid schists, containing hydrous micas, chloritic and argillite beds, specular schistose iron-ore (itabirite), and great masses of crystalline limestone. The analogies between this Brazilian series and the Taconian or Itacolumite series, as studied by Lieber in South Carolina, were long since pointed out by him, and the close resemblance between a collection of these rocks from the province of Minas-Geraes, in Brazil, where they are largely developed, and the Taconian in Pennsylvania, was later insisted upon by Hunt. The ancient series in Brazil has afforded no organic remains, but being unconformably overlaid by older Paleozoic rocks is conjectured by Derby to be altered Cambrian.

This Itacolumite series is the source of the diamonds of Brazil, as shown by Gorceix and by Derby. While these gems are also met with in secondary and derived rocks, they are found in the district of Diamantina, in certain unctuous banded clays which are seen to be derived by subaerial decay from schistose beds belonging to the Itacolumite series, which here has a considerable dip to the eastward. These clays are of various colors (red, white, or black), from disseminated iron-oxide. Associated with the diamonds in the clays are tourmalines, rutile, anatase, martite, and oligist, most of which minerals have been found in quartz veins, with pyrites and gold, traversing the Itacolumite series. Similar clays, derived from the decay of the accompanying schists, are found with the Taconic quartzites and limestones throughout the Appalachian valley. It is in these that chiefly occur the deposits of limonite derived by epigenesis both from siderite and from pyrite, which are so extensively mined from Vermont to Alabama.

A similar Itacolumite series is seen in Guiana, and has been compared by Jannetaz with that of Brazil. Rocks apparently the same occur in the island of Trinidad, where they were many years since studied by Wall and Sawkins, who described them as the Caribbean group. Since this they have been examined by Guppy, and more recently by Crosby. This series, which is, according to him, not less than 10,000 feet thick, consists of quartzites, with argillites and hydrous mica schists, with a great body of crystalline limestone or marble, sometimes micaceous, succeeded by argillites, hydrous mica schists, and sandstones, the whole, according to Crosby, strongly resembling the Taconian as seen in Massachusetts. Overlying unconformably this ancient series, which appears to be unfossiliferous, is a dark-colored, compact, fossiliferous limestone, with interbedded shales, in which, among many obscure forms, Guppy recognized *Murchisonia Anna* and *M. linearis*, both found in the Calciferous sand-rock in Canada.

Analogies both stratigraphical and lithological serve to connect the Caribbean group of Trinidad with the Taconian and Itacolumite group of North and South America, and to assign to all these a position below

the Cambrian. Inasmuch as the rocks of this infra-Cambrian series in Ontario contain the remains of *Eozoön*, the Taconian may be designated as Eozoic. The great unfossiliferous Sinisian series of China, and the Vindhyan series of peninsular India, may perhaps be found to belong to the Taconic horizon, in which connection the association of diamonds with the latter rocks in India, and with the itacolumite in the southern United States is not without significance.

PALEOZOIC ROCKS.

The nomenclature of the Lower Paleozoic rocks, from the base of the Cambrian to the top of the Silurian, has long been a matter of discussion. The Cambrian, as originally defined by Sedgwick, extending above the Bala group in Wales, included the Llandovery; from which to the summit of the Ludlow, was the Silurian of Sedgwick (Upper Silurian of Murchison), corresponding to the third fauna of Barrande, and including in North America the rocks from the base of the Oneida to the summit of the Lower Helderberg. The Upper Cambrian of Sedgwick, embracing the Arenig, Llandeilo, and Caradoc divisions (the Bala group), which hold the second fauna of Barrande, was from the first claimed by Murchison as a lower member of the Silurian system. Subsequently the Middle Cambrian, including a large part of the first fauna of Barrande, was also claimed under the name of Primordial Silurian, Murchison wishing to reserve the name of Cambrian for the lowest division only of the original Cambrian system (the Bangor group of Sedgwick), which other geologists have since attempted to annex to the Silurian; thus obliterating the Cambrian from geological nomenclature. While this extreme view has had its advocates, others would maintain entire the Cambrian as originally defined by Sedgwick, and others still have proposed to limit the name of Cambrian to the lower and middle divisions, and to give to the upper division, originally claimed by Murchison as Lower Silurian, the name of Siluro-Cambrian or of Cambro-Silurian. Lapworth has adopted a new solution of the difficulty by giving to the Upper Cambrian of Sedgwick (Lower Silurian of Murchison) the name of Ordovician (sometimes contracted by him to Ordovian), from the Ordovices, a British tribe who, at the time of the Roman conquest, held North Wales as the Silures did South Wales. The upper limit of the Ordovician or second fauna is, according to Hicks, the bottom of the Lower Llandovery, and its base the summit of the Lower Tremadoc, the so-called Upper Tremadoc or Arenig being included in the Ordovician.*

In North America the Oneida forms the base of the Silurian, and the Ordovician will embrace the Loraine, Utica, and Trenton (including the Birdseye and Black River) divisions of the New York series. The succeeding Chazy, sometimes absent, perhaps belongs rather to the Ordovician than the Cambrian, which latter, as thus limited, will embrace the

* *Geol. Magazine*, II, vi, 1.

Menevian, Potsdam, and Calciferous, including also the Quebec group (Upper Taconic of Emmons).

The base of the Ordovician, as thus defined, is marked by a great stratigraphical break, attendant on continental movements, in eastern North America. As a result of these conditions, this series, so largely developed in the valley of the Saint Lawrence and the great lakes, rests, as is well known, in many places directly upon the Eozoic crystalline rocks of the Laurentides and the Adirondacks. To the south and east—moreover, the effects are seen in the diminished thickness, in changes in lithological characters, and even in the absence of portions of the series. Examples of these changed conditions are the absence of the Chazy in localities where the Trenton rests on the Eozoic, as well as in others, where it rests on the Calciferous; and, moreover, in the thinning out of the Trenton itself, and its disappearance, or its replacement by argillaceous beds resembling those of the Utica or of the underlying Quebec group, as noted by Whitfield and others in the vicinity of Albany. Similar strata of Ordovician age, as long since pointed out, are found in eastern Canada, apparently dipping beneath the older Cambrian (Quebec group), in which they were by Logan included. Recently Selwyn has found in this region portions of these newer fossiliferous strata lying to the east of a belt of crystalline Huronian rocks, and resting directly upon the latter. Such outliers of Ordovician strata, with fossils of Trenton or Utica age, have now been found in several places among the crystalline schists of the Green Mountain belt in the province of Quebec, in connection with lines of fault and downthrow, which have protected these newer strata from erosion. Recently, also, Dodge has found graptolitic slates, referred to this horizon, in Penobscot County, Maine.

These, and other similar facts show the former extension, under more or less modified conditions, of Ordovician rocks over the Cambrian, and still older series to the south and east of the Saint Lawrence, Champlain, and Hudson valleys. The great belt of uncrystalline sedimentary rocks stretching throughout these regions along the western base of the crystalline range was by Mather, and later by Logan, described as the Hudson River group, and supposed to belong to a horizon above the Trenton limestone; while by Emmons, who subsequently assigned it to a position below this limestone, it was called Upper Taconic, and afterwards was by Logan, who adopted the view of Emmons, named the Quebec group. Researches in Canada and in Vermont have long since shown that in this greatly disturbed and involved belt are included fossiliferous strata, holding all three of the great lower Paleozoic faunas, Cambrian, Ordovician, and Silurian.

The rocks of the so-called Hudson River group, near Poughkeepsie, N. Y., have recently been made the subject of studies by Dale, Whitfield, Dana, and Dwight, with the result of discovering there fossiliferous beds referred to the various horizons of the Loraine, Trenton,

Chazy, and Calciferous, the beds of the latter yielding an abundant and remarkable fauna. The strata are here affected by several folds, some of them involving even the newest strata, and generally have a steep easterly dip. Recent observations by Dwight show a direct superposition of Trenton upon the Calciferous, probably unconformably, as is seen elsewhere in the valley, where the Trenton lies upon the slates of the so-called Quebec group. The greater portion of this latter doubtless belongs to a series which includes the typical Calciferous as a stage, but the stratigraphical relations of the latter, as seen near Poughkeepsie, to the Cambrian slates remain to be determined.

Marr has lately studied the lower Paleozoic rocks of Bohemia, where he found the stages B and C of Barrande to rest unconformably upon stage A, the latter being composed of crystalline rocks, which Marr compares with the Pebidian of Wales (Huronian); B he considers to represent the Harlech beds, at the base of the Welsh Cambrian, while C and D are equivalent to the Lingula flags and the Tremadoc, followed, however, by representatives of the Arenig and Bala. These divisions thus include representatives of the first and second faunas of Barrande, while the succeeding stages E and F contain his third fauna. It is in D that are found, according to Barrande, what he described as "colonies" of the third fauna, which he supposed had existed there contemporaneously with the second fauna. Marr, however, after detailed stratigraphical studies, considers these apparent associations to be due entirely to physical disturbances, or, in other words, that they are to be explained by faults and folds by which the younger have been involved in the older strata.

Marr has also discussed the question of nomenclature and classification of the lower Paleozoic rocks, in opposition to the views of Barrande, and in support of the use of the term Cambrian in its original and historic sense. The difficulties in the way of arriving at a general application of the term Cambrian to the upper division of Sedgwick's system, which Murchison, by a mistake in stratigraphy, included in his Silurian, are, however, so great that its general adoption seems impossible, and it is to meet this state of things that the distinctive term Ordovician or Ordovian has been proposed for this division of the lower Paleozoic rocks.

Lapworth, in the *Geological Magazine* for June and July, 1881, has made a detailed comparison between the lower Paleozoic rocks of Great Britain and Scandinavia, and Schmidt has done the same for the Baltic provinces of Russia.

CLASSIFICATION OF Eozoic AND PALEOZOIC ROCKS.

For the better understanding of the nomenclature of the great subdivisions of the Eozoic and lower Paleozoic rocks referred to in the preceding pages, a brief summary is subjoined, numbered in ascending order.

A.—EOZOIC OR ARCHÆAN.

1. *Laurentian*. (Logan and Hunt, 1854.)—Lower Laurentian of Logan. This, as originally defined by the geological survey of Canada, included a lower division of granitoid gneiss, apparently without limestones (Ottawa gneiss of Hunt), and an upper division (Grenville series of Logan) consisting of gneisses with bands of granular limestone, quartzite, and iron-ores, a probable unconformity existing between the two. The lower of these may probably correspond to the Lewisian and the upper to the Dimetian of Great Britain, and it may be found desirable to adopt the name of Lewisian for the Ottawa gneiss, and to restrict the name of Laurentian to the Grenville series. Both of these are probably included in the older gneiss of the Alps.

2. *Norian*. (Hunt, 1871.)—Upper Laurentian or Labradorian of Logan. The hypersthenite rocks of Maculloch and Emmons, a series in which granitoid and gneissoid rocks, essentially composed of anorthic feldspars, predominate, with, however, intercalated gneisses, quartzites, and limestones resembling those of the Laurentian.

3. *Arvonian*. (Hicks, 1878.)—The *hüllefinta* or petrosilex group of Sweden and Wales, consisting essentially of granular or cryptocrystalline quartzo-feldspathic rocks, often jasper-like, but becoming gneissoid or porphyritic, interstratified with more or less of argillaceous, chloritic and hornblendic rocks like those of the succeeding Huronian series, in the base of which it was at first included in North America, but from which it seems generally separated both in North America and in Wales by a stratigraphical break.

4. *Huronian*. (Hunt, 1855.)—The Pebidian of Hicks, and the lower part of the *pietre verdi* or greenstone group of Italy.

5. *Montalban*. (Hunt, 1871.)—The younger gneisses, leptinites, hornblendic and micaceous schists of North America and central Europe; the Upper Pebidian or Grampian of Hicks; included by Gastaldi in the *pietre verdi* zone of northern Italy.

6. *Taconian*. (Hunt, 1878.)—Primitive quartz-rock, lime-rock, and argillite of Eaton; Lower Taconic of Emmons. Primal, Auroral, and Matinal of Rogers, in eastern Pennsylvania; Itacolumite group of Lieber.

[In 1870, the name of Terranvan was proposed by Hunt to include the groups above numbered 5 and 6; but was abandoned by him in 1871, when the name of Montalban was suggested for 5.]

7. *Keweenawian*.—The name of Keweenaw group, 1873, and Keweenawian, 1876, was employed by Hunt to distinguish the so-called Upper Copper-bearing rocks of Lake Superior, which have been shown to be younger than the Huronian and Montalban, and older than the Cambrian (Potsdam). Though they occupy a horizon not far from the Taconian they differ widely from it in character, and constitute a distinct series whose chronological relations to the latter cannot yet be determined.

B.—PALEOZOIC.

8. *Cambrian*.—Lower and Middle Cambrian of Sedgwick; Cambrian and Primordial Silurian of Murchison, containing the first fauna of Barrande. Embraces in North America the Menevian or Acadian, the Potsdam and Calciferous divisions of the New York system, and the Upper Taconic of Emmons or Quebec group of Logan.

9. *Ordovician* or *Ordovian*. (Lapworth, 1879.)—Upper Cambrian of Sedgwick; Lower Silurian of Murchison; Cambro-Silurian and Siluro-Cambrian of others, containing the second fauna of Barrande. Embraces in North America the Chazy, Trenton, Utica, and Loraine divisions of the New York system.

10. *Silurian*. (Sedgwick)—Upper Silurian of Murchison, containing the third fauna of Barrande. Includes in North America the Oneida, Clinton, Niagara, and Lower Helderberg, of the New York system, with the intercalated Onondaga or Saliferous group.

11. *Devonian*, or Erian of Dawson; the Erie division of the New York system.

12. *Carboniferous*.

PALEOZOIC ROCKS OF COLORADO.

S. F. Emmons has given in the report of the United States geological survey for 1881, an account of the geology of the Leadville district in Colorado, where the Paleozoic rocks are associated with numerous eruptive masses and contain large deposits of argentiferous lead-ores, which have given to the region its economic importance. To the west of the Front or Colorado Range rises, with a gentle slope to the east, the Musquito or Park Range, attaining 11,000 feet, and sinking abruptly on the west to the Arkansas Valley. This, which is sixty miles long and fifteen miles wide, is limited to the west by the broad and lofty Sawatch Range. Within the valley, on the western flank of the Musquito Range, is situated Leadville, 10,150 feet above the sea. We here find reposing on the Eozoic rocks of the range a series of Paleozoic strata consisting in ascending order (1) of 200 feet of strata, chiefly quartzites, described as Cambrian; (2) 200 feet of white dolomitic Silurian limestone, to which succeed (3) about 4,000 feet of Carboniferous strata, having at their base 200 feet of blue limestone, and at the summit from 1,000 to 1,500 feet, the Weber grits and shales intervening. The Kanab section on the Colorado exhibits a similar thickness, a remarkable contrast with the Wahsatch in Utah, where King found a series of 30,000 feet of Paleozoic strata, including at the base 12,000 feet of sandstones and shales, regarded as Cambrian, but without observed fossils save in a few feet at the top, which carry a Potsdam fauna. The Mesozoic of the Leadville region, which probably attained 1,000 feet, has been removed, but the Paleozoic strata include eruptive rocks, mostly of the Mesozoic period. These, which are described as quartziferous porphyries, sometimes granite-like, and diorites, are found in the Paleozoic series as inter-

posed sheets, which were spread out between deep-lying sedimentary strata before the folding and faulting of the latter. A layer of white quartziferous porphyry overlies the blue limestone in the lower part of the Carboniferous, and varies from 1,000 to 100 feet in thickness, or thins out altogether. Other sheets of eruptive rock are found in the quartzite below and at various other horizons, in parts of the region as high as the Jurassic. The ores of the district, principally argentiferous galena, and the products of its alteration, are found chiefly in the blue limestone beneath the great porphyry sheet, but also in the white dolomite below, and even in the quartzite. They occur, as is usually the case in deposits of this nature, in irregular cavities in the limestone. Emons is disposed to believe the source of the metals to be in the eruptive rocks, from which they have been dissolved by infiltrating waters and deposited among the sedimentary rocks. But it is to be remembered that we find similar ore-deposits in limestones where eruptive rocks are absent, as in parts of Nevada, for example, and in the Mississippi Valley. The deposition of the ores at Leadville is, however, shown to have been posterior to the intrusion of the igneous rocks and anterior to the faulting of the strata.

GRAND CAÑON OF THE COLORADO.

Dutton, in his studies of the Grand Cañon district, just published by the United States Geological Survey, has given important details with regard to its geological history, which throw light on the differences observed in the thickness of the Paleozoic rocks in different parts of the great western region. He shows that while Cambrian, Silurian, and Devonian beds are frequently met with, the great Carboniferous series, for the most part, rests directly in this region on the Eozoic. Where the older Paleozoic strata underlie the Carboniferous, they are unconformable and have been subject to erosion. This is the case in Nevada, Utah, and in central and western Arizona. Beginning at the base of the Carboniferous, there is throughout this region apparently a continuous and conformable series of sediments to the top of the Cretaceous. The Grand Cañon of the Colorado, some 5,000 or 6,000 feet in depth, is excavated from 4,000 to 4,500 feet in the Carboniferous, the remainder being in Eozoic and in some parts in lower Paleozoic strata. The Carboniferous here has at its base about 1,800 feet of limestone, followed by shales and sandstone, and terminated by about 700 feet of limestone. Above this come Permian, Triassic, Jurassic, and Cretaceous rocks, succeeded by the Eocene, which forms the High Plateau region of southern Utah, the interval from the top of the Eocene to the Carboniferous being there from 4,000 to 5,000 feet. Eastward, towards the Uinta Mountains, the Eocene itself, however, attains a greater thickness, making there the whole volume of deposits above the Carboniferous not less than 10,000 feet. Dutton concludes that while the lower limestones of the Carboniferous were formed in somewhat deep water, the whole

of the succeeding deposits were laid down in shallow seas near tide-level, thus indicating a gradual subsidence from Carboniferous time, going on *pari passu* with sedimentation. The Cretaceous sea, which marked the close of this order of things, appears to have extended from the Gulf of Mexico to the Pacific, with the exception of narrow land-areas. At the close of the period, great movements took place in this area, followed by erosion, which allowed Eocene fresh-water beds to be deposited in some places over Jurassic strata to the thickness in parts, as we have seen, of 5,000 feet. It is difficult to separate the succeeding Miocene from the later Eocene, and we have here no evidence of Pliocene deposits. These were times of gradual emergence. At the close of the Miocene was an uplift of 2,000 or 3,000 feet, and at the close of the Pliocene a still greater one of 3,000 or 4,000 feet. In these later Tertiary times came the great north and south faults of the Plateau region, already described by Powell, producing displacements of many thousand feet, and bringing in one case the Eocene against the Carboniferous.

The great and widely-spread volcanic activities of the region began in Miocene and continued until recent times. The first erosion of the Grand Cañon took place at the close of the Cretaceous, or a little later. The process went on rapidly through the subsequent times of elevation, but has now reached a period of comparative quiescence. The glacial age, succeeding the Pliocene, was, according to Dutton, here marked by pluvial rather than glacial action.

J. J. Stevenson, in a report on the geological survey under Captain Wheeler, has given details of the geology of parts of southern Colorado and New Mexico, along a continuation of the Sangre de Cristo Range, of which he notices the Eozoic rocks, before designated by Hunt as in part, at least, Laurentian. Upon these, to the eastward, rest Carboniferous strata, while farther east Cretaceous strata repose either directly upon the latter or upon the Eozoic, together with some beds which may be Jura-Trias, and elsewhere Tertiary rocks. Stevenson discusses at some length the relations of the Laramie group, and gives new reasons for believing it to be true Upper Cretaceous.

TRIAS OF EASTERN NORTH AMERICA.

W. M. Davis has studied the Trias of the Atlantic border, with its included trappean (diabasic) rocks, as seen in the Connecticut Valley and in New Jersey. These igneous rocks, according to him, occur in three different relations to the associated sandstone: (1) as dikes cutting the strata, (2) as intruded sheets, often of great extent and thickness, lying in nearly all cases conformably between the layers of sedimentary rock; (3) as overflowed sheets, equal in extent and thickness to the last, but poured out at the surface during the formation of the sandstones. Examples of the dikes are seen near New Haven, Conn., from 100 to 200 feet thick, with a transverse columnar structure. These

mark probably the channels through which the material of the great sheets was brought up. They have produced a very limited alteration proportionate to their breadth, of the adjacent strata. The beds of trap of the second class have altered the sedimentary strata both above and below them, and are not accompanied by amygdaloids. To this class belong, according to Davis, the Palisades of the Hudson and the range from West Rock northward near New Haven. To this may be added a great dike at Lambertville, on the Delaware, above which tourmaline, epidote, and specular iron have been developed in the sandstone. The existence in the regions in question of trappean masses of the third class, or overflows, has not been generally recognized, although maintained by Edward Hitchcock for the Connecticut Valley, and also by Dawson for the Trias of Nova Scotia. These subaerial or subaqueous beds are generally very amygdaloidal in their upper portions, and sometimes at their base. The underlying sedimentary rock is but slightly affected, and the overlying bed not at all. Tufaceous layers sometimes accompany these overflows, and fragments of trap are occasionally found in the overlying sediments. These, as Dawson has shown, are frequent in Nova Scotia. Examples of these overflows are seen in Mounts Tom and Holyoke, in the Connecticut Valley, and in their continuation in the Hanging Hills of Meriden; also, as lately shown by Professor Emerson, in the Deerfield mass. Davis next proceeds to consider the question of the general monoclinical arrangement of the strata in the two Triassic areas in question, the dip in the Connecticut Valley being to the eastward at angles generally from 10° to 20° , and more, and in New Jersey and Pennsylvania to the westward, with a similar inclination. H. D. Rogers supposed an original obliquity of deposition; Kerr, a broad anticlinal fold in originally horizontal strata, the belts of eastward and westward dipping beds representing respectively the eastern and western portions of such anticlinals, from which the remainder had been removed by erosion; while E. Hitchcock and Le Conte imagined a simple monoclinical tilting. This would involve an enormous thickness of strata, amounting, as Persifer Frazer has shown, to over 50,000 feet for one measured section in Pennsylvania, a conclusion for many reasons inadmissible. In the view of Davis, lateral compression of the horizontally deposited beds produced a series of folds with peculiar distortion, having the form of long, "shallow oval dishes or boats, of gentle curvature, canted over a little, and faulted on the side of the general monoclinical dip." A careful study of the overflows has enabled him to establish well-marked horizons, and thus satisfactory evidence is obtained that the strata have been both folded and faulted. In this way is explained the general crescent-like forms of the trappean beds, which everywhere present their convex sides to the upward slope; that is to say, westward in the Connecticut Valley and eastward in New Jersey. The great intruded sheets of trap which occur

only near the base of the sandstone series are compared with the western laecolites.

It is satisfactory to find that the monoclinical structure of these Mesozoic areas is due to an arrangement not unlike that which is to be met with in the Paleozoic and still older rocks along the western border of the Atlantic belt from Quebec to Alabama, where, as the result of faults with uplifts on the eastward side, the newer rocks not only seem to pass beneath the older, but in many cases are actually overlaid by them. J. J. Stevenson has lately re-examined and carefully mapped the successive parallel faults in southwest Virginia, by which the basal beds of the Paleozoic are repeatedly brought up against the coal measures.

SERPENTINE ROCKS.

Serpentine was, by the older geologists, regarded as intrusive, and by many supposed to be derived from various eruptive rocks by a process of metasomatism, while others have supposed it to be formed, as is doubtless often the case, by epigenesis from olivine rock, which was also regarded as eruptive. The late studies by Brögger and others of the olivine rocks of Norway have shown these to be clearly of aqueous origin, and contemporaneous with the inclosing strata, thus supporting the views of those who have always held to the aqueous origin of the great rock-masses of serpentine.

The serpentines of Anglesea, of Cornwall and of parts of Scotland are, according to Bonney, to be regarded as intruded among the accompanying crystalline schists, while Hicks and others regard these same serpentines in Anglesea and in Scotland as contemporaneous stratified deposits in Huronian (Pebidian) rocks. The indigenous character of the serpentines and gabbros from the granulite rocks of Saxony is, according to Credner, not doubtful. These latter, as already noticed, are probably to be referred to the Montalban or younger gneiss series, in which, as Hunt has shown, are included also the bedded serpentines and olivine rocks found in the Blue Ridge in North Carolina.

The question of the eruptive or the indigenous character of the similar serpentine rocks (often containing olivine) found in the upper gneisses of the St. Gothard has been discussed at length by Stapft, who has had a favorable opportunity of studying them in directing the construction of the railway-tunnel just opened through that mountain. He maintains, with regard to the origin of serpentines, the view first put forth by Hunt, that the material of these serpentine rocks was originally deposited from water, as hydrous magnesian silicates, in conformably interposed beds among the inclosing sediments.

In the subsequent crystallization of the sediments he supposes the magnesian silicate to have become an anhydrous olivine or enstatite-rock, from which by epigenesis at a later period serpentine has been formed, a process not yet complete, as shown by the presence of included grains of olivine. Movements of the earth's crust by folding and fault-

ing have distorted and broken up the magnesian strata, and have forced the tough and hard rock through or along fissures in the surrounding and more yielding strata, thus giving rise to the deceptive appearance of intrusion. Stapft adduces evidence to show that these displacements took place while these rocks were in the solid state, and cites the existence of polished and striated surfaces, and of fissures filled with a friction-breccia as evidence of this. In parts of the section at the St. Gothard, the conformable interstratification of the serpentine with other rocks is apparent.

In some parts of Italy, notably in Tuscany and Liguria, are areas of serpentine which, appearing in regions among Tertiary strata, have been by most geologists regarded as eruptive and posterior to these. These serpentines are, however, accompanied by euphotides and schistose rocks, and are admitted to resemble very closely the serpentines which, with similar associations, are found in the *pietre verdi* or Huronian series of northern Italy. Gastaldi, as is well known, asserted that these so-called newer and eruptive serpentines were but portions of this underlying ancient series, which, as the result of uplifts, faults, and erosions, are exposed in the midst of more recent deposits. This opinion, although much controverted, is shared by Jervis and by Hunt. The latter, from his examinations of these rocks, in parts of Liguria and of Tuscany, maintains that this view is the only one in accordance with the facts.

ANTHRACITE COAL.

The generally received opinion that anthracite has been formed by a subsequent alteration of bituminous coal, and is in some way connected with disturbance of the inclosing strata, has been contested. The present writer has long maintained that differences connected with the original conditions of formation have given rise to the anthracite, bituminous, and semi-bituminous coals of Pennsylvania, which "have been the result of decompositions going on at ordinary temperatures." Later studies by Franklin Platt, of the geological survey of that State (Report G G.), are in point. In Sullivan County, to the northwest of the great anthracite region, where the strata are affected only by broad, gentle undulations, is a small outlying coal-area known as the Bernice or Loyalsock basin. Here are exposed two coal-seams near the base of the measures. The upper one, eleven feet thick, lying beneath eighty feet or more of thin-bedded sandstones, is an anthracite, while sixty-five feet below is a seam of two feet, beneath five feet of shale, which has the composition of a semi-bituminous coal. The ratio of volatile matters to the fixed carbon, deducting ash, water, and sulphur, is, according to Mr. Creath, for the first, 1:10.289; and for the second, 1:4.132. Another seam in this basin not certainly identified with either of the above consists of two benches separated by six feet of shale, the upper bench being semi-bituminous and the lower an anthracite, with ratios, respectively, 1:2.527

and 1 : 6.932. The upper coal of the Bernice basin is largely mined and sold as anthracite, but is softer, and lacks the usual conchoidal fracture, resembling rather that of the Lykens Valley than the more eastern anthracites.

CHEMICAL GEOLOGY.

That watery solutions have been the efficient agents in the formation of metalliferous deposits is now generally admitted, alike for those contemporaneous with the stratification, and for posterior accumulations, whether in cavities produced by erosion, as in limestone rocks, or in fissures resulting from movements in the earth's crust. That the process of the transport and deposition of metals by solutions has been going on from very early geological periods to the present has also been recognized. The comparative recency of deposits like the great gold and silver bearing Comstock lode, for example, is well known, and Phillips and Rolland have shown that thermal waters are even now giving rise to deposits of sulphureted ores, which lead to the conclusion that the great lode in question has been formed by mineral solutions, of which the hot springs of the vicinity are the actual representatives:

In the Coast Range of California the Cretaceous and Tertiary strata were greatly disturbed at the close of the Miocene, following which, as is well known, was a period of volcanic activity prevailing through Pliocene time and perhaps later. The springs of heated waters charged with soluble and gaseous sulphids (*solfataras*), still abundant in the region, are probably connected with this former vulcanism. Of this solfataric action the Sulphur Bank, as it is called, on Clear Lake, ninety miles north of San Francisco, furnishes a remarkable example. Here a layer of volcanic rock, described as augite-andesite, which overlies the highly inclined sedimentary strata, is found decayed at the surface to a white granular earth, while lower down in the mass are "bowlders of decomposition," consisting of nuclei of the same rock, still undecomposed. The interstices of the mass are filled with crystalline sulphur, which in descending is replaced by cinnabar. An open cutting to a depth of about forty feet in the nearly vertical sedimentary strata, not far from the edge of the volcanic cap, discloses between harder layers a stratum consisting of a soft breccia of fragments of sandstone and shale, with interposed bluish clay or mud, impregnated with cinnabar and pyrites, through which rise hot alkaline waters, carrying sulphydric, carbonic, and boric acids. The outcrop of this bed of rubble or breccia has been traced, and elsewhere mined for cinnabar.

Messrs. Joseph Le Conte and W. B. Rising have described further observations made in levels driven from a shaft sunk with the object of exploring the strata beneath the lava-cap. One level, at a depth of 150 feet, after traversing seventy feet or more of barren sandstone and shale, comparatively dry and cool, reached a belt of brecciated rock made up of fragments of sandstone and shale resembling that already described,

and like it serving as a channel through which rise waters having a temperature of 160° F., holding carbonates and sulphids of sodium and ammonium with borates and sulphureted hydrogen; free carbonic acid bubbling up abundantly. The interstices of this breccia are lined with cinnabar, pyrites, and silica, the first predominating, and sometimes alternating with the silica, which is gelatinous, caseous, and occasionally chalcedonic in character. This irregular metalliferous deposit, now in process of formation, is in large part in the brecciated stratum, but is not confined thereto, sometimes disappearing, to reappear in another stratum, with barren rock between, and at other times diffused through the shattered sandstone on one side or the other of the breccia. The authors conceive this to have been originally a stratum of breccia, which, being less coherent than the adjacent beds, presented a plane of weakness, and was more shattered by the movements of the strata than they. Where the inclination was less steep, however, the disruption, and consequently the ore-bearing fissures, extended to the adjacent beds. These deposits, which are wrought for cinnabar, contain no sulphur, except near the surface, where its separation is due to the action of atmospheric oxygen. The agency of the alkaline sulphids in transporting and depositing the cinnabar seems clear. Details of the condition of the sulphids and the silica are wanting, but this locality yields beautifully crystallized cinnabar enclosed in opaline silica. J. A. Phillips moreover has shown that the silica deposited from certain thermal waters in California, and from the Steamboat Springs in Washoe County, Nevada, is of the nature of crystalline quartz.

The authors insist upon the twofold character of the action going on in connection with these solfataras. The oxidation of sulphureted hydrogen under certain conditions gives rise, as is well known, to sulphuric acid, which, carried downward by atmospheric waters, exerts a solvent action on the decaying rocks and by neutralizing the ascending alkaline waters, helps to diminish their solvent power, to which result, however, diminished temperature and pressure contribute. These studies are important as throwing light on the formation of veins and other posterior deposits of minerals in rock-masses. When we recall, in this connection, the effects of thermal waters, as seen in the masonry of ancient Roman baths, where various crystalline silicates and other mineral species have been developed in historic times, we are able to understand many cases of so-called local metamorphism, not only in visible proximity to igneous masses, but elsewhere in sediments far removed from such, where faults or permeable strata have served as channels to heated waters from below. Matters dissolved in these waters, and others present in the sediments, contribute alike under these conditions to the genesis of crystalline minerals.

Hunt has described the reactions going on independent of solfataric or thermal waters in the auriferous gravel of California. This consists in large part of the ruins of feldspathic and hornblendic rocks, holding

pyrites and lignite in the form of scattered trunks of trees. Where it is, from drainage, subjected to subaerial decay, the pyrites is oxidized, and the silicates are decomposed with liberation of bases and much silica, which is deposited in a crystalline form in the fissures and cavities of the gravel, and also produces a veritable petrification of the lignite, by a process which is marked by three stages. The first of these is the filling up of the pores in the wood, the organic tissues remaining; the second, the slow removal of these by oxidation, and the third, a filling up the vacant spaces thus left. After the second stage, the silicious casts of coniferous wood are often separable in the form of fibers which have been mistaken for asbestos. A similar condition of things has been observed by Kerr in the auriferous gravels of North Carolina, where also the decay of silicates and the silicification of fossil wood is going on.

The oxide of tin, cassiterite, which, like quartz, occurs crystallized in ancient granitic veinstones, appears like it also to have been deposited from solutions in recent times. Collins, in the Transactions of the Royal Geological Society of Cornwall, has described his examinations of deer's horns from the tin-bearing gravels of the region, which are impregnated with cassiterite, and even contain visible crystals of the mineral. Some of these horns are so rich in tin-ore as to be sought by the smelter. A specimen examined by Collins of the horn of the red deer (*Cervus elaphus*) contained 2.6 per cent. of oxide of tin and 1.6 per cent. of pyrites, both of which were seen by the microscope to be inclosed in the cells of the horn. The process of stannification is thus, like that of silicification, one in progress in modern times, though under conditions as yet unknown to us.

GEOGRAPHY.

By Commander F. M. GREEN, *U. S. Navy.*

In considering the geographical work of the world in 1881 and 1882, while there does not seem to be any startling fact or great discovery to announce, it is evident that the general interest in geographical studies and researches is not diminishing. So many nations are taking an active part in the endeavor to solve geographical problems; so many interests, commercial, scientific, political, and missionary, are earnestly pushing inquiry in every direction, that each year the field for extensive and striking discovery becomes more limited. English, French, Germans, and Belgians have been vying with each other to discover new regions where their trade may be extended, and new routes by which merchandise may be transported with ease and economy; especially is this the case in Africa.

Large portions of South America, Asia, Africa, and Australia still remain comparatively unexplored, and for many years to come ample opportunities will be afforded for the scientific traveler to complete our knowledge of details in regions imperfectly known.

As soon as any discovery of any importance is made it is at once published to the world, in English, German, and French, in the excellent geographical periodicals, from which, in fact, this summary is condensed.

At the meeting of the British Association, at York, in September, 1881, it being the fiftieth anniversary of the foundation of the association, especial attention was paid in the geographical section to a review of the progress of geographical knowledge during the last fifty years, and a most valuable essay, by the hydrographer to the Admiralty, Sir F. J. Evans, on the progress of hydrographic surveys, was read.

Sir Frederic Evans called special attention to the increased accuracy in determining astronomically geographical positions, particularly with reference to longitudes. Of the fifty positions selected some years ago for secondary meridians by the Admiralty, the longitudes of thirty either have been exactly verified, or are in course of verification, by means of the electric telegraph, nineteen of these verifications being made by the labors of officers of the United States Navy and Coast Survey.

An extensive work of this sort has just been completed by United

States naval officers who have measured differences of longitude through submarine cables from Madras, by way of Singapore, Hong-Kong, Shanghai, and Nagasaki, to Wladiwostok in Siberia, connecting there with the chain of measurements made from Pulkowa Observatory by Russian officers, and joining at the Madras end to the Indian longitudes also determined electrically from Greenwich by officers of the great trigonometrical survey of India.

So accurately is it now possible to perform work of this kind that the great polygon from Greenwich by way of Suez, India, China, Japan, Siberia, and Russia, back to Greenwich, closes with an error only of thirty-nine one-hundredths of a second of time.

HYDROGRAPHY.

In almost all parts of the world hydrographic surveys have been progressing by the labors of officers of different nations, although the year has witnessed neither the inception nor the completion of any great undertaking. In considering the constant hydrographic work in progress on the shores of our own country, as well as others, it must be borne in mind that from the nature of the work it must be practically interminable, for no sooner is a chart of a harbor or coast line published than corrections are made necessary by the changes in the bottom, and consequent depths of water, caused by the action of tidal and other currents, as well as by the never-ceasing elevations and depressions of the shore line, which geologists tell us are all the time going on.

On the coast of the United States the work has been prosecuted zealously by the officers of the United States Coast Survey, some of the more important pieces of hydrographic work performed being, in Maine, the survey of Dyer's and Gouldsborough bays; in Massachusetts, the examination of Salem and Gloucester harbors and of Pollock Rip shoal; in New York, the resurvey of the lower bay of New York; an examination of changes in Delaware and Chesapeake bays; a resurvey of Chincoteague shoals; a resurvey of Norfolk harbor; examination of shoals on the coasts of North and South Carolina; a resurvey of Beaufort harbor; continuation of the hydrographic survey of the east and west coasts of Florida, including the bars of Saint George's sound and Pensacola harbor; a resurvey of Key West harbor, and a continuation nearly to completion of the coast of Texas. On the Pacific coast, the general hydrographic survey of the Californian coast has been continued, as well as a survey of bays, inlets, and ports in Puget Sound, and a reconnaissance of the waters of Southern Alaska.

The only important surveys executed under the orders of the Navy Department have been on the west coast of Mexico, by Commander Philip, in the U. S. S. *Ranger*, and a survey of the Bay of Samana, in the island of Santo Domingo, by Commander Bridgeman in the U. S. S. *Despatch*. This survey embraced the Yuna and Barracouta Rivers as

far as navigable. In the circulation and exchange of important hydrographic information and the correction and publication of charts, the United States Hydrographic Office has silently and unostentatiously contributed a very great deal to geographic knowledge.

The Coast Survey, from an early period in its existence, has devoted much time and expense to investigations of the currents and temperature of the Gulf Stream; but the appliances for both sounding and ascertaining temperatures were very imperfect. The invention and perfection of the wire sounding-machine and the deep-sea thermometers have afforded opportunities for correcting former errors and discovering new features in hydrographic science, so that the results of the last ten year's work are of more importance as far as our knowledge of the deep sea goes than all the work done before. During the last two years Commander J. R. Bartlett in the U. S. Coast Survey Steamer Blake has been engaged in an examination of the Gulf Stream not only after its full development has been reached on the coast of the United States, but where the currents manifest themselves at the entrances from the Atlantic Ocean to the Caribbean Sea.

From the very numerous soundings and temperatures taken during Commander Bartlett's cruises, and previously by Commander Sigsbee, in the Gulf of Mexico, the following deductions may be drawn, subject, however, to modification in minor details:*

The equatorial current of the North Atlantic is deflected northward by the coast of South America, a portion of it passing along the shore of the Spanish Main, between Grenada and Trinidad. A larger portion, however, pours into the Caribbean Sea, between the Windward Islands, and another part, proceeding westward, north of Hayti, enters the Caribbean Sea by the Windward Passage, still more continuing along the north shore of Cuba to the Straits of Florida. The water, warmed by the sun while passing over a series of shoals and banks, is several degrees warmer at the Windward Passage than at the Windward Islands. Proceeding westward, the current, entering the Gulf of Mexico from the Caribbean Sea, does not make the circuit of the Gulf, and has no necessary connection with the currents of the Gulf of Mexico, but passes to the northward and eastward, issuing from the Straits of Florida with such addition as may come from between Cuba and the Bahama Bank.

The temperature of the Gulf Stream, in the early part of its course, rarely exceeds 83° in June and July, except under a very hot sun in calm weather. By carefully measuring the area of the cross-section of the stream between Jupiter Inlet and the Little Bahama Bank, as well as its velocity, it is shown that the delivery is very much less than the amount called for by the volume of warm water extending over the Atlantic Ocean from Cuba to Norway, and heretofore ascribed to the out-

* For these deductions the compiler is indebted to an excellent article in the Nation, October 5, 1882.

pour from the Gulf. The stream varies from 50 to 100 miles in width, and its velocity and temperature are both greater in the middle than on the edges. The maximum rate of the current observed is said to be five miles per hour, and its average rate is perhaps two and a half.

Instead of running in a trough, as some observers have described it, the stream from the Bahama Banks to Hatteras passes over a rather even plateau, growing narrower to the northward. The mistake of supposing a trough or groove to exist has evidently been made by the current carrying away the bight of the sounding-line, and thus a greater depth being shown. This error is common to all soundings made with rope in a current. The bottom in the path of the stream, at 400 fathoms, seems to be swept clean down to the hard coral rock. The cold bands described by previous observers do not seem to have been met with, and appear to have been due to local rain-squalls or other causes producing accidental inequalities of temperature. Before the limits and velocity of the Labrador or inshore cold current can be described accurately, further soundings and serial temperatures are necessary.

A deep-sea thermometer devised by Dr. Siemens was used on board the Blake, and was found principally useful in verifying the temperatures, which can be ascertained with much more ease and rapidity by the Miller-Casella thermometer.

The action of the Siemens thermometer depends upon the variations in the electrical resistance of metals caused by changes of temperature. Two resistance coils, one of which is so arranged as to be lowered into the sea to any required depth, are connected with a Wheatstone's bridge and a Thomson's mirror galvanometer. The galvanometer being adjusted to show zero when the resistances experienced by the coils are equal, the resistance of the coil on board ship is made equal to that of the one lowered overboard by applications of ice or warm water, and its temperature, which will be that of the submerged coil, ascertained by an ordinary thermometer. In all trials the accuracy and trustworthiness of the Miller-Casella deep-sea thermometer were demonstrated. As opportunities offer this examination of the Gulf Stream is being continued.

Under the direction of the British Admiralty, hydrographic surveys have been prosecuted on the shores of Great Britain, in the Red Sea and Indian Ocean, and on the coasts of Borneo, China, Corea, Japan, Australia, the Fiji Islands, West Indies, and Newfoundland, employing five sloops of war, six smaller vessels, seventy-nine officers and nearly six hundred men.

The officers of the Indian marine survey have continued the survey of the long Indian coast line and the publication of excellent charts.

French surveyors have been engaged in perfecting detailed surveys of the French coasts and the northern coasts of Africa and correcting the charts of the Grecian Archipelago, while pushing forward the surveys of the coasts and rivers of Cochin China and the Gulf of Tonquin.

Under the direction of a Government commission composed of MM. Milne-Edwards, Vaillant, Perrier, Marion, de Falin, and Fischer, the French gunboat "le Travailleur," commanded by Lieutenant Richard, has carried out an extensive programme of sounding and dredging in the Bay of Biscay, off the coast of Portugal, and in the eastern part of the Mediterranean Sea. The greatest depths found were 2,789 fathoms in the Atlantic, and 1,454 fathoms in the Mediterranean.

The Spanish Government has undertaken a new survey of the Mediterranean shores of the Spanish kingdom, and are also energetically pushing a survey of the entire Philippine group.

FIGURE OF THE EARTH.

In Appendix No. 8 to the United States Coast Survey Report for 1879, Mr. C. A. Schott discusses the deflection of the plumb line along the oblique arc from Calais, Me., to Atlanta, Ga., and demonstrates the superior accuracy of Clarke's elements of the spheroid figure of the earth over those determined by Bessel. So evident is this superiority that the substitution of Clarke's spheroid for Bessel's as the surface of development for all Coast Survey maps of the Atlantic and Gulf coasts is recommended, it having already been adopted for the charts of the Pacific coast. When this arc, already 1,200 miles long, is extended $4\frac{1}{2}^{\circ}$ farther to Mobile Point, the Atlantic and Gulf coast systems of triangulation will be united, and the value of the arc for geodetic purposes will be increased 25 per cent.

The European Association for the Measurement of Degrees, formed by geodesists of various nations in 1861 under the auspices of Lieutenant-General von Baeyer, and having for its objects the measurement of arcs of meridian and parallel, are making arrangements for the completion of an arc measurement extending from Palermo to Levanger in Norway.

Work is now in progress to connect the general system of Swedish triangulation from a point on the frontier south of Christiania with Levanger as well as another point in Sweden farther north. This measurement will give an arc covering $25\frac{1}{2}^{\circ}$ of latitude, and its discussion will afford a valuable addition to geodetic knowledge.

Renewed interest has been manifested within the last few years in the observations of pendulum vibrations as bearing on the figure and density of the earth, and pendulum work which had been suspended for many years has been resumed by the Government surveys in Europe, America, and India. The pendulum so well used by Major Herschel, R. E., in the work of the great trigonometrical survey of India, has been carried by Mr. Edwin Smith of the United States Coast Survey, to the stations in New Zealand where he observed the transit of Venus in December last, and he will observe its vibrations there, and afterward at Batavia, Hong-Kong, Tokio, Point Barrow, and San Francisco.

NORTH AMERICA.

The geographical work of the United States Coast Survey has consisted, as heretofore, of topographic surveys for the exact definition and delineation of the shore line, hydrographic surveys and resurveys where changes have taken place, of the coast, harbors, and rivers, and in the interior the continuation of the observations for the connection by triangulation of the Atlantic and Pacific coasts, as well as astronomical determination of important inland points and the carrying of a double line of geodesic levels from the Atlantic coast at Sandy Hook to the Mississippi River at Saint Louis. This line of levels is marked by permanent bench-marks from 2 to 40 miles apart, and when completed to San Francisco will be of great value in furnishing reference points for measurements of elevation. As the details of all this important work will be found in the United States Coast Survey Reports for 1881 and 1882, it is not worth while to enumerate them here.

The United States Geological Survey was organized in the spring of 1879, taking the place of several independent geological and geographical surveys which had previously been conducted under the direction of the Interior and War Departments. During the first two or three years of its existence comparatively little geographical work was done. The labors of the survey being confined mainly to mines and mining, the surveys were in great part limited to the making of detailed maps of mining districts. There was, however, some topographical work done in Southern Utah and Northern Arizona, in the neighborhood of the Grand Cañon of the Colorado, in order to complete a map commenced and nearly finished by the survey of the Rocky Mountain region. In addition to this, a survey was made of the volcanic region of the San Francisco peaks in Northern Arizona. Some geographical work was also done in connection with Mr. G. K. Gilbert's investigation of the history of the ancient lakes in the Great Basin, and the climatic changes indicated by them, but this was not of a connected character.

In the year 1881 it was decided to increase the topographical force with a view of preparing maps for the use of the geological corps. Work was commenced in the western part of New Mexico, in the neighborhood of Fort Wingate, where a base line was measured and triangulation extended therefrom in the neighboring region. A small area of country was mapped in this neighborhood and also in the neighborhood of the Moqui towns in Northeastern Arizona.

In 1882 the topographical force was largely increased and work was commenced simultaneously in several different sections of the country. Besides the detailed surveys of mining regions, a division consisting of two topographical parties commenced work in Northern California with the view of mapping eventually the great volcanic range of the Cascades extending across Oregon and Washington Territory, preparatory to a study of its geological phenomena. The triangulation for this division

was based upon points located by the Coast and Geodetic Survey. About 3,000 square miles were mapped in the Coast and Cascade ranges and in the volcanic region lying east of the latter.

Another division, consisting of one triangulation party and two topographical parties, commenced work near Bozeman, Mont., having in view the mapping of this country about the heads of the Yellowstone and Missouri Rivers and a connection with the triangulation of the old survey under Dr. Hayden, which had been extended from the line of the Union Pacific Railroad northward to the Yellowstone Park. The triangulation was expanded from a base measured in 1879, near Bozeman, by the surveys west of the one hundredth meridian. The expansion was effected and several stations occupied in the mountains, but an unusually early winter put a premature stop to all operations, and but little topographical work was done.

A third division, consisting of one party for triangulation and two for topography, continued the work commenced in the preceding year in Western New Mexico and Eastern Arizona. The triangulation was extended to include a very considerable area, and about 1,500 square miles were mapped.

Congress having authorized the Geological Survey to extend its operations into the older States outside the public domain, work was commenced this year simultaneously in Western North Carolina, Southern Virginia, and Eastern Kentucky and Tennessee. Four surveying parties, including one for carrying on primary triangulation, were organized for this work and have been carrying it on rapidly and satisfactorily. The triangulation was based upon that of the Coast and Geodetic Survey along the Blue Ridge, and was thence extended westward nearly to the Cumberland Mountains, and about 4,000 square miles were mapped, the larger portion of which is in the high mountainous region of North Carolina. It is the intention of the survey to push the work of this the Southern Appalachian division as rapidly as possible, as it is believed that no section of the country will so amply repay in a directly economic manner the labors of the geologist as this. Its immense resources of coal and iron are just beginning to be known, and its magnificent forests of hard and soft wood timber are rapidly assuming great importance in view of the unprecedented destruction of valuable forests in other sections of the country.

With the view of commencing operations in the Ozark Hills of Arkansas and Missouri, a base line was measured at Malvern, Ark., just at the south-western border of the hills, from which work will be carried on quite extensively during the coming year.

The State geological survey of New Jersey has recently commenced a detailed map of that State on a scale of one mile to an inch. The primary triangulation is supplied by the Coast and Geodetic Survey. The topographical work is done with the plane-table; contours are run at vertical intervals of ten feet in the flat country and twenty feet in

the hilly regions. The first sheet has recently been published (1882), comprising the northeastern portion of the State.

The second State geological survey of Pennsylvania, while making no pretense of publishing a map of the State, has surveyed very considerable areas in connection with its study of the mineral deposits, and a large number of maps have been published during the last three or four years upon various scales suited to the character of the investigation which they are designed to illustrate.

The State geologist of North Carolina has recently published a map of that State on a scale of 10 miles to an inch, embodying the results of his own labors and those of Professor Gryot.

The State survey of New York is steadily continuing its triangulation, as evinced by the brief annual reports of the director.

A great part of the region tributary to the lines of the Northern Pacific Railway, lying in Washington, Montana, Idaho, Wyoming, and Dakota Territories, is almost unexplored geographically, and its resources are still less known. To obtain an adequate knowledge of the capacities of this extensive country a survey has been organized on behalf of the railroads under the able superintendence of Mr. Raphael Pumpelly. The organization is divided as follows: division of mineral resources; division of climate, rivers, and irrigation; division of soil; division of forests; division of economic botany; laboratory; division of topography.

Topographical work was begun in September, 1881, between the Cascades and the Columbia River, about 2,500 square miles of country being mapped. During the season just passed three topographical parties were employed, one extending the maps of the region just mentioned, one east of the Colville reservation, and one between the Yellowstone and Missouri Rivers, making altogether between 20,000 and 30,000 square miles of territory surveyed and plotted. It is proposed to show all the information developed by the survey in a cartographic form, so that all the important physical facts will be shown on the maps. The topographical survey will show the form of the surface by contour lines of 200 feet of vertical distance, and in addition the maps will show the grades of the streams, the extent of the bottom and bench land, and the extent and conformation of the uplands.

On one set of maps will be shown the minimum volume of water at different seasons in the principal streams and the classified distribution of the soils. On another set of maps will be shown the climatic conditions, giving the rainfall and temperature by months from the observations of a long series of years. Another set of maps will show the distribution and relative abundance of forage plants, with the climatic facts affecting stock grazing; and still another set will show the mineral resources. The work will be so carried on as to be able to represent on the maps each winter the results of each season's work. A more valuable work to the prospective immigrant, to say nothing of its importance to the companies themselves, can hardly be imagined.

SOUTH AMERICA.

After a residence of seven years in Bolivia as engineer to the Government, Mr. J. B. Minchin has published, through the medium of the Royal Geographical Society, a great deal of information regarding this productive and fertile but little known country. In fact there is hardly any country of the world so little known as Eastern Bolivia. With an area of 500,000 square miles its productions are so numerous and valuable that, settled by a working population, it would become one of the most prosperous in South America. Its great need is a route for conveying its exports by way of the Madeira and Amazon Rivers to the sea. In addition to determining the latitude, longitude, and height of numerous points, Mr. Minchin has published an excellent map of Bolivia, showing the river systems as far as they have been explored. He has devoted much attention to the depth and rapidity of the various rivers which may be used for navigation, and a great deal of information regarding them has now for the first time been published. Mr. Minchin has also surveyed and described a part of the vast Andean table-land and salt desert not hitherto visited or described. He finds from an ancient water-mark, 200 feet above the present level of Lake Poopó, unmistakable evidence that a vast sheet of water, some 20,000 square miles in extent, once covered a great part of this table-land, and considers that the gradual subsidence and escape of the waters of this lake to the Pacific may have contributed to the formation of the great nitrate deposits of the coast.

In continuation of the work of the late Professor Orton, Mr. Edwin R. Heath has been engaged in exploring the Beni and other rivers of Bolivia. Starting in September, 1880, from Cabinos, a rubber camp on the Madidi, a small affluent of the Beni, he discovered a new river entering the Beni from the south, a short distance above its junction with the Madre de Dios, which he reached on October 8, and determined carefully the latitude and longitude of the confluence. Continuing to descend the Beni he discovered a new branch coming in from the north which he called the Orton. Between this point and the junction of the Beni and Mamoré he found navigation interrupted by falls and rapids, but making a short portage he reached the river below the falls and ascended the Mamoré for 300 miles to Santa Ana, thence across the pampas to Reyes. Dr. Heath's claim to have been the first white man to see the mouth of the Madre de Dios is probably erroneous, as there seems to be no doubt that the Madre de Dios was descended in 1861, by Don Faustino Maldonado, who was afterward drowned in the rapids of the Madeira.

Dr. Jules Crevaux, whose explorations in Guiana and on the Amazon have added so much to the knowledge of those regions, in 1880 was engaged in exploring the Upper Guyabero in Colombia. Accompanied by M. Lejanne, after crossing the Cordillera from the Upper Magdalena,

he embarked on a raft on the Guyabero, and with great difficulty and danger made the descent to Bolivar by way of the Orinoco, losing the raft in the rapids and having one of their men killed by the poisoned arrows of the Indians. During their journey 2,550 miles were traversed, of which 1,275 were through new country. In the latter part of 1881 Dr. Crevaux left France, intending, under the direction of the French ministry of public instruction, to pass, by one of the branches of the Paragnay, to the Amazon water shed, but on arrival at Buenos Ayres he was induced to undertake the exploration of the Pilcomayo, about which little was known. After discovering some important Indian ruins at or near Salta, he had prepared to embark his expedition in canoes on the headwaters of the Pilcomayo, not far from Tupiza, in Bolivia, when he was massacred, in April, 1882, with his party by the Tobas Indians.

An exploration of the upper part of the river Cuyuné has been made by Mr. McTurk, an official of British Guiana, who penetrated about 40 miles farther into unknown Venezuelan territory than has been done by any other white man, and found numerous Carib settlements.

Mr. Edward Whymper, F. R. G. S., made, in 1880, a most adventurous journey among the Andes of Ecuador, from which much information of value may be derived. Mr. Whymper fairly tested aneroid barometers for determining mountain heights, and concludes that generally speaking they are untrustworthy. He also compared systematically the results of elevation measurements made by boiling water and those by mercurial barometers, and finds that in all cases the boiling-point observations yielded lower altitudes than the barometers. Mr. Whymper also states that, contrary to the showing of most of the maps of that at region, the Cordilleras do not lie in two parallel ranges.

The elevations of a large number of mountains were measured, the results generally agreeing with those of Drs. Reiss and Stubel, but Mount Sarauren, reputed to be a volcano, was found to be non-volcanic and only 15,500 feet high, 1,900 feet lower than stated by Villavicencia.

During a residence of several years in Magdalena, United States of Colombia, Mr. F. A. Simons made extensive and numerous journeys through the region of the Sierra Nevada. He has described the river system at length in the *Journal of the Royal Geographical Society*, and has made many measurements of mountain heights. The greatest height he was able to determine was 17,500 feet, ascertained from the boiling point of water.

A new boundary line has been agreed upon between the Chilian and Buenos Ayrean possessions in Patagonia, which finally settles, it is to be hoped, this long disputed subject. The Andes, stretching south to Mounts Sarmiento and Darwin, will be the dividing line, while the southern limit of the Argentine Republic will be formed by a line from Cape Virgin to a point on the Andes, in latitude 52° south, longitude 72° west from Greenwich. The coasts of the Straits of Magellan are

thus allotted to Chili, and the straits are declared free to vessels of all nations.

In the course of an address before the geographical section of the British Association, Mr. John Ball calls attention to the remarkable contrasts existing between the climate of the eastern and western sides of South America. Not only is there an immense difference between the rainfall of the two coasts, there being a portion of the west coast (formerly Bolivia) where no rain ever falls, but a radical difference exists in the climate of neighboring places on the western coast only one hundred miles apart. Mr. Ball finds that the reasons heretofore adduced for these remarkable differences are entirely insufficient, and likewise fails to find any adequate reason for the exceptionally mild climate of the Straits of Magellan.

ARCTIC REGIONS.

Beyond the more accurate delineation of one or two coast lines, the geographical results attending the numerous Arctic expeditions of the last few years cannot be said to be very great in spite of the energy and devotion of the explorers, attended in so many cases with extreme hardship and loss of life.

During a long succession of years numerous attempts were made to sail from Europe to the Pacific Ocean by the north of Asia; no less than thirteen expeditions having been fitted out at various times and by different nations for this purpose. The only successful expedition was the last one, in 1878, commanded by Prof. A. E. Nordenskjöld, in the Swedish steamer *Vega*, which, after passing the strait south of *Novaya Zemlya* on August 1, found the *Kara Sea* nearly free of ice, and, dredging, sounding, and surveying as they went along, succeeded in reaching a point within 120 miles of *Behring's Strait* on the 28th of September, but were there ice-bound all winter, only passing into the Pacific on the 20th of the next July. This experience seems to have convinced Professor Nordenskjöld that voyages could be made every year from the north of Europe by way of the *Kara Sea* to the mouths of the rivers *Yenesei* and *Obe*, affording a much better means than formerly of conveying the wheat and other products of Southern Siberia to Europe, but subsequent events do not appear to justify this conclusion.

In the summer of 1880 steamers were not able to pass through any of the passages into the *Kara Sea*, owing to an ice-field 20 to 30 miles wide, on the east coast of *Novaya Zemlya*, which entirely blocked the mouths of the *Waigat* and the *Matyuskin Shar*. The passage north of *Novaya Zemlya* by the *Orange Islands* was also tried, but the sea was full of ice, and the steamers escaped with difficulty late in the season by way of the *Matyuskin Shar*. Late in September, M. *Sibiriakoff* succeeded in passing the *Jugor Strait* with two steamers and reached the mouth of the *Yenesei*, too late, however, to return.

In 1881 the edge of the ice-pack is said to have laid nearer to the coast of Norway than is known to have been the case before. The Matyuskin Shar and the straits south of Novaya Zemlya were heavily blocked with ice, but the northern passages seem to have been clear, and possibly in September vessels might have made their way to the Yenesei.

In 1882, in spite of several determined efforts, steamers could not pass the ice which blocked the approaches to the Kara Sea, and were obliged in October to return.

The facts seem to indicate that no reliance can be placed on the navigability of these northern waters, except perhaps for steamers constructed expressly to struggle against the ice, and that the outlet for the products of Southern Siberia must be looked for in the development of railways and canals.

The reports of the survivors of the unfortunate Jeannette expedition seem to show that beyond the discovery of three islands to the north-eastward of the New Siberia group and the more exact delineation of the shores of Wrangell Land, no important geographical results are to be expected from their labors except the confirmation of the belief that the waters surrounding the pole are constantly covered with a mass of ice heaped up and impassable, or, in other words, that Sir George Nares' theory of the Paleocrystic Sea is the true one.

The Jeannette left San Francisco on the 8th of July, 1879, fitted for three years' stay in the Arctic regions, under the command of Lieut. Commander G. W. De Long, U. S. N., with four other officers and twenty-four men of the naval service and two civilian attachés. On the 26th of August the ship started north from Saint Lawrence Bay, inclining toward the coast of Siberia with the hope of communicating with the Vega. On September 5 the ice-pack was entered, and on the 8th the Jeannette was frozen in solidly and never escaped; the ship after this time drifting helplessly with the masses of ice until June, 1881, a period of one year and nine months. The drift was with the wind, covering a large area of ground and having a general direction towards the north-west, and demonstrating that the only lands in this region were the small, rocky, uninhabited islets called Jeannette and Henrietta Islands.

On June 12, 1881, the Jeannette was crushed by the ice and sunk, giving time, however, for the crew to land and to secure provisions, &c., and on the 17th of June, with five sleds and three boats, the whole party started in good order for the coast of Siberia.

Progress over the rough and melting ice was slow and difficult, and it was not till the 29th of July that Bennett Island, in latitude $76^{\circ} 38'$ north, longitude $148^{\circ} 20'$ east, was reached. This island, small, high, and rocky, and the Jeannette and Henrietta islets, form the only geographical discoveries of this unfortunate expedition.

After a few days' stay to rest the exhausted crew, the men and officers were divided between the three boats and progress southward was re-

sumed by way of the open leads between the ice-floes. On the 28th of August, Thaddeus Island, of the New Siberia group, was reached, and a delay of ten days ensued from the ice openings being closed. It was not until September 12 that a start could be made for the coast of Siberia, and very soon afterward the boats were separated in a gale of wind. The boat commanded by Lieutenant Chipp, and having a crew of eight men, has never since been heard of. Lieutenant-Commander De Long's boat reached the Lena delta, where all the party but two seamen died of starvation and exposure; while the party in the third boat, commanded by Chief Engineer Melville, safely reached the Russian settlements on the Lena, terribly exhausted and frost-bitten.

The officers of the United States steamer *Rodgers*, Lieut. R. M. Berry commanding, while engaged in a search for the *Jeannette* in the autumn of 1881, made a thorough examination of Wrangell Land, which was supposed by the late Dr. Petermann to form a part of an extensive Arctic continent, but has now been definitely ascertained to be an island about 70 miles long, east and west, and 35 miles broad, including the sand-spits which make out from the north and south coasts from 6 to 10 miles. The whole island is a succession of peaks and valleys, one peak near the center of the island rising to a height of 2,500 feet, with a range of high hills extending round the island near the coast line. One small harbor was found on the southern coast. Lieutenant Berry explored the island thoroughly and made a chart of it.

After leaving Wrangell Island, Lieutenant Berry picked his way through the floes of ice to a point 132 miles farther north, in latitude $73^{\circ} 44'$ —the highest latitude ever attained in this sea. From the mast-head at this point no indication of land could be seen to the northward, and the depth (82 fathoms) here was increasing as the vessel proceeded northward. Lieutenant Berry found no evidences of a current in this sea, other than that produced by the ebb and flow of the tide.

After a full discussion of the various alleged currents of Bering's Sea (Appendix No. 16, Coast Survey Report for 1880), Mr. W. H. Dall, whose experience entitles his opinions to great respect, comes to the conclusion that no warm current from the southwest enters Bering's Strait with the exception of water from the adjacent rivers or sounds; that the Kuro Siwo, or Japanese Gulf Stream, sends no recognizable branch northward into Behring's Sea, and that the strait is incapable of carrying a warm current of sufficient magnitude to have any marked effect on the water of the polar basin. He agrees with Lieutenant Berry in considering the currents as chiefly tidal, and finds nothing developed in his investigation to support in the slightest degree the hypothesis of large areas of water in the Polar Sea free from ice. The opinion of Mr. Dall, that the movements of the ice are largely dependent on prevailing winds, is fully borne out by the experience of the officers of the *Jeannette*. During Mr. Dall's examination of the currents

and tides, most valuable determinations of geographical positions were made along the coast of Alaska by the party under his command.

The voyages of Mr. Leigh Smith in the English steam yacht *Eira* will hereafter take an important position in the annals of Arctic discovery. In June, 1880, the enterprising explorers left Great Britain, and after an ineffectual attempt to reach the east coast of Greenland, finding the ice impassable, the ship's head was turned to the eastward, and passing south of Spitzbergen, on the 14th of August the coast of Franz-Joseph Land was reached. Between this time and the 1st of September, Mr. Smith explored 110 miles of the south coast of Franz-Joseph Land and its off-lying islands, landing frequently and keeping a very full journal. Geological and botanical specimens were obtained and great numbers of walruses and seals were seen. From the 1st to the 10th of September the *Eira* endeavored unsuccessfully to find an opening in the ice pack which would enable the explorers to reach Wiche's Island east of Spitzbergen, but it was necessary to take a homeward course as the season was advancing, and on the 24th of September the *Eira* reached Hammerfest.

Among the important results of the voyage was the demonstration of serious errors in the Admiralty charts of the regions about Walter Thymen's Straits and other places frequented by vessels every year. Mr. Clements Markham, a most capable judge, pronounces this voyage of the *Eira* to have been the most important summer cruise ever made in the Arctic regions.

Again, in June, 1881, Mr. Smith sailed in the *Eira* with the hope of extending his discoveries of the previous year. The autumn and winter passed with no news of the expedition, and in June, 1882, a relief ship was sent to search for the missing explorers. On reaching Novaya Zemlya it was found that the *Eira* had been sunk by the ice in August, 1881, and that after wintering on Franz-Joseph Land Mr. Leigh Smith and his companions had fortunately escaped in their boats to Novaya Zemlya. As they had not been able to save any provisions from the ship they would all have starved to death but for the walrus and bear meat they were enabled to obtain.

Under an international arrangement stations have been established in the Arctic regions by observers of various nations for the purpose of making meteorological and other physical observations.

Although no announcements of geographical discovery have yet been received from any of these parties, it is to be expected that, in addition to meteorological observations, valuable contributions will be made to our geographical knowledge by the able officers at the head of these parties.

The United States have established two stations, one five miles west of Point Barrow, under charge of Lieut. P. H. Ray, United States Army, and one commanded by Lieut. A. W. Greely, United States Army, on the shores of Lady Franklin Bay, in Grinnell Land.

In July, 1882, as previously arranged, a relief ship was dispatched to

communicate with the party at Lady Franklin Bay, but failed to reach that place on account of unusually heavy pack ice. Depots were established on Cape Sabine and Lyttelton Island for use in case Lieutenant Greely's party should be forced to retreat, and as soon as the season opens in 1883 a determined effort will be made, under command of Lieutenant Garlington, United States Army, to reach the beleaguered colony.

The British station has been established at Fort Rae, in the northern part of British America, under the direction of a committee of the Royal Society.

On the island of Jan Mayen a party of Austrian observers have been left, to be relieved in 1883. The Danes have chosen Godhaab, in Greenland, where six skillful observers under the leadership of Mr. A. Paulsen have been placed; and the Dutch party, under charge of Dr. Snellen, of the Utrecht Observatory, are established at Dickson's Haven, at the mouth of the Yenesei. The Norwegian station is situated at Bozekop, on the Alten Fiord. The Russians have chosen a point at the mouth of the river Lena and at Moller Bay, in Novaya Zemlya. The Swedes have established observers on Spitzbergen; and the Germans, in addition to placing a staff of observers under command of Dr. Giese on the shores of Cumberland Sound, Davis Strait, have sent another party, under Dr. Schrader, of the Hamburg Observatory, to the island of South Georgia, 1,100 miles east of Cape Horn.

ASIA.

The most important geographical event relating to Central Asia is the completion of the expedition commanded by Colonel Prejevalsky, and the return of its members to Russia. The first part of the account of this famous journey in Thibet and China has been issued. It is divided into two parts, and is illustrated with maps and engravings. A German translation is in course of preparation. Under the auspices of the Imperial Russian Geographical Society, Colonel Prejevalsky proposes to start in March, 1883, on his fourth expedition to Central Asia, chiefly with a view to studying the volcanic phenomena presented by the Tien Shan, and also to penetrate, if possible, into the mountains of Thibet.

In an address before the British Association, Sir Richard Temple, in giving a summary of all existing knowledge relating to the geography of the central plateau of Asia, calls attention to the imperfection of that knowledge, the importance of the region, and the field offered by it for research and discovery. The principal geographical problems in Asia yet unsolved relate largely to this unknown region.

The Pamir, by which name is known the elevated region immediately south of Chokand, in Central Asia, and called by Asiatics the "Roof of the World," has frequently been described by geographers as a part of

this great plateau; but M. Severtsof, who has been engaged in exploring that region, states that the Pamir is not a table-land, and, up to the height of about 12,000 feet, has no steppe formation. Up to the height of about 14,000 feet the rivers flow in narrow valleys never exceeding about thirteen miles in width. There are no lofty plateaus in the Pamir, the mountains rising 6,000 or 7,000 feet above the level of the valleys, elevations above the sea of 19,000 feet being frequently found, with three mountain groups attaining a height of 25,000 feet. From evidence obtained by M. Severtsof, he considers that elevation is continuously and steadily going on.

M. and Mme. Ujfalvy have accomplished a long journey in Kashmir and Little Thibet, bringing with them an important collection, valuable from a geographical and ethnographical point of view, and which is to be preserved in the Ethnographical Museum of Paris.

Among the many obligations which geographical knowledge owes to enterprising newspaper correspondents must be reckoned the account given by Mr. E. O'Donovan of the supposed desert of Merv. Mr. O'Donovan, who penetrated into this region from Persia under circumstances of great peril and hardship, states that so far from the country being a desert, the soil is fertile, and only requires that the irrigation works be repaired by dams on the Murghab and Tejend Rivers to become productive again. Mr. O'Donovan further states that though the ruins of two cities, one Alexandrine and one Mussulman, can be traced and show evidences of a high degree of civilization, no such city as Merv exists at present.

Mr. P. M. Lessar, an employé of the Russian Government, has been engaged in exploring the country bordering on the southwest portion of the Caspian Sea, and lying between that sea and Herat, in order to ascertain the possibility of constructing a railway from some port on the Caspian toward the frontier of British India. He finds the physical obstacles easily surmountable, and demonstrates that, in the region to be traversed, the Paropamisus, or high range of mountains, which north of Cabul rise to an elevation of 20,000 feet, dwindle as they range to the westward to mere hills less than 1,000 feet in height.

Dr. Albert Regel has, under the auspices of the Imperial Russian Geographical Society, been engaged in the exploration of the region surrounding the headwaters of the Amu Daria River. The year 1881 was devoted to the investigation of the Bokharan province of Drwvag; and a translation of his report of proceedings up to September, 1881, is published in the Proceedings of the Royal Geographical Society.

In carrying a chain of spirit-level observations across the Indian peninsula from Bombay to Madras, by the officers of the grand trigonometrical survey of India, the result seemed to show that the mean sea level is about three feet higher at Madras than at Bombay. After a very careful investigation the surveyor-general has concluded that this anomalous result is due to an accumulation of minute errors in the

course of the observations and not to any real difference in the mean sea level.

The English, always alive to the importance of establishing new trade routes, have eagerly sought to open a road by which Western China would be open to receive British manufactures from India by way of Assam. With this end in view, and assisted largely by money contributed by English merchants, Mr. A. R. Colquhoun, of the English consular service, has just performed a journey from Canton, through Southern China and Bumah, to Bhamo on the Irrawady, and thence to Rangoon. Being provided with passports from the Chinese Government and accompanied by a Chinese interpreter, Mr. Colquhoun proceeded, in February, 1882, up the Canton or Si-Kiang River as far as Pe-se, the limit of navigation. It was found that the river is navigable for about 400 miles above Canton for steamboats drawing 4 feet, but none are allowed there. The travelers were obliged to adopt complete Chinese costume to escape notice and insult, as a great deal of hatred was shown toward the Fan-qui or western devils.

From Pe-se the Yunnan plateau was ascended and crossed, but on reaching Ssumao, where Mr. Colquhoun intended to turn southward toward Moulmen, his progress was effectually barred in that direction by the hostility of the Chinese mandarins, and he was obliged to take a northward course over the mountains to Ta-li and thence to Bhamo, a route which he pronounces entirely unfit for trade caravans from the natural obstacles. After discussing the various proposed routes for trading with Southwestern China, Mr. Colquhoun pronounces in favor of a railway extending from British Burmah and already partially constructed.

AFRICA.

Although explorations have been carried on with much success, on a small scale, so that the unknown regions are constantly being diminished, there have been no very striking discoveries on the continent of Africa. The principal journey to chronicle is that of the Italians, Lieutenant Massari and Dr. Matteucci, from Suakin, on the Red Sea, by way of Khartum, across Kordofan and Darfur, thence, by a southwesterly course, to Egga on the river Niger; then descending this river in one of the West African Company's steamers they reached home, after a journey of sixteen months. Although English and German travellers had previously traversed this region, these two travellers have added to the knowledge of it, and have fixed the latitude and longitude of many towns.

Mr. H. M. Stanley, whose name is so noted in African explorations, has succeeded in making a practicable route between the Lower Congo and Stanley Pool, at the head of a long series of falls and rapids on the Congo River, and has also been engaged in exploring the Congo above Stanley Pool.

M. Savorgnan de Brazza returned to France from his second expedition to the Ogowé and Congo Rivers, and in June, 1882, gave an account of his travels to the Geographical Society of Paris. He has explored the river system of a large tract of country between the Ogowé and Congo Rivers, and has at least attempted to take possession of some parts of it for the French Government.

Dr. Junker, who is known by his former journeys to the west of the Albert Nyanza Lake, has been endeavoring to explore the Welle River, which it seems should be called the Makua. The reports thus far received of his journey seem rather vague, but his return will enable a great deal of uncertainty about the maps of the equatorial region and of the southwest affluent of the Nile to be cleared up.

Mr. Joseph Thomson has proceeded to Zanzibar, under the direction of the Royal Geographical Society, to explore a direct route to the shores of the Victoria Nyanza, and to examine Mount Kenia.

The difficult country between the southern border of Abyssinia and Lake Victoria Nyanza is being examined by Mr. Schuver and Dr. Stecker, who are, however, working separately. No trustworthy report of their labors has yet been published.

METEOROLOGY.

By CLEVELAND ABBE.

NOTE.—The following collection of notes and extracts from *Nature* (Volumes XXIII to XXVI) presents a summary of progress in meteorology during 1880, '81, and '82, so far as it has been recorded in that journal, and is supplementary to the meteorological record published in the annual report for 1881.

SYNOPSIS.

- I.—*a* Institutions; *b* Special stations and work; *c* Individuals and necrology.
- II.—*a* General treatises; *b* History; *c* Climate.
- III.—*a* Aeronautics; *b* Barometers; *c* Thermometers; *d* Anemometers; *e* Miscellaneous apparatus and methods.
- IV.—Physical questions.
- V.—*a* Solar radiation; *b* Terrestrial temperature.
- VI.—*a* Evaporation; *b* Condensation; *c* Rainfall.
- VII.—Winds.
- VIII.—Barometric pressure.
- IX.—Storms.
- X.—*a* Atmospheric electricity; *b* Terrestrial magnetism; *c* Ground currents; *d* Auroras.
- XI.—*a* Refraction and mirage; *b* Halos.
- XII.—*a* Periodicity and sunspots; *b* Hypsometry; *c* Geology, physical geography, glaciers, hydrology; *d* Climate and biology; *e* Vulcanology and seismology.

I.—*a* INSTITUTIONS; *b* SPECIAL STATIONS AND WORK; *c* INDIVIDUALS AND NECROLOGY.

Perhaps the most important event that has characterized the year 1882 has been the actual inauguration of the first year of international observations in accordance with the programme of the Polar Commission. The original proposition made in 1875 by Lieutenant Weyprecht has finally become a successful effort at international co-operation in taking special simultaneous meteorological and magnetic observations in the arctic and antarctic regions, while the permanent observatories of the temperate zones continue their regular work. The following gives a general history of the undertaking, and a list of the stations occupied by the various nations, and the works undertaken by them. The instructions under which these stations carry on the work have been printed in the official *Mittheilungen* published by the International Polar Commission.

Much of modern progress in science is due to co-operation on a large scale; and this is especially true of geography and astronomy. During the present century the rapid progress in meteorology and terrestrial magnetism has been remarkably furthered by international conventions, and by agreements among the leaders of these scientific enterprises, until now it would be regarded as injudicious to attempt any great undertaking in these departments without a mutual understanding between the interested nations.

In September, 1875, Lieut. Carl Weyprecht, a well-known arctic explorer, proposed that the nations of the world should unite in one uniform system of simultaneous magnetic and meteorological observations at as many stations as possible in the arctic and antarctic regions.

This was an important extension of the international work already in hand within the temperate zone, and was considered so certain to result in a great advance of our knowledge that the idea was universally approved.

The details of the plan were elaborated at an International Polar Congress, held at Hamburg, in August, 1879, and at another held at Bern, in July, 1880. As a result of the agitation of this question, ten delegates met at St. Petersburg, in August, 1881, and organized an official "Polar Commission," all the members of which had authority to act for their respective Governments.

Since the organization of this commission, other nations have enlisted in the work; the observing parties have all been dispatched to their respective destinations, and they now are actually engaged in the contemplated observations. The stations will be occupied for at least one, and, in some cases, for three years, and may be divided into two classes, namely, (1) the special polar stations within 30° of the north or south pole, and (2) the auxiliary stations, which are spread over the rest of the habitable globe. Besides these land stations, observations made on shipboard are extensively called for, and it is hoped that enough observations will be accumulated to allow the making of a complete map of the weather, and of the magnetic disturbances throughout the whole globe, for any amount of time during the period in question. In addition to the main work of these international stations, all possible attention will be given to numerous collateral subjects. The great extent of the work will be appreciated by an examination of the following list of the objects of observation, and the number of stations to be occupied.

The observations which are considered obligatory are as follows :

I. Meteorological: 1. Temperature of the air; 2. Temperature of the sea; 3. Barometric pressure; 4. Humidity; 5. Wind—direction and force; 6. Clouds—their kind, amount, and motion; 7. Rainfall; 8. Weather and optical phenomena.

II. Magnetic: 1. Absolute declination; 2. Absolute inclination; 3. Absolute horizontal intensity; 4. Variations of declination; 5. Variations of inclination; 6. Variations of horizontal intensity.

All the preceding observations are to be made hourly, except on the 1st and 15th days of each month, when the readings will be made every five minutes.

III.—Miscellaneous: 1. The aurora—shape, color, motion, and position; 2. Astronomical latitude and longitude; 3. Astronomical time.

The observations, which are considered desirable and will be generally undertaken, but which are not obligatory, are as follows: 1. Varia-

tions of temperature with height; 2. Solar radiation; 3. Evaporation; 4. Galvanic earth currents; 5. Parallax of the aurora; 6. Spectroscopic observations on the aurora; 7. Ocean currents; 8. Tidal observations; 9. Structure of ice; 10. Density of sea-water; 11. Atmospheric electricity; 12. Atmospheric refractions; 13. Twilight; 14. The force of gravity; 15. Collection of samples of air for analysis; 16. Collection of samples of atmospheric dust for analysis; 17. Observations and collections in zoology and botany, geology, &c.

It is hoped that all these observations will be eventually published *in extenso* on a uniform system.

Thirteen nations have thus far entered heartily into the project; fifteen polar stations and over forty auxiliary stations have been established.

Co-operation of the respective nations in the International Magnetic and Meteorological Observations.

UNITED STATES.

	Polar stations.	Lat.	Long.
1. Lady Franklin Bay, Grinnell Land.....		N. 81° 20'	W. 64° 58'
2. Point Barrow, Alaska.....		N. 71° 18'	W. 156° 24'
	Auxiliary stations.		
3. Los Angeles.....		N. 34° 03'	W. 118° 16'
4. Fort Chimo, Ungava Bay.....		N. 59° 00'	W. 68° 00'
5. Copper Island, Kamtehatka.....		N. 55° 00'	E. 168° 00'
6. Preparation of Daily International Weather Bulletin and map for the entire globe.			

AUSTRIA-HUNGARY.

	Polar stations.		
1. Jan Mayen.....		N. 70° 58'	W. 8° 35'
	Auxiliary stations.		
2. Special course of observations on telegraphic earth currents will be made by the tele- graphic department at 12 or 14 stations.			
3. Pola.....		N. 70° 52'	E. 13° 51'

DENMARK.

	Polar stations.		
1. Godthaab.....		N. 64° 10'	W. 51° 45'
	Auxiliary stations.		
2. A special north polar expedition started to explore north of Siberia, but the latest news reports it frozen up near Nova Zembla.			

FINLAND.

	Polar stations.		
1. Soudan Kyla.....		N. 67° 24'	E. 26° 36'
	Auxiliary stations.		
2. Helsingfors.....		N. 60° 12'	E. 25° 00'
3. Wasa.....		N. 63° 00'	E. 21° 05'

	Lat.	Long.
4. Knopio.....	N. 62° 54'	E. 27° 10'
5. Wartsila.....	N. 60° 32'	E. 21° 19'
6. Telegraphic ground currents will be observed on two telegraph lines.		

FRANCE.

Polar stations.		
1. Cape Horn.....	S. 56° 00'	W. 67° 00'
Auxiliary stations.		
2. Paris.....	N. 48° 50'	E. 2° 20'
3. The two vessels carrying the party to Cape Horn will explore and take observations in the Antarctic Sea until they bring the party back again.		

GERMANY.

Polar stations.		
1. South Georgia Island.....	S. 54° 30'	W. 38° 00'
2. Kingawa..... (Hogarth Inlet, Cumberland Sound.)	N. 67° 30'	W. 67° 30'
Auxiliary stations.		
3. Munich.....	N. 48° 09'	E. 11° 34'
4. Hoffenthal, Zoar, Nain, Ramah, Hebron, Okak, on the coast of Labrador.		
5. Potsdam.....	N. 52° 25'	E. 13° 00'
6. Breslau.....	N. 51° 00'	E. 17° 00'
7. Falkland Islands.....	S. 51° 30'	W. 60° 00'
8. Will also observe ground currents on 6 or 8 telegraph lines.		

GREAT BRITAIN AND CANADA.

Polar stations.		
1. Fort Rae or Fort Simpson on Great Slave Lake.....	N. 62° 30'	W. 115° 40'
Auxiliary stations.		
2. On all vessels on the Atlantic Ocean, extra observations have been called for, and daily maps will be prepared for the entire year by England.		
3. Toronto: observations will be made by Canada.....		
	N. 43° 39'	W. 79° 23'

HOLLAND.

Polar stations.		
1. Dickson Haven or Port Dickson.....	N. 73° 30'	E. 82° 00'
Auxiliary stations.		
2. Special observations will be made on the reg- ular annual voyages of Government vessels to Nova Zembla.		
3. Utrecht.....	N. 52° 05'	E. 5° 07'

ITALY.

Polar stations.		
1. Punta Arenas, Patagonia.....	S. 53° 10'	W. 70° 55'

Auxiliary stations.		Lat.	Long.
2. Colon, near Montevideo	.....	S. 34° 22'	W. 57° 50'
3. Paysander, Buenos Ayres	.....	S. 34° 45'	W. 58° 20'
4. Naples	.....	N. 40° 52'	E. 14° 18'
5. San Nikolas,	} Patagonia.....	S. 40° 55'	W. 63° 00'
6. Carmen,			
7. Moncalieri	.....	N. 45° 00'	E. 7° 42'

NORWAY.

Polar stations.		Lat.	Long.
1. Bossekop	.....	N. 69° 56'	E. 23° 00'

Auxiliary stations.

2. Will send Professor Tromholdt to observe auroras at Kautokeino, Finmark	N. 69° 00'	E. 23½° 00'
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RUSSIA.

Polar stations.		Lat.	Long.
1. Nova Zembla (Karmakule Bay)	N. 72° 30'	E. 53° 00'
2. Mouth of the Lena	N. 73° 00'	E. 124° 40'

Auxiliary stations.

3. Pavlosk (St. Petersburg)	.....	N. 60° 00'	E. 30° 00'
4. Observations of ground currents on four telegraph lines will be made, two in southern and two in central Russia.			

The Russian Geographical Society will maintain the following special meteorological stations in Siberia:

5. Preobrashensk	.....	N. 59° 30'	E. 107° 00'
6. Werchojansk	.....	N. 68° 00'	E. 133° 00'
7. Orlensk	.....	N. 73° 00'	E. 122° 00'
8. Orlekminsk	.....	N. 60° 30'	E. 121° 00'
9. Witimsk	.....	N. 59° 25'	E. 112° 30'
10. Kirensk	.....	N. 57° 00'	E. 108° 30'
11. Nochtuisk	.....	N. 60° 00'	E. 117° 00'

SWEDEN.

Polar stations.		Lat.	Long.
1. Spitzbergen	.....	N. 79° 53'	E. 16° 00'

ARGENTINE REPUBLIC.

Auxiliary stations.		Lat.	Long.
1. Steps have been taken to establish a magnetic observatory at Cordoba	.....	S. 31° 30'	W. 64° 30'

MISCELLANEOUS.

Special simultaneous observations will be made by the local physical observatories at—

1. Tiflis	.....	N. 41° 43'	E. 44° 47'
2. Havana	.....	N. 23° 08'	W. 82° 28'
3. Göttingen	.....	N. 51° 30'	E. 10° 00'
4. Lisbon	.....	N. 38° 42'	W. 9° 08'
5. Stonyhurst	.....	N. 53° 51'	W. 2° 28'

	Lat.	Long.
6. Breslau	N. 51° 07'	E. 17° 02'
7. Zi-ka-wei (Shanghai)	N. 31° 10'	E. 121° 30'
8. Manila	N. 14° 35'	E. 121° 00'
9. Batavia	S. 6° 10'	E. 106° 50'

Signal Office memorandum.

The International Polar Commission held its third annual meeting at St. Petersburg September (August) 1, 1881. The instructions that had been issued to the United States parties (which were now already in the field) were presented to the members.

The first subject discussed was the time at which observations should be taken, and their frequency. Observations will begin for all the expeditions in the polar regions, as also for observations in the temperate zones, as soon as possible after August 1, 1882, and will finish as close as possible to September 1, 1883. All the meteorological and magnetic phenomena will be observed hourly during all this time; and besides there will be taken on the 1st and 15th of each month magnetic observations every five minutes for twenty-four hours, and every twenty seconds during some one hour of the day fixed on in advance, and everywhere according to the mean time of Göttingen. These latter observations have for their especial end to obtain a perfect knowledge of perturbations or magnetic storms, and their connection with the aurora borealis.

The assembly approved three proposals by Count Wilezek: (1) To found, if possible, a special publication to convey more quickly to the knowledge of the scientific world, as well as to the leaders of the expeditions, the proposals and reports concerning the expeditions, as also their first results. (2) To leave, if possible, on the spot, the buildings and other arrangements likely to be useful to future expeditions of the same kind, and to recommend them, in each country, to the care of navigators, or to the inhabitants. (3) To ask steamboat and railway companies to grant a reduction in the fares for the staff and effects of various international polar expeditions. The stations proposed are, two on the north coast of Siberia, one in Nova Zembla, one in Spitzbergen, one on Jan Mayen Island, one on the west coast of Greenland, one in Lady Franklin Bay, one in Behring Strait region; and the participating countries are, Russia, Sweden, Denmark, Germany, Austria, and the United States. (*Nature*, September, 1881, VOL. XXIV, p. 479.)

Loewy states that the International Polar Scientific Expedition sent by France to Cape Horn will carry out a programme of observations as arranged by Angot; direct observations will be made every four hours, self-recording apparatus will also be kept in operation. Special attention will be given to the austral auroras. (*Nature*, xxvi, p. 192.)

According to General Hazen's Annual Report for 1881, the United States Arctic stations at Lady Franklin Bay and Point Barrow are es-

tablished for the purposes of meteorological researches and not polar geographic explorations.

In regard to the subject of polar researches, the English journal, *Nature*, November 18, 1880, says: "To squander £30,000 in one huge attempt to reach the pole would be as mad as for a merchant to embark all his capital in one hazardous undertaking. Polar research and polar expeditions are not incompatible, but as Dr. Neumayer showed, in an admirable address at the Dantzic meeting of the German Association, the former must be subordinated to and guided by the results of the latter. The days of Arctic campaigns are past. We have reached the precincts of the citadel itself, and now the sappers and miners begin their slow but sure work, to be capped at the proper time by a grand assault. Germany, Austria, Russia, Sweden, Norway, Denmark, the United States, and, we believe, Canada are all to take part in this great work by establishing observing stations at suitable points all around the polar area, while Italy is to send out next year a scientifically equipped expedition to the Antarctic regions, our knowledge of which is meager and uncertain. This last will be an observing as well as an exploring expedition, preparatory to the establishment of an Antarctic station.

"As Dr. Neumayer said, in the address alluded to, men of science do not demand practical or so-called utilitarian reasons before giving their adhesion to any new work; it is enough if it can be shown that such work will conduce to the advancement of knowledge. And that Weyprecht's scheme of polar observatories, of which so many Governments approve, will lead to vast additions being made to scientific knowledge, no man of science needs be told. In meteorology, terrestrial magnetism, biology, geology, and glacial physics the gains would be immense, and the history of science has taught us over and over again that the surest path to practical and beneficent results is through the gate of pure scientific research. Every day is the science of meteorology becoming more and more important." (*Nature*, November, 1880, XXIII, p. 50.)

In connection with the Panama Canal, De Lesseps has established a meteorological station at Colon. Stations on both sides of the isthmus have long been desirable, and it is to be hoped that such will be well maintained.

The Scottish Meteorological Society has, since the spring of 1881, maintained a series of daily observations on the summit and sides of Ben Nevis. The summit is 4,406 feet above sea-level and is the highest spot in the British Isles. The importance of building a residence for the observer, and maintaining at the summit more frequent if not more continuous observations, is strongly urged. The society accepted a handsome offer by Mr. C. L. Wragge, who has had experience of such work, to climb to the top of Ben Nevis every morning in time to make observations there at 9 a. m. A complete set of the best instruments has been procured. The barometer (a Fortin) is an excellent instrument, and is constructed to read as low as 23.000 inches, in the procur-

ance of which Mr. Scott, of the Meteorological Office, kindly gave his assistance. On Tuesday, May 31, 1881, Mr. Wragge, with Mr. Livingstone, of the public schools, and nine workmen, ascended the mountain, and the instruments were fixed and secured in their proper positions; and all, including the barometer, were found to be in good working order. The regular observations began on the following day, June 1. Mr. Wragge being at his post on the top of the Ben, 4,406 feet above the sea at 9 a. m. He remains an hour at the top, and makes three observations, viz, at 9, 9.30, and 10 a. m. Even during the stormy weather of Saturday last the observations were made and the observer back at Fort William at 1.30 p. m., on which occasion the temperature at the top was as low as 28° 0.

Simultaneous with the Ben Nevis observations a complete series of observations are also made near sea-level by Mrs. Wragge. These observations, together with the observations made at the neighboring stations of Roy Bridge, Corran, Landale, Airds, Lismore, and Dalnaspidal (1,400 feet above the sea), will give the data required in dealing with some more important problems in meteorology. (*Nature*, June, 1881, Vol. xxiv, p. 131.)

The daily observations by Mr. C. L. Wragge, which ended with October-1881, have been supplemented by those of Mr. Livingstone, who has offered to climb to the summit once a month, whenever practicable, during the winter. (*Nature*, December, 1881, xxv, p. 135.)

Mr. Livingstone ascended Ben Nevis for the second time on Saturday, February 10, 1882. He found the snow much deeper than usual. (*Nature*, February, 1882, xxv, p. 372.)

Mr. Wragge has made every effort to secure land for a permanent summit observatory, but thus far without success—meeting with opposition from unexpected quarters. (*Nature*, March, 1882, xxv, p. 491.)

The observations on Ben Nevis and at Fort William were recommenced June 1, 1882. A series of very frequent observations are made at Fort William from 5 a. m. to 9 p. m., simultaneous with those taken by Mr. Wragge on his ascent and descent. Self-recording thermometers, spectroscopes, and actinometers and additional rain-gauges have been provided. (*Nature*, June, 1882, xxvi, p. 112.)

Mr. Wragge has established a subsidiary station at Stafford where full series of observations will be made at 9 a. m. daily. On the morning of July 23 Mr. Wragge found that wanton mischief had been done to some of the instruments at the intermediate stations of Redburn Crossing, and he appeals to the public to co-operate with the attempt to prevent such wantonness. (*Nature*, August, 1882, xxvi, p. 330.)

The Swedish Government has decided to send a scientific expedition to Mossel Bay, for the purpose of collecting meteorological information. The expedition will be directed by Captain Malmberg, and will have to remain during the summer of 1882 and the winter of 1883 in order to obtain the observations of the entire year. Mossel Bay is situated to

the north of Spitzbergen, latitude $79^{\circ} 54'$, longitude $16^{\circ} 15'$ east. The locality is well known to the Swedes. Professor Nordenskjöld staid there in the winter of 1872 and '73 with three ships. A Swedish man-of-war will take the expedition to Mossel Bay, under the command of Captain Palander, who, after having fixed the special meteorological station of Captain Malmberg, will return to Sweden. (*Nature*, July, 1881, XXIV, p. 295.)

The proposed Physical Observatory in Hong-Kong is, we regret to see, still under consideration, notwithstanding Major Palmer's complete scheme was in the hands of the colonial office in 1882. It is to be hoped that he may be engaged upon the work before he leaves China. (*Nature*, XXVI, p. 113.)

The Shanghai General Chamber of Commerce has received an elaborate report from Father de Chevrens, of Zikawei, on the proposed meteorological system for the protection of the Chinese shipping. He recommends that the Zikawei Observatory should receive twice daily observations telegraphed from Manila, Hong-Kong, Amoy, Tientsin, Nagasaki, and Vladivostock. (*Nature*, XXV, p. 368.)

Woeikoff suggests that Chinese typhoon warnings will always be unsatisfactory until telegraphic connection is made with Formosa and the Loo Choo Islands. (*Nature*, XXV, p. 410.)

The Chamber of Commerce at Shanghai has failed to secure the co-operation of the Chinese maritime customs in meteorological observations on the coast of China, but as the latter, under the inspectorate of Sir Robert Hart, has long since promised to establish its own system, we may still hope to see that realized. (*Nature*, XXVI, p. 136.)

Sir Robert Hart, inspector-general of Chinese maritime customs, has directed that meteorological observations at all Chinese ports be sent regularly to Shanghai; we presume that this is part of the meteorological system promised by Mr. Hart at the Vienna Conference in 1874. (*Nature*, XXVI, p. 414.)

The telegraph line between Shanghai and Pekin—which is the first of any length in China—has been opened to traffic, and has already found some useful application in the distribution of weather information.

Maxwell Hall, of Kingston, Jamaica, writes that he is slowly progressing in his efforts to establish a proper meteorological system for the West Indies. An international system of observation, reports, storm warnings, &c., will be fully practicable only when the British colonial government takes steps to encourage his labors; meanwhile he is elaborating a system of observations for Jamaica that will, he hopes, eventually cover the whole isle, and will be found practically useful in weather predictions and in the development of special agricultural and botanical enterprises. (*Nature*, XXV, p. 18.)

The observations made in Iceland for the Scottish Meteorological Society by Mr. Thorlacius, show that in that island the mean barometric

pressure was remarkably low while the temperature was high during the winter of 1881-'82. This mild winter has been followed by a very cold summer. A general study of the distribution of pressure and temperature over Northern Europe during this period has been undertaken by Wild. (*Nature*, xxvi, p. 322.)

Dr. Steineger, of Norway, has been sent to establish meteorological stations on the Russian side of the Bering Sea. [Professor Wild writes that he has also made some effort to procure observations in that region. A knowledge of the storms of the North Pacific would seem to be an important desideratum to the United States Signal Service if ever it is to make early predictions of the storms that arrive on the Pacific coast.] (*Nature*, xxvi, p. 113.)

The scientific results of the Jeannette expedition were partially lost, but the many important records will, it is believed, be published as a part of the proceedings of the Board of Inquiry which has been investigating all the particulars relating to this expedition and that of the Rodgers, which vessel was sent in search of the former. The Jeannette was 20 miles northeast of Herald Island on September 5, 1880, when she was frozen in, and for twenty-one months thereafter was drifting towards the northwest in the ice-pack. She was lost on June 13, 1882, at $77\frac{1}{2}^{\circ}$ north and 155° east. (*Nature*, xxvi, p. 479.)

The International Meteorological Committee, Messrs. Wild, Scott, Buys-Ballot, Cantoni, de Brito Capello, Haun, Mascart, Mohn, Neumayer, appointed by the Congress of Rome, held its first meeting at the Observatory, Berne, from the 9th to the 12th of September, 1880. All the members of the committee were present. The committee recommend that each national meteorological office carry out a comparison of its own standard instruments with those of other countries; it also recommended that all organizations publish regularly the mean values for the most important meteorological elements for the telegraphic and international stations. Messrs. Scott and Hellmann were appointed to act as a committee on publication of a catalogue of meteorological literature, the cost of which was estimated at £550 for the manuscript and £750 for the publication. Messrs. Mascart and Wild were appointed to prepare a plan for collecting and publishing numerical tables for the reduction of observations.

The second meeting of the International Meteorological Committee took place at Copenhagen, August 1, 1882. The following are among the proceedings of this meeting: It was resolved, *first*, to organize in London an exhibition of storm-warning and other correlated apparatus; *second*, to collect information relative to meteorological observations; *third*, to request precise observations as to the time of rain, &c.; *fourth*, to request that monthly means be published promptly; *fifth*, to secure observations in distant localities; *sixth*, to encourage the publications of daily weather charts of the Atlantic Ocean; *seventh*, to recognize the importance of weather telegrams from Iceland and the Faroe Islands; *eighth*, to publish

the international reduction tables; *ninth*, to draw up a scheme of instructions for the observation of cirrus clouds; *tenth*, to invite different nations to prepare catalogues of the meteorological literature of the respective countries. (*Nature*, XXVI, p. 370.)

Lieutenant-Colonel Donnelly, R. E., made some introductory historical remarks to Professor Stokes's first lecture of April, 1881, at the South Kensington Museum, which was the first of the series, from which we extract the following :

“ It has been considered desirable that some explanation be given of what has led to the formation of this Committee on Solar Physics, and what has led to the giving of these lectures.

“ Our history commences in the year 1875, when the Royal Commission on Scientific Instruction and the Advancement of Science made their eighth and final report, strongly recommending the establishment by the state of an observatory for solar physics.

“ In 1876 a very large and influential deputation from the British Association had an interview with the then lord president of the council, the Duke of Richmond and Gordon, with the view of urging on the Government the necessity of taking action on this and other recommendations of the royal commission.

“ The representation by the council of the British Association was followed by a memorial from a number of eminent men of science. It was under those circumstances that the lords of the committee of the Council of Education, in August, 1877, referred the question to Professor Stokes, Professor Balfour Stewart, and General Strachey, for their opinion as to whether a start could not be made by utilizing the advantages offered by the laboratories at South Kensington.

“ Just at that particular time the Indian Government had made arrangements for having daily photographs taken of the sun's disk at Dehra-Doon, in the Northwest Provinces, by Mr. Meins, who, while he was sapper in the Royal Engineers, had been trained by Mr. Lockyer. The committee of three, already referred to, reported at the end of 1877, and they state what, in their opinion, may be done at once and without entailing any serious cost. The report is published in the Parliamentary paper of March 20, 1879. Nothing, however, was done at that time, and in November, 1878, the Duke of Devonshire, as chairman of the Royal Commission on Scientific Instruction and the Advancement of Science, wrote again, calling attention to the subject and strongly urging that the report of this committee should be acted upon. In 1879 a small sum, £500, was taken in the estimates for the expenses of the Committee on Solar Physics, and this has been continued ever since. As soon as that vote had been put in the estimates with the sanction of the treasury a committee was formed, consisting of the gentlemen already mentioned, namely, Professor Stokes, Professor Balfour Stewart, and General Strachey, to whom were added Mr. Norman Lockyer, Captain Abney, and Colonel Donnelly, R. E. This committee make annual reports to

both houses of Parliament, collect and reduce the solar observations commenced by Mr. Meins in India, and report on all items relating to this subject. They also have inaugurated the present course of lectures on Solar Physics." (*Nature*, October 20, 1881, XXIV, p. 594.)

At the annual meeting of the Meteorological Society, London, January 18, 1882, the secretary reported the society in a remarkably flourishing condition: the number of active fellows was 555, the annual receipts £840 (sterling) and expenditure £197 (sterling); number of meteorological stations maintained, 83, the observations of which are regularly published in the record. The president for the succeeding year is J. K. Laughton. The society has published instructions to observers and an index to the publications of English meteorological societies. (*Nature*, XXV, p. 307.)

Mr. G. J. Symons, president of the Meteorological Society of London, in his annual address traced the history of English meteorological societies from 1723 to 1880. The earliest English effort at forming an English meteorological society, or at any rate securing observations made with comparable instruments, recorded upon a uniform system, was made in 1723, by Dr. James Jurin, then secretary to the Royal Society. In a Latin address made that year by Dr. Jurin, he anticipated nearly all the conditions which are now considered essential for comparable observations. This appeal did not lead to much being done, and in 1744 another attempt was made by Mr. Roger Pickering, F. R. S., who read before the Royal Society a paper entitled "Scheme of a diary of the weather, together with drafts and descriptions of machines subservient thereunto." The Meteorological Society of the Palatinate was established in 1780 under the auspices of the Elector Charles Theodore, who not only gave it the support of his public patronage but entered with spirit and ability into its pursuits and furnished it with the means of defraying the expense of instruments of the best construction, which were gratuitously distributed over Europe and even to America. One of the first acts of the association was to write to all the principal universities, scientific academies, and colleges, soliciting their co-operation and offering to present them with all the necessary instruments, properly verified by standards and free of expense. The offer was accepted by thirty societies, and the list of distinguished men who undertook to make the observations shows the importance which was attached to the plan and the zeal with which it was promoted in every part of the continent. In 1823 the first meeting of the Meteorological Society of London was held, and was attended by Luke Howard, Thomas Foster, Dr. Birbeck, and others. After 1824 the society languished but was never regularly dissolved. Owing to several letters and articles which appeared in *Loudon's Magazine of Natural History*, a meeting was held on November 15, 1836, at which the society was revived, W. H. White appointed secretary, and regular meetings resumed. Application was made to the Royal Society for permission to compare the instruments

of the society with the Royal Society's standards, and leave was granted March 13, 1838. A volume of *Transactions* was published in 1839, and among other articles contains one entitled "Remarks on the present state of meteorological science, by John Huskin." The cost of the publication of this volume exhausted the funds of the society, but in 1841 Mr. Gutch undertook personally the pecuniary risk of a new publication entitled the *Quarterly Journal of Meteorology*; but this does not appear to have been very successful owing to the high rate of postage. Shortly after this the society practically came to an end. On April 3, 1850, a meeting of some friends of the science was convened by Dr. Lee, at Hartwell, when the "British Meteorological Society" was established, and Mr. S. C. Whitbread elected president. The first general meeting of the members was not held till March 25, 1851, but in the meanwhile several important steps had been taken by the council. Annual reports were published from 1851 to 1861, and since then five volumes of the *Proceedings* and six volumes of the *Quarterly Journal* have been published. Up to 1858 nothing had been done towards forming a library, but in 1862 a catalogue was published containing about 200 titles. In 1876 a new catalogue was issued, which extends to 80 pages and contains over 1,200 entries. On January 27, 1866, the society obtained a royal charter of incorporation, and has since been known as the "Meteorological Society." On April 4, 1872, the council resolved upon taking a room for an office and for the protection of the library, and appointed Mr. Mariott as their assistant secretary. The subsequent eight years have been characterized by great progress. A series of second-order stations has been organized, which are systematically inspected and at which strictly comparable observations are made. On January 1, 1880, another and larger series of stations, called climatological, was started, at which the observations are less onerous than those at the second-order stations, but at which they are required to be equally accurate. Observations on natural periodical phenomena are also made at many places, and discussed yearly by the Rev. T. A. Preston.

At the request of the society a conference has been appointed, consisting of delegates from several other societies, to prepare accurate instructions respecting the erection of lightning-conductors. (*Nature*, January 27, 1881, XXIII, p. 307.)

Prof. W. Förster, the director of the Berlin Observatory, made an interesting communication to the Geographical Society of Berlin regarding one of the most important tasks of travelers in unknown regions, *i. e.*, the exact determination of latitude, longitude, and elevation above sea-level. In several of the results of recent German expeditions serious errors in this regard were detected. Professor Förster stated that the Berlin Observatory staff would shortly be in a position to undertake the practical and theoretical instruction of travelers and to superintend the selection, testing, and packing of the neces-

sary scientific instruments for the various expeditions before starting. (*Nature*, March 3, 1881, XXIII, p. 420.)

A meteorological observatory has been erected at Port-au-Prince, Hayti, under the care of Rev. Father Wick, on ground granted by the state. It is an octagon of two stories and a platform. Besides the indispensable instrument it has electric clocks (for communicating time to clocks outside), telephones, microphones, phonographs, radiometers, &c. (*Nature*, March 31, 1881, XXIII, p. 516.)

A meteorological conference was held at Sydney in November, 1879, the representatives of the different colonies being Messrs. James Hector, of New Zealand, Charles Todd, of South Australia, R. L. J. Ellery, of Victoria, and H. C. Russell of New South Wales. The whole question of weather telegrams was under consideration. The system then in operation embraced only the colonies of South Australia, Victoria, New South Wales, and Queensland, but a resolution was passed declaring it desirable to secure the co-operation of the Governments of Western Australia, Tasmania, and New Zealand in the system of intercolonial weather telegrams. The conference voted that weather telegrams and forecasts shall in all cases depend upon the observations used for general meteorological and climatological statistics. Much emphasis was laid on the establishment of high-level stations with a more special view to the investigation of the winds, and the conference recommended that there be established in each of the colonies, upon a high mountain peak, a meteorological observatory for the special study of winds and other meteorological phenomena. (*Nature*, XXII, p. 160.)

Prof. Sophus Tromholt, of Bergen, Norway, writes that in order to get nearer, if possible, to the unraveling of the mysteries of the aurora borealis, he has in the course of the last two years endeavored to procure a greater number of observations of this phenomenon in Norway, Sweden, and Denmark. He has succeeded in engaging throughout the above-named countries several hundreds of observers, who, led only by scientific interest, have given him their assistance, and from whom he has already received a considerable amount of information. These observations are to be continued, as there is reason to suppose that the aurora borealis in the near future will appear much more frequently than has been the case during the last years. Finland and Iceland will also now be drawn within the circle, and *it would be most desirable that similar observations were made also in Great Britain*, which country, especially in the maximum years of the appearance of the aurora borealis, certainly would yield characteristic contributions in this respect. He therefore invites friends of science to make such observations in accordance with the system which he has introduced in Scandinavia. A schedule for recording observations, along with the necessary instructions, will be sent to any one who desires them. (*Nature*, XXII, p. 192.)

Miss Pogson has been appointed meteorological reporter to the government of the Madras Presidency, India.

The German Government has been requested by many eminent hydrologists to establish a hydrological "Reiche-Centralstelle." They consider hydrological researches extending over the whole empire necessary for the general welfare, with regard to the general utilization of water and for the general protection of arable lands against floods and inundations. As these researches would necessarily often be combined with meteorological observations, it is proposed to connect the Hydrological Office with the Meteorological Central Office. The work would have to be done principally by hydrologists and meteorologists, but the staff would have to comprise geologists, agriculturists, and foresters. (*Nature*, July 21, 1881, Vol. XXIV, p. 265.)

Sir G. B. Airy, in his annual report, June 4, 1881, reviews the relation of Greenwich Observatory to meteorology, navigation, and the subjects in which he has taken an interest as bearing on navigation. The self-recording apparatus of the observatory has all been altered, so that the time scales are uniform throughout. The earth-current register on ordinary telegraph lines indicates the existence of numerous petty fluctuations that almost completely mask the proper feature of earth currents. The photographic records of currents on buried lines continue to be maintained with regularity. A new pressure plate has been supplied to the Osler anemometer. Campbell's sunshine recorder has continued in action during this its fifth complete year. The discussion of the electrometer results for 1879 shows that on days of magnetic disturbance, when aurora is visible, nothing unusual is shown by this instrument. The greatest electric disturbances are observed in showery weather and during thunder-storms. The Greenwich and Deal time-balls are dropped regularly at 1 p. m., and an hourly bell to be established at The Start is urged. (*Nature*, June 9, 1881, XXIV, p. 128.)

The first annual report of Mr. Christie, Astronomer Royal, June 8, 1882, shows that these observations are kept up as usual. (*Nature*, XXV, p. 140.)

The voluntary retirement of Sir G. B. Airy, in the eightieth year of his age, and the appointment of Mr. Christie to the directorship of the Royal Observatory will not materially affect the maintenance of the long series of magnetic and meteorological observations conducted at Greenwich.

The Algerian system of meteorological observations extends to forty-eight stations, of which thirty-six send daily reports by telegraph. Storm warnings are sent from the central station to twelve sea-coast stations. The office is under the control of military engineers, and is independent of the French Bureau at Paris. (*Nature*, XXV, p. 492.)

The London Meteorological Council have taken every practicable step to obtain the largest possible number of meteorological observations from the North Atlantic Ocean during the years 1882 and 1883. Their circular inviting these observations states that they propose to prepare daily weather charts similar to (but possibly more elaborate than) those

that have for some years been published by the Army Signal Office. As the latter office has received reports from about 560 vessels, it is evident that the proposed work of the London office is one of no small magnitude. We hope that it may give a great stimulus to meteorological observations at sea. (*Nature*, XXV, p. 606.)

Mr. Cruls, temporarily director of the observatory at Rio Janeiro, has established the publication of the astronomical bulletin of that observatory. He has also established a time-ball similar to that at Greenwich. (*Nature*, XXVI, p. 352.)

A great international fisheries exhibition will be held in London, at the Gardens of the Royal Horticultural Society, in 1883. At the Copenhagen meeting of the International Meteorological Committee it was resolved to invite the weather bureaus of all countries to contribute at the same time towards a complete display of all systems of forecasting weather and forewarning of storms, and of whatever else in their work seemed to bear upon the fishing industries. (*Nature*, Vol. XXVI, p. 480.)

Bischoffsheim, the member of the French Deputies for Nice, having built a fine observatory near that city, on Mont Gros, at an altitude of about 1,000 feet, and within a park of 80 acres, has appointed Perrotin director of the observatory, Carvallo assistant director, and Puiseux in charge of meteorologic and magnetic observations. The observatory will be under the general charge of the Bureau of Longitudes, its entire cost and endowment having been donated by the munificent banker.

The French departmental meteorological commissions hold an annual meeting under the presidency of the minister of public instruction. At the meeting of April 18, 1882, it was announced that the Central Bureau receives daily 97 telegrams from foreign parts and 52 from France. Five maps are drawn in the morning and three in the evening; warnings are sent by telegraph to aid agricultural and maritime districts; 82 per cent. of verifications are claimed. (*Nature*, XXI, p. 593.)

A geographical association was established in 1882 at Jena, under the presidency of Dr. E. E. Schmid.

At the annual distribution of prizes by the Paris Academy of Sciences, February 6, 1882, the prize of 5,000 francs was awarded to Brault for his studies in marine meteorology.

The Royal Agricultural and Commercial Society of British Guiana proposes to publish meteorological information in its journal, edited by Mr. E. F. Im-Thurn. It is to be earnestly hoped that the meteorology of this interesting part of the world may be more thoroughly studied. (*Nature*, XXV, p. 419.)

Neumayer and Buys-Ballot have respectively received gold medals from the Dutch Society of Sciences at Harlem for eminent services in meteorology. Among the prize subjects announced by this society for the year 1883 are the mariner's compass, the diffusion of light, the con-

densation of gases on solid substances, and electric discharge in rarefied gases. (*Nature*, XXVI, p. 510.)

Sir Charles Wyville Thomson, born 1830, March 5, at Linlithgow, Scotland, died March 10, 1882, at Edinburgh, specially known to meteorologists by his great contributions to our knowledge of ocean temperatures, depths, and currents. (*Nature*, XXV, p. 467.)

Thomas Romney Robinson, D. D., born in Dublin, April 23, 1792, died at Armagh, March 7, 1882. In 1824 Dr. Robinson was appointed director of the Armagh Observatory, and has long been the oldest living English astronomer. In meteorology he is especially known by his invention and theory of the hemispherical cup or Robinson anemometer. (*Nature*, XXV, p. 468.)

Mr. J. L. E. Dreyer, formerly of the Dunsink Observatory, has been appointed to succeed Dr. Robinson.

Prof. W. B. Rogers, president of the Massachusetts Institute of Technology, born in Philadelphia, December, 1805, died suddenly in Boston, May 30, 1882. Although especially active in geology, yet of late years the whole range of physical sciences were enriched by his remarkably lucid presentations. (*Nature*, XXVI, p. 182.)

Prof. Dr. J. C. F. Zöllner, born November 8, 1834, at Berlin, died in 1882 at Leipsic. His papers on celestial photometry and spectroscopy of the solar prominences have important bearings on meteorology. During recent years he is said to have had almost entirely confined his attention to non-scientific subjects. (*Nature*, XXVI, p. 88.)

Dr. P. A. Bergsma, well known by the important and meteorological work that he has for the past fifteen years carried on as director of the Observatory of Batavia, was returning to Holland, where he was to have been settled in an important scientific position when, unfortunately for science, on the way through the Red Sea he died on May 1, 1882.

Mr. Scott Russell, the eminent engineer, died on Thursday, June 8, 1882, in London, in the seventy-fifth year of his age. Beside his important work in engineering he is especially known to physicists by his researches upon waves and wave-motions, the resistance of moving water, &c. (*Nature*, XXVI, p. 159.)

J. A. Gautier, born in 1792 died December, 1881, at the age of eighty-nine. Gautier was the Nestor in the scientific circles of Switzerland, and has been long known as a worker in astronomy and terrestrial magnetism.

Dr. Isaac I. Hayes, well known by his meteorological observations in the Arctic seas, died December 18, 1881, in New York City.

Robert Mallet, born in Dublin June 30, 1810, died November 5, 1881. Besides his numerous valuable improvements in departments of engineering, he has made his name famous by his labors in terrestrial physics, especially in whatever related to earthquake phenomena and volcanic energy.

Prof. John William Draper, born in England May 5, 1811, died in New York January 4, 1882; best known by his scientific work in actinometry and by his valuable historical and medical works.

Prof. E. Plantamour, born in Geneva in 1815, died September 7, 1882. Beside his extensive works in astronomy and geodesy, pendulum, &c., he will always be remembered in meteorology for his contributions to barometric hypsometry. (*Nature*, xxvi, p. 505.)

The death is announced, in July, 1882, of G. C. Brauer, for a long time mechanician to the Pulkova Observatory, and latterly, also, to the Central Physical Observatory. Russian astronomers and physicists have greatly profited by his remarkable ability in the construction of scientific instruments.

Lütke, the well-known Russian navigator and explorer, born at St. Petersburg September 29, 1797, died August, 1882. His explorations of the coast of Nova Zembla, 1821 to 1824, and his voyage around the world, 1826 to 1828, in which Lenz was the chief of the scientific staff, gave him a prominent position in the geographical world. (*Nature*, xxvi, p. 447.)

Giffard, born in 1825, died April, 1882. This eminent French engineer is known the world over as the inventor of the famous injector, and to meteorologists by his construction of the great captive balloon at Paris and its utilization for meteorological observations. (*Nature*, xxi, p. 591.)

The Rev. Humphrey Lloyd, D. D., provost of Trinity College, Dublin, died on the 17th of June, 1881, at the age of eighty-one years. Dr. Lloyd's contributions to scientific literature have been many and important. His father had been provost before him, and his own life has been equally divided between devotion to science (1824 to 1862) and to education (1862 to 1881). Optics, magnetism, and meteorology have all been advanced by his labors. In company with Sir John Herschel he succeeded in carrying out the desire of the British Association for the Advancement of Science, that the British Government should carry on magnetic and meteorologic observations throughout the globe. (*Nature*, January 20, 1881, xxiii, pp. 275 and 292.)

II.—*a* GENERAL TREATISES; *b* HISTORY; *c* CLIMATE.

The second edition of Thomson and Tait's Treatise on Natural Philosophy, Vol. I, Parts I and II, is in the press; so also a volume of mathematical and physical papers, by Sir William Thomson, relating especially to thermo-dynamics and to be followed soon by other volumes. The second and third volumes of Professor Stokes' mathematical and physical papers are also nearly completed. (*Nature*, xxv, p. 613.)

Professor Oberbeck publishes in Wiedeman's *Annalen* a memoir on the motions of the atmosphere on the surface of the earth, in which the most recent principles of aero-dynamics find full application. This work is

therefore virtually an extension of Ferrel's well-known memoirs, in which latter only the simpler mathematical principles are involved.

E. D. Archibald furnishes English readers with a highly appreciative review of the important meteorological researches of Prof. William Ferrel. He finds that Ferrel's results are in every way confirmed by the statistical works of Ley, Meldrum, and others. Viewing the work as a whole, he says: "The author may be congratulated on having presented to the world a memoir of such luminous research. When we compare his work with the numerous crude treatises and hypotheses evolved during the past half century we feel a deep sense of relief at finding the question dealt with by a mathematician of ability." (*Nature*, XXVI, pp. 8 and 33.)

Chevreul communicates to the Paris Academy of Sciences evidence that General Joseph Hubert, the friend and successor of Poivre in the island of Réunion, recognized as early as 1788 (some ten years before German and English savants) the gyratory character of cyclones. In 1818 Hubert got the complete and correct formula expressing their double motion of gyration and translation (several years before Dove). (*Nature*, XXVI, p. 496.)

Bjerknes, of Christiania, after devoting fifteen years to the mathematical theory of the mutual action of vibrating bodies immersed in a liquid, has been able to so completely master the subject as to devise apparatus that perfectly exemplifies his theoretical results, and shows that the action of such vibrating planes and spheres upon the surrounding incompressible fluid reproduces nearly all the phenomena of magnetic and electrical attraction, diamagnetism, and magneto-induction. His apparatus was shown at the Paris electrical exhibition, 1881, and is well illustrated in *Nature*, XXV, p. 272.

A recent number of the Japan Gazette contains a translation of a work written in 1821, entitled "Ideas about Heaven and Earth," which is essentially an exposition of Japanese ideas on meteorology. Of course this is mostly of the nature of the most primitive philosophy, and it is said that the work represents the ideas of educated Japanese fifty years ago, but that the present generation has entirely outgrown them. (*Nature*, XXVI, p. 15.)

Among the bibliographical works we notice a complete index of works and papers published by different members of the Bohemian Association at Prague. This valuable work is published in the annual reports of the society. (*Nature*, XXVI, p. 165.)

Piazzi Smyth communicates to the Royal Society of Edinburgh a paper on the meteorology of Madeira. The humidity at Madeira is traced by him to the influence of the Gulf Stream. Observations with the psychrometer and spectroscope prove the climate of Madeira to be remarkably humid. (*Nature*, XXVI, pp. 47, 48.) This subject is further elaborated in his little volume, "Madeira Meteorology."

Among recent climatological changes perhaps none are more interesting than the conclusion of Dr. Lenz with reference to the African Sahara, which region Dr. Lenz explored in 1880. The northern portion of the Sahara is a plateau, 1,200 feet high, consisting of horizontal Devonian strata. South of this are depressions 400 feet above sea-level, but the remainder of the desert is 800 or 900 feet high. Evidences were frequently seen of the ancient fertility and population of the desert. During his forty-three days' travel through the Sahara, Dr. Lenz observed that the temperature was not excessive; it usually was from 34° to 36° C., and only in the Igidi region it reached 45° . The wind blew mostly from northwest, and it was only south of Tandeni that the traveler experienced the hot south winds (edrash) of the desert. As to the theory of northeastern trade-winds being the cause of the formation of the desert, Dr. Lenz remarks that he never observed such a wind, nor did his men; it must be stopped by the hilly tracts of the north. Another important remark of Dr. Lenz is what he makes with respect to the frequent description of the Sahara as a sea-bed. Of course it was under the sea, but during the Devonian, Cretaceous, and Tertiary periods. As to the sand which covers it now, it has nothing to do with the sea; it is the product of destruction of sandstones by atmospheric agencies. Northern Africa was not always a desert, and the causes for its being so now must be sought for, not in geological but meteorological influences. (*Nature*, xxv, p. 211.)

Dr. F. Augustin communicates to *Sitzungsberichte* a paper on the climate of Prague, being a summary of meteorological observations made since 1840, and also a paper on the influence of cloudiness on the diurnal march of temperature at that station. The average temperatures are for winter, $-0^{\circ}.56$ C.; for spring, $8^{\circ}.77$; for summer, $19^{\circ}.01$; for autumn, $9^{\circ}.60$; for the year, $9^{\circ}.18$. (*Nature*, xxvi, p. 165.)

The London Meteorological Office has published a volume of charts on the meteorology of the ocean in the neighborhood of the Cape of Good Hope. These charts, among other things, show by means of Galton's wind-rose the probability for any particular place and season of a wind from any point of the compass. In combining the wind observations, an attempt has been made to allow for the tendency of the marine observers to overestimate adverse winds. The charts show in an interesting manner the intermingling of hot and cold water currents in that portion of the ocean. (*Nature*, xxv, p. 140.)

From seven and a half years' observation at Alexandria, Egypt, the following summary of its climatological features is derived. Atmospheric pressure is remarkably steady, the annual range being three-tenths of an inch. During the winter months, northerly and southerly winds are almost equally frequent, but during the summer months northerly. The lowest relative humidity occurs during winter, and the maximum in July; but the average cloudiness is a maximum, namely, 0.4 in winter, with a minimum of 0.1 in summer. The minimum tem-

perature is 58° in January, and the maximum 79° in August. The mean annual rainfall is 8.12 inches. During these seven and a half years, on thirteen occasions the rainfall for one day exceeded an inch. On advancing from the Mediterranean southward into the interior the rainfall becomes less, the air becomes drier and the sky clearer, the sun's heat stronger, the nights cooler. (*Nature*, XXVI, p. 339.)

In reference to oceanic influences upon climate, Rev. Samuel Haughton writes :

"The Gulf Stream of the North Atlantic, so far from 'fending off' imaginary cold-water streams from the polar regions, is the *cause of their existence*. If there were no Gulf Stream, there could be no Labrador current of cold water running south. The same statement is true of the Kuro-Siwo of the North Pacific, of the Brazilian current of the South Atlantic, and of the Mozambique current of the Indian Ocean.

"If the globe were covered with water, or in the condition of an archipelago, pretty uniformly distributed, there would be no exchange between the tropics and the poles, and consequently no effect upon climate. Within the tropics there would be a broad, slow current of warm water moving from east to west, and producing no effect upon climate. In the temperate zones there would be in the northern hemisphere a feeble interchange of southwesterly and northeasterly currents, and in the southern hemisphere a similar interchange of northwesterly and southeasterly currents, both incapable of affecting climate to any sensible degree.

"If a north and south barrier be constructed to the westward of a locality like the west of Europe, such a barrier as North and South America affords, a gulf stream is at once formed and a corresponding Labrador current running in the opposite direction. The effect of the Gulf Stream is to raise the temperature of the west of Europe to its maximum, and the effect of the Labrador current is to depress the temperature of the east coast of North America to its minimum.

"It is *impossible* to suggest any rearrangement of land and water which shall sensibly *raise the temperature of the west of Europe or sensibly depress the temperature of the east of North America.*" (*Nature*, 1880, XXIII, pp. 98, 99.)

In reviewing the daily simultaneous weather maps of the northern hemisphere and the accompanying monthly means, as published by the Army Signal Office, *Nature* says: "The questions which a perusal of these maps raises are of the first importance, whether we consider the atmospheric changes they disclose, these being repeatedly so vast as to stretch across four continents at one time, besides being often profoundly interesting from their influence on the food supplies and the commercial intercourse of nations, or the large problems hereby presented, with hints toward their solution, which underlie physical geography, climatology, and other branches of atmospheric physics. We have thus had shown us from month to month, in a way not hitherto possible, the great

atmospheric changes by oceans and continents, including the important parts played in bringing about these changes by mountain ranges, extensive plateaus, and physically well defined river basins. Much yet, however, remains to be done, principally by extending the net-work of observation in order that the weather-maps may show, in an approximately adequate manner, the meteorology also of the North Pacific and southern hemisphere. Till this be done many fundamental questions cannot be discussed, such as the inter-relations of the different continents and oceans of the globe in their bearings on successive meteorological changes; and the important inquiry as to whether the pressure of the earth's atmosphere be practically a constant from month to month, and if not, what are the conditions or forces on which the observed differences depend. For the bringing of this great international work to so happy consummation we look with confidence to the War Department of the United States, since this implies no more than a continuance of the same energy and enlightened liberality that have won for the Americans their position in meteorology." (*Nature*, 1880, XXIII, p. 40.)

III.—*a* AERONAUTICS; *b* BAROMETERS; *c* THERMOMETERS; *d* ANEMOMETERS; *e* MISCELLANEOUS APPARATUS AND METHODS.

On September 1, 1881, an Aeronautical Society was founded at Berlin, under the presidency of Dr. William Augerstein.

Mouchez has proposed to undertake meteorological observations at an elevation of over one mile by means of a captive balloon, in connection with the investigation of atmospheric refraction. (*Nature*, XXV, p. 137.)

According to *Nature*, XXV, p. 565, this project has been given up, but the captive balloon will be established at the Mont Souris Meteorological Observatory.

The British War Office is systematically experimenting with a view to improvements in the application of the balloon to military operations, and has also offered to co-operate with the meteorological office in the utilization of its ascensions for the study of the atmosphere.

The celebrated American aeronaut, S. A. King, has lately made several instructive voyages, notably one in which the Signal Service took part wherein the balloon lay becalmed for twelve hours. It is very desirable that such work should be more systematically carried on. (*Nature*, XXIII, p. 113.)

A special department of aeronautics has been established in the Engineers and Architects' Union at Vienna. The application of aeronautics to meteorological study is especially cultivated. (*Nature*, XXIII, p. 232.)

The aeronautic organization in the French army display their system of captive balloons, for signaling, reconnoitering, and photographing at the fêtes in Paris in September, 1882. The Paris Academy of Aero-station also made a full trial of their system of aerial panoramic photography. (*Nature*, XXVI, p. 482.)

Some of the results of the observations made from the two balloons sent up from the Crystal Palace, London, on Thursday, October 21, 1880, are as follows: The direction of the wind was remarkably steady, as during the run the two balloons were constantly kept in view of each other in spite of the want of light and of aerial transparency. This result is all the more to be noted that the variations in the altitude of the two balloons were frequent and considerable, 10 to 5,000 feet. The variation of temperature did not amount to more than 5° C. between the maximum of the readings and their minimum. A peculiar current was observed just on arriving on the coast, which is usual under such circumstances. The composition of the clouds was very complex. First a layer of transparent fog covered almost the whole of the land and gave a watery appearance to it; second, cumuli described as analogous to pulled bread were floating at a height of 1,000 meters and descended gradually as the sun was nearing the horizon; and, lastly, a large number of parallel strati stretching southwesterly in the direction of the sun, and seemingly diverging from it. The velocity of the wind was about half a mile per minute, and pretty well determined by observers located in one of the two towers of the Crystal Palace. As to the prognostication of the route, it was nicely done by Mr. Coxwell, who told M. de Fonvielle that he should land between Portsmouth and Winchester. A question arose between M. de Fonvielle and Commander Cheyne about the bearing, the latter's compass having been reversed by an optical illusion, but the azimuth was given with great accuracy, and the uncertainty between the two would not have lasted for a minute if the possibility of the error could have been ascertained. The swinging of the balloon round its axis was sufficient to prevent the use of a new compass designed on purpose for aeronauts. (*Nature*, xxii, p. 615.)

M. Jules Godard, the well-known aeronaut, has invented an electrical warner; when the balloon is descending an electrical bell is set in operation; when it is ascending another bell rings. This effect is obtained very simply by a valve which is in equilibrium when the balloon keeps its level, but is moved by a slight wind. (A similar result is obtained by the use of the horizontal balanced fan or vane introduced by the writer in 1872 and 1881 in balloon ascents for the Signal Office.) (*Nature*, August, 1881, xxiv, p. 340.)

M. W. de Fonvielle, editor of *L'Electricité*, and M. Lippmann, one of his contributors, made a balloon ascent on July 2, 1881, shortly after midnight. The descent took place near Rambouillet, at a quarter past five, the distance traversed being 48 kilometers. The balloonists carried with them a small Planté accumulator with a special safety electric lamp constructed by Trouvé, composed of a platinum wire inclosed in a glass tube. While the apparatus did not weigh more than 1 kilogram, it gave sufficient light for reading the barometer and thermometer, and writing notes with accuracy. A special luminous compass for aeronauts

will be constructed on this plan and sent to the Exhibition of Electricity. (*Nature*, July, 1881, XXIV, p. 225.)

At the festivities in Paris, 1882, two balloons will ascend connected by telephone wires, and it is hoped if such connection can be maintained to make interesting observations on sound, wind, electricity, &c.

One of the greatest velocities recorded in aeronautic voyages is that experienced on the trip of Mr. Joseph Simmons on June 10, who passed from England to France, 170 miles, in $1\frac{3}{4}$ hours, or very nearly 100 miles per hour. (In 1869 Prof. S. A. King traveled from New York into Canada, 400 miles, in 4 hours.) (*Nature*, XXVI, p. 160.)

Carlier has made a number of balloon ascensions in Paris in order to test the possibility of steering a balloon by means of a large oar with a wooden handle, and weighing altogether about 25 pounds; the surface of the blade of the oar was about 2 square yards, and its efficacy in sculling seems incontestable. (*Nature*, XXVI, p. 17.)

One of Jordan's glycerine barometers (see *Nature*, XXI, p. 377) has been erected at the office of the London Times, and its records are published daily in that paper. It seems unquestionable that an instrument showing like this on a large scale the minute changes in atmospheric pressure will be very useful for public use in seaports, collieries, &c. (*Nature*, XXII, p. 614.)

Professor Kraevitch, of St. Petersburg, exhibited at the annual meeting of the Association of Russian Naturalists, 1879, his new self-recording barometer, which amplifies 140 times the oscillations of a common mercury barometer, and is very sensitive. (*Nature*, XXII, p. 208.)

Professors Dufour and Amstein describe a simple registering barometer, now in use in the Meteorological Observatory of Lausanne. It depends on displacement of the center of gravity of a glass tube containing mercury. The form of the tube may be described as that of an **L** leading down to a **U** by a vertical portion. The lower end is open. The tube swings in the plane of its angles on a horizontal axis placed above the center of gravity; with increased barometric pressure it inclines to the right, with decreased pressure to the left; and these movements are recorded by means of a style attached to the **U** part and applied to a moving strip of paper. By a simple contrivance the pendulum of the clock is made to impart a slight shock every second swing to the tube so as to destroy any adherence of mercury. (*Nature*, XXV, p. 374.)

Kraevitch has investigated the limit of rarefaction possible to be obtained by means of the mercury pump. He maintains that the tube will always remain filled with vapor of mercury and the vapors of the desiccating substances, so that it is impossible to obtain the low pressure of 0.00004 as maintained by Mr. Crookes. After a sketch of different air-pumps, he recommends that of Mendelieff. By means of this he says "that the elasticity of the permanent gases may be reduced to

0.0002, but the pressure of the vapor of mercury always remains." (*Nature*, XXV, p. 377.)

At the meeting of the Physical Society, June 23, 1882, Dr. Braun exhibited a somewhat modified Huyghens barometer, which had both at the upper and the lower meniscus of mercury points for exact measurement, and which served to measure both the variations and the amount of air pressure. (*Nature*, Vol. XXVI, p. 240.)

J. T. Brown communicates to *Nature* an historical summary of the various forms of barometer, mercurial and aneroid, including self-registering. The various forms which this instrument has assumed during the past two hundred years form a very instructing study and should receive the attention of those novices who are perpetually inventing and patenting the so-called new devices. American literature on this subject seems to have been only partially examined by Mr. Brown, as we find only very imperfect notices or entire omissions of some well-known names. Of foreign names, we especially miss Ernst, Fuess, and Wild & Brauer, of St. Petersburg, and especially Mendelieff, whose method of isolating all gases that may chance to remain in the vacuum chamber seems to us a capital suggestion. (*Nature*, XXVI, p. 282.)

In a further communication on his gravity barometer, Mascart states that he made a rough trial of his instrument in his journey to Norway. He finds that it is easily transportable, and its precision is apparently not less than that obtained with the pendulum. One has merely to observe the mercury-level and the temperature, and the installation may be done in less than an hour in a hotel room. (*Nature*, XXVI, p. 616.)

J. Joly, of Dublin, communicates a description of a barometer recording by electricity; the idea being that as the barometer rises and falls an electric current passing through a fine wire dipped in the mercury will have its potential altered by every change in the height of the barometer. (*Nature*, XXV, p. 560.)

Hagen makes to the Physical Society at Berlin a report on experiments for measuring the vapor-tension of mercury at various temperatures. The values given by Regnault are very unsatisfactory. Hagen's apparatus consists of a U-shaped tube, by having at the lower part a long straight tube united to it by fusion, while above either branch terminated in a tube twice bent at a right angle and closed at the lower end. By means of a Hagen air-pump this tube-system was gradually evacuated to a pressure of $\frac{1}{12000000}$ mm mercury, and the long straight tube opened under mercury at the lower end. The mercury rose in both branches of the U-tube to barometric height. One of the lateral ends of the apparatus was now kept constant at 0°, while the other was first cooled to -42° and then heated to various temperatures. Each time the position of the mercury in the two branches was observed with a cathetometer, and the difference of their heights gave the vapor-tension. The values so obtained for the vapor-tension of the mercury were less for all temperatures than those given by Regnault. Thus, *e. g.*, Herr Ha-

gen found the tension at $0^{\circ} = 0.015^{\text{mm}}$, Regnault, 0.02; at 20° , Hagen, 0.021, Regnault, 0.037; at 100° , Hagen, 0.61, Regnault, 0.75; at 200° , Hagen, 16, Regnault, 19.9^{mm} . Though the values now found have no claim to absolute accuracy (owing to the difficulty of taking readings with the cathetometer through round glass), these experiments at least make certain that the Regnault values for the vapor-tension of mercury, which have passed into all text-books, are considerably too large. (*Nature*, XXVI, p. 168.)

Professor Rucker, in a paper "On the calibration of mercurial thermometers, by Bessel's method," stated that the late Mr. Welsh, of Kew Observatory, described to the British Association, in 1853, the methods which he introduced of making and correcting mercurial thermometers. The correction with which the author dealt was that due to the variations in the bore of the tube. Mr. Welsh's method of making this correction, which is still employed at Kew, is less theoretically perfect than others, and has been unfavorably criticised abroad. The author, in conjunction with Professor Thorpe, has recently corrected a number of thermometers with great care by Bessel's method. One set of three thermometers was made for them at Kew and calibrated according to Welsh's method. Afterwards the measurements necessary for the application of Bessel's method were made by the Kew authorities, the calculations being performed by the author and Professor Thorpe. The Kew thermometers were thus subjected to the most rigorous possible test, and they were able to announce that in one instrument the errors left after the application of Welsh's method were not greater than four-thousandths of a degree centigrade, and in no case did they exceed one-hundredth of a degree. As it is impossible to read on these thermometers less than a hundredth of a degree with certainty, Welsh's method, as applied at Kew, is practically perfect. (*Nature*, September, 1881, XXVI, p. 467.)

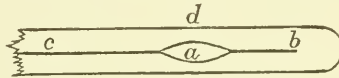
The alteration of the zero of thermometers after undergoing sudden changes of temperature is a well-known phenomenon, as is also the gradual rise in the zero in thermometers during the first few months after they have been made. M. Pernet has lately examined the question whether the distance between the "boiling point" and the "freezing point" of a thermometer is constant at all different stages of secular alterations in volume of the bulbs, and finds that this is so, provided the freezing point be determined immediately after the boiling point. On the other hand, if the boiling point be determined and a long interval elapse before the zero is determined, there is considerable error. Suppose a thermometer to be (owing to recent heating or to long rest) in any particular molecular state. In this state its reading will probably be in error; but this amount (so far as due to the above cause) may be ascertained by immediately plunging the thermometer into ice, and observing the error of the zero reading. In order that a thermometer should read rightly at any particular temperature it should be exposed for a considerable time to the temperature for which exact

measure is desired, or else for a few minutes to a slightly higher temperature. (*Nature*, July, 1881, XXIV, 294.)

Mr. Crafts communicates to the Paris Academy of Sciences, a paper on the depression of the zero point of the mercurial thermometer. He finds that the greater the interval between the temperature that has produced a depression and that at which the thermometers are kept in order to raise it again, the slower is the movement; he gives a table by which the depression through heating may be estimated. (*Nature*, XXVI, p. 72.)

Dr. Leonard Waldo suggests slight changes in the manufacture of the Kew standard thermometers as follows:

1. The calibrating chamber at the top of the thermometer is now made as in the figure, where *cab* is the capillary column, which expands at *a* into the calibrating chamber. Instead of being rounded off at *d*, the capillary column is continued a short distance to *b*. This causes serious inconvenience in the transportation of the instrument, or in its calibration, because a small particle of mercury readily detaches itself from that in the chamber *a*, and once in *b*, with a cushion of air between it and the remainder of the column, nothing but heat will dislodge it.



It does not require very great skill on the part of the glass-blower to form the chamber *a* by means of the pressure of the mercury itself against the walls of the capillary column. The glass-blower, as is perhaps well known, can soften the finished tube at *a*, and while the glass is in this condition the gentle application of the flame to the bulb will force the mercury into the part at *a*, and the careful application of both flames will then form a pear-shaped cavity of a form which will not retain a particle of mercury, and is exceedingly convenient in use.

2. It is often desirable to hang these thermometers in a comparator or other place, and it would facilitate this if a glass ring were attached to the upper end, as is the case with ordinary chemical thermometers. It is observed that the plane of this ring should be parallel to the enameling in the tube.

3. It is often convenient to know the kind of glass used in the tube, and the date of filling. Something more exact than the commercial name of the glass would be needed in stating the former, but both of these particulars might with propriety be engraved on the tube. (*Nature*, June 2, 1881, XXIV, p. 100.)

H. T. Brown describes a new self-recording thermometer for reading the approximate temperature of any region, which is telegraphed to the observer by a system of electric connections. (*Nature*, XXIII, p. 464.)

The London Meteorological Society, in March, 1882, erected thermometers at the summit and base of Boston church tower, 270 feet high.

The details of the apparatus are as follows: At the summit one of Dr. Siemens's electrical thermometers (kindly placed at the society's disposal by Messrs. Siemens, Bros. & Co.), and an ordinary thermometer are mounted in a small screen fixed to one of the pinnacles of the tower; on the roof of the belfry, which is 170 feet above the ground, a Stevenson screen has been mounted, containing maximum, minimum, dry, and wet bulb thermometers. In the church-yard another Stevenson screen has been fixed containing a similar set of thermometers, for comparison with those above. All the thermometers will be read every morning at nine o'clock. The electrical thermometer consists of a coil of wire wound round a cylindrical piece of wood inclosed in a small brass tube; a third wire is joined to one of the wires; and the three, insulated by gutta-percha, form a light cable which is brought down to the base of the tower and connected to a galvanometer, the terminals of which are in connection with the two poles of a six-cell Leclanche galvanic battery. The instrument is read by depressing a key, which causes the needle of the galvanometer to deflect; a pointer vernier (moving a contact roller upon a wire in a circular groove) is then pushed to the right or to the left upon a divided scale until the needle remains stationary on the zero point, when the electrical resistance of the wire is measured upon the scale. The number indicated by the vernier is then read off, and by referring to a table of equivalents the actual temperature in degrees of Fahrenheit is readily ascertained. Simultaneous readings of the electrical thermometer at the summit of the tower and of the dry-bulb thermometer in the church-yard will be made frequently during the day by the verger of the church. (*Nature*, xxv, p. 470.)

Siemens describes the deep-sea electrical thermometer used by the Coast Survey in recent researches. This is, he states, a modification of the apparatus suggested by himself in 1871 and used by Weinhold for high temperatures in 1873. The observations made with it by the Coast Survey in the summer of 1881 have every indication of being more accurate than those made with the protected Miller-Casella thermometers. About five minutes are required to enable the resistance coil to assume the temperature of the water surrounding it, and a second period of five minutes is needed for adjusting the temperature of the comparison coil on deck. (Similar apparatus can of course be used for measuring underground temperatures, as has indeed been done by Becquerel at Paris.) Siemens's apparatus consists of a coil of silk-covered iron wire .15^{mm} diameter, and about 432 ohms resistance, attached to an insulated cable by which it can be lowered to the required depth, and connected so as to form one arm of Wheatstone's bridge. The corresponding arm of the bridge is formed by a second coil made precisely similar to the former one and of equal resistance. This coil is immersed in a copper vessel filled with water, and the temperature of the water is adjusted by adding iced or hot water until the bridge is balanced. The temperature of the water in the vessel is then read by a mercurial ther-

mometer, and this will also be the temperature of the resistance coil. To avoid the error, which would be otherwise introduced by the leads of the resistance coil, the cable was constructed of a double core of insulated copper wire, protected by twisted galvanized steel wire. One of the copper cores was connected to each arm of the bridge, and the steel wire served as the return earth connection for both. Sir W. Thomson's marine galvanometer with a mirror and scale was employed to determine the balance bridge. (*Nature*, XXVI, p. 190.)

Commander Magrath has invented an improved form of Negretti and Zambra's deep-sea thermometer, the so-called upset thermometer. In this form the straight thermometer tube is retained in place of the original siphon shape. The revolving fan of the depth meter ceases its action the moment the thermometer is upset. The act of hauling up is that which stops the fan and upsets the thermometer. Any number of thermometers may be fastened upon the sounding line, and all make their record at the same moment when their line is hauled up. (*Nature*, XXVI, p. 15.)

Professor Tait has made an exhaustive examination of the corrections to the deep-sea protected thermometers furnished by Casella to the Challenger exploring expedition. These were not wholly protected according to the plan proposed by Sir William Thomson, and were subject to larger errors than was necessary. Tait says corrections of a half degree Fahrenheit per mile may seriously affect our theories of oceanic water circulation, and demands minute investigation. The Challenger thermometers were all of the Six pattern, and had both maximum and minimum indices, set by means of magnets. Tait also investigated two wholly protected thermometers belonging to Sir C. Wyville Thomson, but whose indices are not easily set for recording. His testing apparatus consisted principally of a Frazer cannon, whose available interior was $4\frac{1}{2}$ inches diameter and 4 feet long, affording abundant room to experiment on several thermometers at once.

The effect of pressure upon ordinary thermometer tubes is very appreciable, notwithstanding the relative thickness of the glass sides. A very interesting study of the distortion due to pressure is given by him. The compression is the same for every portion of the glass tube, but it is accompanied by a shear that increases towards the inner surface of the tube until the resulting extension disrupts that surface. When a tube is exposed to dilation by force from within, the dilation of the walls aids the shear. A thin tube is much better able to resist external than internal pressure. (*Nature*, XXV, p. 90.)

All the thermometers which have large aneurisms have had special calculations made for them, but in no case does the correction to be applied to the minimum index exceed 0.14° F., or about one-seventh of a degree per mile of depth. The appendices to Professor Tait's report give every detail of his formulæ and observations, and afford data for

application to many other problems in thermometry and the measurement of pressures and of compressibilities. (*Nature*, XXV, pp. 90-127.)

Professor Tait found it necessary to determine the pressure within his Frazer gun to within a certainty of about 1 per cent., corresponding to the reading of his thermometers to within $0^{\circ}.1$ F. His pressure gauge was founded on the principles adopted by Amagat in his measurements of volumes and pressures of gases, and consisted essentially of a small reservoir full of air, the compression of which is measured by the amount of mercury forced into the vessel and retained there by a small self-acting wedge or triangular pyramid of glass. In his later experiments the amount of mercury forced into the gauge is shown by the chemical action of the mercury upon a thin film of silver with which the interior of the tube is coated, and the dissolving of which leaves a perfectly definite record of the distance to which the mercury has advanced. Professor Tait says that he is at present engaged in measuring, by means of a gauge of this kind, the compression of various gases up to pressures of 10 tons to the square inch, or four times those used by Amagat. Professor Tait finds that no less than five different causes contribute to produce errors in the Challenger thermometers when tested in this apparatus, namely: 1st. The direct effect of external pressure upon the exposed part of the thermometer tubes; 2d. The heating of the water by compression; 3d. Heating due to friction within the pump; 4th. Heating due to the compression of the massive vulcanite slabs employed in the mounting of the thermometers; 5th. The temperature effect produced by pressure upon the protecting bulb surrounding the true thermometer bulb. This latter is the most difficult of all; but of these four causes which are active in the experimental apparatus, only one is present in the actual use of the thermometer in deep-sea sounding, for in the latter case the heating of the water and the vulcanite by compression and pumping is absent. Therefore, as a final conclusion, Tait asserts that if the Challenger thermometers had had no aneurisms (or enlargements of the bores of the tubes), the amount of corrections to be applied to the minimum index would have been somewhat less than $0^{\circ}.5$ F. for every ton of pressure or for every mile of depth. (*Nature*, XXV, pp. 90, &c.)

Michelson describes a very sensitive thermometer, in which the motion of a mirror is effected by hardened caoutchouc. (*Nature*, XXV, p. 615.)

As a practical application of the diurnal fluctuations of temperatures, we note the invention of Biji, who has constructed an apparatus by means of which these variations excite thermo-electric currents, which in their turn are continually winding up the driving weight or spring of a clock. (It may be remarked that this is a pretty clear case of perpetual motion, depending for its efficiency principally on the diurnal rotations of the earth.) (*Nature*, XXVI, p. 384.)

Rev. F. W. Stow describes a new metal screen to replace the Stevenson wooden screen, from which it differs only in the following particulars:

1st. It is somewhat larger; 2d. It has a single set of double zinc louvres; 3d. It is partly closed at the bottom to cut off radiation. (*Nature*, xxvi, p. 215.)

J. T. Brown has communicated to *Nature* an historical memoir on methods of regulating temperature. Although the methods he enumerates are especially applicable to small masses in the physical laboratories, yet some of them will find extensive application in testing meteorological instruments. (*Nature*, xxvi, p. 116.)

Dr. F. D. Brown presents to the Physical Society some notes on thermometry, apparently executed with the partial assistance of Professor Guthrie. He describes a convenient method of calibrating; he finds that a constant zero temperature is best obtained by a mixture of ice and distilled water; the attention is called to the changing of zeros in thermometers in heating. (*Nature*, xxvi, p. 71.)

G. M. Eldredge communicates to the Franklin Institute at Philadelphia a simple form of thermograph, in which a mercurial thermometer having a tube of large bore, the upper end of which is open, records its fluctuations by pricks upon a sheet of paper by means of an electromagnet. The entire thermograph differs only in minor details from those which have been introduced by Hough and others. (*Nature*, xxvi, p. 163.)

Rivière has observed the cooling of a platinum wire heated by an electric current in dry air within a glass cylinder whose surface is kept at a uniform temperature. He finds the formula of Dulong and Petit to give too rapid cooling, and that of Rosetti to agree somewhat better with the results. (*Nature*, xxvi, p. 520.)

Prof. J. M. Crafts communicated a paper to the chemical section of the British Association on the use of the hydrogen thermometer; this is an air thermometer of constant volume, in which the air is replaced by hydrogen because of the more rapid flow of that gas through a capillary tube, and because the bulb of the thermometer could be greatly reduced in volume. He redetermined the boiling point of mercury as 357° C., and investigated the boiling points of a large number of carbon compounds. (*Nature*, xxvi, p. 466.)

J. K. Laughton, at the March meeting of the London Meteorological Society, gave an exhaustive historical sketch of all kinds of anemometers known to him. In conclusion, he stated that all forms of anemometers give very unsatisfactory results, and what we need is not so much an improved apparatus as a more thorough investigation of the errors and method of action of the best forms of instruments now in use. (*Nature*, xxv, p. 547.)

Rev. T. R. Robinson, of Armagh, Ireland, has published results of further studies on his anemometer. Two similar instruments were established side by side, in one of which the friction was more variable; their revolutions were recorded chronographically. The equation of an anemometer's motion is $V^2 + v^2 - 2Vvx - (f \div a) = 0$.

where V is the unknown velocity of the wind, a and x two constants which are to be determined. Each observation gives two equations in which there are four unknown quantities, for it is found that the value of V changes from one instrument to another; this is partly owing to eddies caused by the buildings, but also in great measure to the irregularity of the wind itself. It is, however, also found that these wind-differences are as likely to have + as - signs, and therefore it may be expected that their sum will vanish in a large number of observations. The ordinary methods of elimination fail here even to determine with precision a single constant, and Dr. Robinson therefore proceeded by approximations. He tried five different types of anemometers, and obtained very unexpected results, for he found that the x varied as some inverse function of the diameter of the cups and the arms. He gives its values :

No.		Diameter of cups.	Radius of arms.	x	Limit.
		<i>Inches.</i>	<i>Inches.</i>		
1	Original instrument.....	12	23.17	= 1.5880	2.812
2	Kew pattern	9	24	1.5919	2.831
3	Do.....	9	12	1.7463	3.035
4	Do.....	9	8	2.1488	4.051
5	Do.....	4	26.75	1.8587	3.425
6	Do.....	4	10.67	2.5798	4.958

No. 6 is similar to No. 2, and it might be expected that their constants would be equal. The cause of these differences is partly the eddies caused by the cups which are more powerful when the arms are short, but still more the presence of high powers of the radii and diameter occurring in the expressions of the mean pressures on the concave and convex surfaces of the hemispheres. In the present state of hydrodynamics we cannot assign these expressions, but we know enough to see that such powers may be present.

As each type of anemometer has its own constants, the author would suggest to meteorologists the propriety of confining themselves to one or two forms. For fixed instruments he considers the Kew as good as any, and would wish to see it generally adopted. For portable ones he has no experience except with Casella's 3-inch cups, 6-inch arms, which he found very convenient; he has not, however, determined its constants. Some selection of the sort seems necessary if it is wished to have a uniform system of wind-measures. (*Nature*, xxii, p. 404.)

An unpublished investigation of the accuracy of the Kew anemometers was made by Messrs. S. Jeffoy and G. M. Whipple about 1873 at Kew and the Crystal Palace. These observations have been discussed by Prof. G. G. Stokes, who concludes as follows :

"1. That at least for high winds the method for obtaining a factor for an anemometer which consists in whirling the instrument in the open air is capable, with proper precautions, of yielding very good results.

"2. That the factor varies materially with the pattern of the anemom-

eter. Among those tried, the anemometers with the larger cups registered the most wind, or, in other words, required the lowest factors to give a correct result.

"3. That with the large Kew pattern, which is the one adopted by the Meteorological Office, the register gives about 20 per cent. too much, requiring a factor of about 2.5 instead of 3. Even 2.5 is a little too high, as friction would be introduced by the centrifugal force beyond what occurs in the normal use of the instrument.

"4. That the factor is probably higher for moderate than for high velocities; but whether this is solely due to friction the experiments do not allow us to decide. - - -

"The problem of the anemometer may be stated to be as follows: Let the uniform wind with the velocity V act on a cup anemometer of given pattern, causing the cups to revolve with a velocity v , referred to the center of the cups, the motion of the cups being retarded by a force of friction F ; it is required to determine v as a function of V and F , F having any value from O , corresponding to the ideal case of a frictionless anemometer, to some limit F_1 , which is just sufficient to keep the cups from turning. I will refer to my appendix to the former of Dr. Robinson's papers (*Phil. Trans.*, 1878, page 818), for the reasons for concluding that F is equal to V^2 , multiplied by a function of $V \div v$. Let $V \div v = \xi$, $F \div v^2 = \eta$, then if we regard ξ and η as rectangular co-ordinates, we have to determine the form of the curve lying within the positive quadrant $\xi O \eta$, which is defined by these co-ordinates.

"We may regard the problem as included in the more general problem of determining v as a function of V and F where V is positive, but F may be of any magnitude and sign, and therefore v also. Negative values of F mean, of course, that the cups, instead of being retarded by friction, are acted on by an impelling force, making them go faster than in a frictionless anemometer, and values greater than F_1 imply a force sufficient to send them around with the concave sides foremost." (*Nature*, July, 1881, xxiv, p. 253.)

C. E. Burton describes as follows an integrating anemometer that gives the quadrantal components of the movement of the wind: "A roller with a spherical edge is made to revolve with a velocity proportional to that of the wind as recorded on an anemogram. This roller presses on a plane table carried by two mutually perpendicular pairs of rails in planes parallel to that of the table. The lowest of the pair of rails is supported by a frame carried on the extremity of a vertical shaft. The point of contact of the roller with the table lies in the prolongation of the axis of the shaft. The table can rotate with the shaft, but not independently. By a simple arrangement the shaft and, consequently, the table are caused to take up positions corresponding from moment to moment with the direction of the wind-record on the anemogram. A style concentric with the shaft presses lightly against a compound sheet of tracing and carbonized paper attached to the under side of the table.

Arrangements are also made for obtaining the sum of the movements of the table toward each of the four cardinal points. If the roller be moved with a velocity proportional to that of the wind, whether directly by a cup anemometer or by a mechanical translation of the trace as given by such an instrument, while the table simultaneously assumes orientations corresponding to the direction of movement of the air, the line drawn by the style will be a miniature copy of the path of an imaginary particle animated by the movements actually belonging to the masses of air which successively affect the anemometer at the given station during the selected period, rigorously in accordance with the principle known as Lambert's." (*Nature*, October, 1881, XXIV, p. 583.)

H. S. Hele Shaw and Dr. Wilson have invented a new integrating anemometer. An ordinary Robinson's cup anemometer is used to drive a train of wheels, and thus ultimately a serrated roller, which moves a board in the direction of, and with a velocity proportional to, that of the wind. On the board, which is horizontal and about two feet square, is placed a sheet of paper, upon which the roller presses, and in turning leaves the required trace, at the same time moving the paper underneath it. The board is prevented from having a rotary motion by means of a pair of frames, the upper moving by means of wheels on the lower, each of which can move only in one direction, and these directions are perpendicular to each other. By a clock-work adjustment the time element is able to be introduced, which, taken in connection with space, gives velocity. (*Nature*, September, 1881, XXIV, p. 467.)

Messrs. Burton and Curtis have published the result of a series of observations on the distribution of pressure over the surface of a flat plate exposed perpendicularly to the action of the wind. They obtain this distribution by inserting on the rear of this plate a number of small Pitot's tubes, each of which gives the pressure for its own location. They find, of course, the maximum pressure at the center diminishing to scarcely one-half of that near the edge of the plate, the rates of diminution varying with the size and shape of the plate. (*Nature*, XXV, p. 427.)

Ventosa describes an integrating anemometer invented by himself very nearly identical with that proposed by Shaw and Wilson, and simpler than that of Von Oettingen. (*Nature*, XXV, p. 79.)

Bourdon describes to the Paris Academy of Sciences a new form of multiplying anemometer. His system consists of convergent divergent tubes. In one such tube, made according to Venturi's proportions, is fixed concentrically a second, much smaller, and having its divergent end exactly at the point where the truncated summits of the cones of the larger tube unite. (For very small velocities a third tube may be similarly fixed within the second.) A hollow sleeve is fixed round the union of the truncated cones of the wide tubes; its interior communicates with that of the latter and with a manometer, on which the pressure is read. If a manometer at the mouth of the large tube register 1

with a current, the other manometer will register, *e. g.*, 6; the pressure here is negative, and due to acceleration of the velocity of the current. (*Nature*, xxv, p. 356.)

Prosser having exhibited a drawing of the anemometer of D'Ons en Brays at the anemometer exhibition of the London Meteorological Society, under the impression that it was the earliest self-registering anemometer, also gives in *Nature*, Vol. XXV, page 505, references to the anemometer invented by Sir Christopher Wren, as described in Birch's History of the Royal Society, published in 1663. (If we combine his references with the description of an anemometer given in Sprat's History of the Royal Society, London, 1667, we must be convinced that to Sir Christopher Wren is due the invention of that form of anemometer that has of late years frequently been styled Wild's tablet anemometer; indeed, to him seems to be due almost wholly the early stimulus given to meteorological observations in England.) Prosser also refers to the famous paper by Edgeworth on the pressure of the wind upon surfaces of different forms, published at page 136, Phil. Trans. for 1783.

In order to avoid the assumptions that seem necessary in reducing ordinary anemometric observations at sea, Abbe has proposed to establish at various parts of a vessel triple anemometers, recording respectively the three vertical and horizontal rectangular components of the compounded motions of the wind and the instruments. As a first step in this investigation, three anemometers were, in October, 1882, set up at different points on the steamship Ohio, and observations kept up by Mr. Frank Waldo between Baltimore and Hamburg.

Mr. W. Bailey exhibited to the Physical Society of London on the 10th of June a model of the new integrating anemometer. The disk is revolved by means of Robinson's cups. (*Nature*, xxvi, p. 167.)

The brothers Brassart, of Rome, philosophical-instrument makers, have devised a simple inexpensive anemoscope and anemometer, about forty of which are now at work at various Italian stations. (*Nature*, xxvi, p. 511.)

MM. Mignan and Ranard have constructed an integrating hygrometer for precipitating the vapor of the atmosphere, and analyzing the products, if required. It is composed of an iron tube, filled with liquor ammoniæ; by gently opening a tap the ammonia is absorbed by water, and the hygrometer is covered with moisture, which is collected in a cup arranged for the purpose. During the recent dry weather the amount of precipitation was 3 grams of water in twenty minutes. The weight of liquor ammoniæ was 34 grams. A peculiarity is that a number of floating particles are precipitated with the humidity of the air. It has been suggested by M. W. de Fonvielle that the hygrometer might be used for analyzing the matter of clouds where the precipitation of a few grams will be a question of a very few minutes. (*Nature*, xxv, p. 565.)

Crova describes a new condensation hygrometer. A small tube of

nickel-plated brass, carefully polished within, is closed at one end with ground glass, and at the other with a lens of long focus, through which one looks along the tube towards a source of light. Through two parallel tubulures the air to be examined is drawn into the tube, which is cooled by means of sulphide of carbon traversed by an air current in a metallic envelope round the tube. The changes of aspect in the tube at the temperature of saturation enable one to estimate the dew-point to one-tenth of a degree. (*Nature*, XXVI, p. 168.)

J. F. D. Donnelly calls attention to the recent perfections introduced into the spectroscope by Mr. Hilger, who has managed to secure increased dispersion and an excellent vision of the so-called rain band; the spectroscope is also fitted with a telescope and with a second object glass in front of the slit, for the purpose of bringing light from external objects to a focus on it. (*Nature*, XXVI, p. 501.)

The Comité International, representing several countries of Europe, the United States, and South America, has published an important volume of memoirs by Drs. Broch, Pernet, René-Benoît, and Marek, on subjects relating to the determination of units of measure and weight.

As the intensity of weight varies with the geographical height and position above sea-level, the committee give in their first memoir tables of the ratio of acceleration of weight at the level of the sea for different latitudes to its acceleration at latitude 45° (Paris), to which latitude they recommend that all weighings be referred.

In the second memoir, which relates to the tension of aqueous vapor, certain corrections of hitherto accepted results are also indicated, particularly the errors of calculation in Regnault's tables, as shown by Moritz, and new tables are given for tensions at all temperatures on the new scale of normal degrees from -30° to $+101^\circ$ C.

With reference to the fixed points of mercurial thermometers, the Comité adopted the proposition that the point 0° of the centigrade thermometer should be fixed at the pressure of 760^{mm}, when determined in 45° latitude and at the mean level of the sea. Also at the Congress of Meteorologists at Rome, in 1879, there was adopted the proposition of Dr. Pernet to fix the boiling point of water, 100° C., under the above pressure, so as to render strictly comparable the temperatures observed at different places. Degrees of temperature between these points are called normal degrees.

Tables are also given by which may be calculated the weight of a liter of pure air in different latitudes and at different altitudes. In London (latitude = $51^\circ 30'$, altitude = 6.7^m.) the weight is 1.2938 grams. (*Nature*, August, 1881, XXIV, p. 384.)

Schloesing, as the result of experiments on the absorption of volatile bodies with the aid of heat, is led to propose the application of his method to the determination of the quantity of nitric acid in the atmosphere. (*Nature*, XXVI, p. 24.)

Mr. C. V. Boys read before the Physical Society, London, a paper on the

new meter for measuring electric currents. He says: "The force due to an electric current is proportional to the square of the current; hence if part of an electric circuit is capable of vibrating under an electro-magnetic force, the speed of vibrations will be proportional to the strength of the current. If, then, such a contrivance takes the place of a balance of a pendulum clock, the latter will measure electric currents instead of time." (*Nature*, xxv, p. 355.)

Mascart describes to the Paris Academy of Sciences his method of determining the quantity of carbonic acid contained in the atmosphere. He measures directly the diminution of pressure of a mass of air consequent on the removal of the carbonic acid. Travelers will find it more convenient to fill glass flasks with the air of their localities, and submit the contents to analysis on their return home. (*Nature*, xxvi, p. 119.)

The application of mechanical methods to replace laborious mathematical computations is sometimes so ingenious that there is every reason to hope that mechanical methods may yet be devised for taking into account the numerous disturbing elements that affect the motions of the atmosphere, thus enabling us to quickly predict from the weather-maps of to-day what the weather-map of to-morrow will be, instead of going through the laborious use of tables and estimates that always have the appearance of empiricisms. We are led to these remarks by reading the résumé of a paper on integrating machines presented by Mr. C. V. Boys to the London Physical Society. (*Nature*, xxv, p. 167.)

G. H. Darwin, in connection with his tidal investigations, has drawn some conclusions with reference to Jupiter's atmosphere, which latter he believes to be the cause of the well-known belts. He finds that the rapid rotation of the nucleus is not sufficient to explain the belt; but that with it we must assume a proportionately large amount of gas in its atmosphere and a high temperature for the nucleus. (*Nature*, xxv, p. 360.)

Prof. J. J. Thomson has communicated to the Royal Society of London a memoir on the vibration of a vortex ring and the action of two vortex rings upon each other. This was an important paper on hydrodynamics, bearing as it does directly upon the question of the representation of optical phenomena by the vortex-ring theory of the constitution of matter. (*Nature*, xxv, p. 354.)

Chardonnet communicates his experimental study of actinic power and the influence of specular polish. This polish increases the total quantity of radiations reflected, but the relative intensities of different portions of a spectrum depend on the material of the mirror. (*Nature*, xxvi, p. 520.)

Violle describes a calorimeter depending on cooling, and adapted especially to very high temperatures. It consists of a small, narrow-necked bottle of thin glass, with double envelope, and a vacuum produced in the interval before the closure. Through the neck are introduced a thermometer and a stirrer. (*Nature*, xxvi, p. 168.)

Deprez described, at the La Rochelle meeting of the French Association. H. Mis. 26—26

tion, a new apparatus for determining the mechanical equivalent for heat, and hopes to obtain its real value to within .001. (*Nature*, XXVI, p. 470.)

The velocity of the motion of a ship through the water is ordinarily given by the observations of some form of log. Froude and Burnet invented an electric log, on which, however, Mr. Kelway has made some decided improvements. The complete instrument has many and important applications, and its adoption is to be encouraged. (*Nature*, XXV, p. 585.)

Professor Bramwell exhibited and explained the method of action of a speed indicator in use on railroad trains. It consists of a drum, on which are marked by two pencils the speed of the train and the condition of the track. On a calm day a railroad train weighing 125 tons and moving at the rate of 45 miles an hour ran 5 miles and 5 yards after the steam was cut off. (*Nature*, XXVI, p. 495.)

Professor Rücker presented the report of the committee on methods of calibrating mercurial thermometers, in which, as the result of a long investigation, it is concluded that labor is saved and equal accuracy secured by the repetition of Gay-Lussac's method of correction, instead of the employment of more elaborate schemes. (*Nature*, XXVI, p. 458.)

G. J. Symons, after relating the history of progress in our knowledge of the subject of diminution of rainfall with elevation, explained the theory of Stanley Jevons—that it depended on eddies about the gauge itself, and gave an account of the comparative researches of Mr. Roger Field, who took the matter up a few years ago, and who has shown (1) that the ratio of the rainfall on the tower to the rainfall on the ground depends on the force and direction of the wind; (2) that when there is no wind the rainfall on the tower is about the same as the rainfall on the ground; (3) that when there is wind the amount of rain falling on the tower will vary on different portions of the tower, the portion nearest the point at which the wind strikes the tower receiving less rain than falls on the ground, and the portion farthest from the point at which the wind strikes the tower receiving the same or more rain than falls on the ground; (4) that the excess of rain falling on the portion of the tower farthest from where the wind strikes will, to a large extent, compensate the deficiency of rain on the portion nearest to where the wind strikes, but whether to a sufficient extent to make the average amount of rain falling on the tower equal to that falling on the ground cannot be determined from these experiments. From these conclusions it is clear that if the building be flat and large, the fall in the middle of the roof ought to be nearly the same as on the ground, and in two instances this is so—first at Messrs. Marshall's factory at Leeds, and secondly, at Mr. Dine's, on a roof with 5,000 square feet of area. Thus finally experimental evidence has corroborated the views of Mr. Stanley Jevons, given above. (*Nature*, September, 1881, XXIV, p. 491.)

One of the features of the International Electrical Exhibition and Congress at Paris in September, 1881, was the meteorograph of M.

Van Rysselberghe, exhibited by the Royal Observatory of Brussels. It gives its records not only at the place of observation but at one or more distant stations, and gave every night at Paris a record of the indications of the instruments at Brussels. Once every ten minutes it comes into action, and registers one after the other the six following elements: 1, temperature; 2, humidity; 3, water in rain-gauge; 4, direction of wind; 5, barometer; 6, velocity of wind. It also makes a mark about every half-second, due to the action of clock-work at the sending station.

The registration is made by a diamond point on a thin plate of zinc, which is bent round the surface of a revolving cylinder, which is covered with lampblack to make the marks more visible. This plate serves afterward for printing any number of copies. There may be several of these cylinders at as many different stations, all receiving simultaneously the indications furnished by any one station. By one line wire and one diamond point the curves for six instruments are drawn at a station which may be 200 or 300 miles distant. The value of such an instrument for furnishing the director of a central station with accurate data on which to base his weather predictions speaks for itself; and as regards expense, all the expenses of photography and of reducing and engraving photographic traces are saved. It has been worked in Belgium over a wire of the length of 750 miles. [We do not, however, understand that such instruments can possibly replace the services of a corps of intelligent observers; certainly each instrument would require an attendant mechanician.] (*Nature*, October, 1881, xxiv, p. 588.)

M. Dufour describes an apparatus for indicating the variations of chemical intensity of the sunlight. It has some likeness to Draper's tithonometer; its principle is opposing the variable action of light on a mixture of chlorine and hydrogen, with an electric current (of variable intensity and measurable each instant), which by its passage causes decomposition of a quantity of hydrochloric acid equal to that produced by action of light on the mixture of chlorine and hydrogen. The apparatus is like a Rumford differential thermometer; in one bulb is some hydrochloric acid solution, with carbon electrodes; in the other some sulphuric acid. The light acts on the former. One mode of measurement is to note the time taken in displacement of the sulphuric acid column a certain distance along the connecting tube. Then bring back the column to its original position by passing the current. (*Nature*, November 25, 1880, xxiii, p. 87.)

An instrument has been recently introduced by Messrs. Francis & Co. (telegraph engineers, Hatton Garden, London) for the purpose of receiving the "Greenwich time signal" at the various telegraph stations of offices and private firms who may be in communication with the postal telegraph service. Hitherto the passage of the time-signal current at 10 a. m. along the wires gave no indication of its pres-

ence than a deflection of the needle of ordinary instruments and a corresponding movement of the armature of the Morse ink-writer and sounder, so that unless a sharp outlook be kept with the eye constantly directed to the instrument the actual time of the signal may be lost, perhaps also to be lost again on the following day through similar accident. By the new instrument, however, the instant the current is sent the needle on its dial is deflected, and simultaneously a bell rings and continues to ring as long as the current is passing; the index needle, or, in other words, the needle of the galvanometer, which is the principal feature of the invention, when deflected, presses against a small spiral spring surrounding the stops or ivory pins on the dial plate, and by this contact the galvanometer forms itself into a "relay" and brings a local battery in circuit with the bell, which is contained in the same instrument, so that when the first part of the time signal is sent the needle is deflected and at the same moment the bell rings; thus attention to the time is at once arrested. It should be mentioned that the resistance to the line, although low, is intended to be inserted only during the transmission of the time signal, as by means of what is generally termed a "switch" the instrument is put on and off the circuit at will, and employed only during the time set apart for the transmission of the Greenwich time signal. However feeble the current may be, the galvanometer is so sensitive that a deflection of its needle is absolutely certain, whilst the bell cannot fail to answer to the power of its local battery. We are informed that not only is Messrs. Francis & Co.'s new instrument capable of doing what we have already stated, but it may be available for communication from different parts of the building, an advantage which is certain to be recognized and approved by many conducting large business establishments, where the saving of time in conveying messages and giving orders is a matter which is frequently of great importance. (*Nature*, February 10, 1881, XXIII, p. 347.)

R. A. Smith has devised a new actinic process by means of which he hopes to investigate the absorbing power of the atmosphere and other gases. From some preliminary remarks we extract the following: The fundamental idea is that when iodide of potassium in solution is treated with nitric acid, so small in quantity as to cause no change of color in dull diffused light, a change takes place when the same mixture is brought into clear light—iodine is set free and the solution becomes yellow. The amount of iodine freed can be triturated with great exactness by the use of hyposulphite; this constitutes the whole process. Some slight allowance for time and temperature may have to be made. After giving a few samples of experiments with iodide of potassium triturated with nitrogen, Dr. Smith says: "There seems, therefore, no reason to doubt that this is a true photometric process, with special capacities to be developed in time. I may add that I did obtain better results at the window of my house than at the observatory at the same

time, the latter being nearer the center of the town. Thus the process has done the duty it was intended for, although only once tried for this special purpose. I am looking to it as an agent specially for the examination of climate, but of course it may have many uses. This process does not aim at delicacy, but at accumulation of effect. I have not spoken of a standard; the results are only comparative, but the process may be made to supply its own standard."

Since writing the above it appears that by using sulphuric acid some of the fears at first entertained may be avoided.

The strength of solutions and the kind of acid to be used may vary. Similar results may vary by using bromide of potassium, but it is less delicate. The surface exposed and other questions require attention. (*Nature*, XXII, p. 71.)

Professor Fornioni has recently described to the Instituto Lombardo a simple nefodoscope or instrument for measuring the direction of motion of clouds (the instrument of the kind known as that of Braun being thought expensive and inconvenient to use). It consists of a flat compass case, with pivoted needle, above which is fixed horizontally a plane mirror, occupying the whole of the case. On the surface of the mirror are drawn diagonal lines corresponding to the rose of winds.

The amalgam is removed in a narrow circular arc extending from north to northwest, so that the end of the needle may be seen for the purpose of orientation, and this arc is graduated. A rod with terminal eye freely pivoted on the edge of the case completes the instrument.

When the direction of a given cloud is to be determined the nefodoscope is placed in a horizontal plane and properly oriented. The rod is then moved to such a position that the observer's eyes see three points in a straight line, viz, the eye of the rod, the center of the mirror, and the reflected image of a selected point of the cloud. The direction of the displacement which the latter undergoes (after a time proportional to the velocity of the cloud, and inversely as its distance) is the required direction. (*Nature*, XXII, p. 132.)

Mascart communicates to the Paris Academy of Sciences a method of measuring variations of gravity by utilizing the pressure of a given mass of gas at constant temperature, and finds the method capable of great precision. He uses a kind of siphon-barometer, with the short branch closed and holding CO_2 , introduced at a pressure sufficient to balance a mercury column of 1^m when the tube is vertical. The instrument is placed in a metallic cylinder filled with water, which is agitated by an air-current, and contains a thermometer measuring $\frac{1}{100}$ degree. The divided scale is fixed on the tube; one sees it by reflection on a gilt surface, which sends the virtual image into the axis of the tube, and the mercury is seen through the gold layer. Thus one can see, with a single microscope, the mercury-level and the corresponding division of the scale. (*Nature*, XXVI, p. 312.)

IV.—PHYSICAL QUESTIONS.

B. J. Hopkins suggests that specimens of the atmospheric dust that are to be examined with reference to the question of the presence of meteor dust should be collected regularly by apparatus attached to properly constructed captive balloons, so as to avoid the presence of a mass of dust of terrestrial origin. (*Nature*, xxv, p. 339.)

Professor Schuster, in the report of the committee on meteoric dust, says that the occurrence of magnetic particles in dust, especially that discovered by Tissandier in the snows of Mont Blanc, is explicable only on one of three hypotheses: First, the particles may be of volcanic origin; second, they may come from the smoke of our own chimneys; third, they may have a cosmic origin. The latter hypothesis is strongly favored by the consideration that the iron particles issuing from our chimneys contain neither nickel nor cobalt, while these metals do exist in the microscopic magnetic particles of atmospheric dust. Schuster finds that the sand near the great pyramids and the desert of Rajpootana, and also from the Nile mud near the canal, all contain these rare metals. As regards their origin, he concludes that at high elevations the proportion of oxygen in the atmosphere is very small, and that inasmuch as there is still a line in the aurora spectrum that has not been recognized as belonging to any known substance, he is convinced that it is due to some unknown gas of very small density. It is the contact of the meteors with this gas that fills the upper regions with meteoric dust which first makes it possible for the aurora to exist at those elevations, and afterwards, settling towards the earth, is brought down by the snow and rain to the surface. (*Nature*, xxvi, p. 488.)

Prof. F. A. Abel, in a lecture before the Royal Institution on atmospheric dust, shows the various dangers to which the human race are thereby subjected. Passing by the microscopic germs of disease floating in the air, he confined his attention to the larger dust particles, for instance, those of coal dust in mines, the sulphur dust in powder mills, finely divided cotton fibers in cotton mills, and the dust in flour and rice mills; all these and many other forms of dust, when sufficiently abundant in the air, make a dangerously explosive mixture, and there can be no doubt many explosions in coal mines have been due to dust-laden air rather than fire-damp. The lecturer paid special attention to the suggestion of methods for the avoidance of danger from these sources. (*Nature*, xxvi, p. 20.)

Müntz and Aubin have observed the relative proportion of carbonic acid in the upper and lower regions of the atmosphere they observed on the Pic du Midi and the plain around—the difference seems inappreciable. (*Comptes Rendus*, Paris, November 14, 1881.)

Dumas communicates to the Paris Academy some observations on the amount of carbonic acid in the atmosphere. After noticing the defects of several methods of measurement, he commends the exactness

of M. Rerret's and accepts his results, that about 3 volumes in 10,000 represent the general ratio of CO_2 in air. The variations through great movements of the atmosphere now require study, by observers placed at many different and distant stations, and the transit expeditions should keep this in view. MM. Müntz and Aubin's methods are most suitable for this. (*Nature*, xxv, p. 476.)

Berthelot has communicated to the Paris Academy of Sciences an important memoir on the propagation of the waves of explosion as distinguished from waves of sound. An explosion starting in a mixture of oxygen and hydrogen propagates itself at a rate of 28.14^m per second, but the velocity of sound is 514; he therefore concludes that the explosion wave is not an acoustic wave, but a wave of chemical action, and he attempts to explain its nature on principles suggested by the kinetic theory of gases. (*Nature*, xxv, p. 44.)

Sir William Thomson read before the Royal Society of Edinburgh a paper on the thermo-dynamic acceleration of the earth's rotation. He shows that there must be tides in the atmosphere, and that the line of crests, namely, the maximum of atmospheric pressure, so lies with respect to the line joining the earth's center and the sun's that the couple due to the sun's attraction upon the ellipsoidal mass of air always acts in the direction of the earth's rotation, and therefore accelerates it slightly. (*Nature*, xxv, p. 380.)

Stanley has published a volume on experimental researches into the properties and motion of fluids. The author, in writing section second, seems not to have taken advantage of the works of the best modern students on meteorology and the motions of the atmosphere.

Maj. John Herschel has completed the pendulum experiments recommended by the Royal Society, and, having swung one of the original Kater pendulums in India and Europe, and finally in New York and Washington, has deposited it with the United States Coast and Geodetic Survey. The latter has, we understand, immediately started it again on its travels in connection with its own most elaborate pendulum work under the direction of Prof. C. S. Peirce.

Joly, at Munich, has attempted to determine the force of gravitation by means of a delicate balance, from each of whose scale-pans was hung by a wire, at a depth of about 60 feet, another pair of pans. A heavy lead ball is brought under one of the lower scale-pans, while a small body can be placed in either an upper or lower pan at will, and thus have its weight determined under the influence of the lead ball and again when beyond its influence. The result of his experiments has given him for the mean density of the earth, 5.692 plus or minus 0.068, agreeing closely with the results of the torsion balance. (*Nature*, xxv, p. 137.)

Tyndall has in a series of brilliant experiments introduced Bell's radiophone as a means of easily deciding the question as to the absorption of radiant heat in its passage through gases and vapors. He finds every observation to completely justify the position he has so long main-

tained, enforcing the diathermancy of gases and the opaqueness of vapors. He also further claims that his views are independently confirmed by observations of Professor Langley on Mount Whitney. Tyndall states that in November, 1880, he resumed investigations in reference to radiant heat, and it is to be hoped that his recent work will ere long be published in full. (*Nature*, xxv, p. 233.)

Captain Abney in a lecture on solar physics has given a general view of the theory in practice of the photography of the ultra-violet and especially the ultra-red portion of the spectrum. It is to be hoped that the study of this subject and the application of Rowland's perfect cylindrical gratings will enable us to fix for future study those bands due to the absorption of solar radiation by our atmosphere that have been so laboriously studied by Langley with the help of his bolometer. (*Nature*, xxv, p. 162.)

In *Nature*, xxvii, p. 15, will be found all necessary details as to his method of photographing the infra-red portion of the spectrum. He states that in photographs taken at an elevation of 1,000 feet the general absorption due to water almost vanishes, but the presence of other absorbents, especially alcohol vapor, still higher up, becomes demonstrable. Fuller details of Professor Langley's results were communicated by him in immediate connection with the address of Captain Abney to the British Association at Southampton, and are published in *Nature*, xxvi, p. 526.

Langley also communicated his results to the Paris Academy of Sciences, and he estimates that the solar heat on a square centimeter at the outer surface of the atmosphere would raise one gram of water in one minute about 3° C. Of all this solar energy one-fourth is to be found in the visible spectrum and ultra-violet portion; the other three-quarters exist in the infra-red. In general, absorption increases as the wave length diminishes. (*Nature*, xxvi, p. 520.)

Professor Langley communicates to *Nature*, and also to the Paris Academy, a short account of some results derived from the spectroscopic and bolometric observations on Mount Whitney, in Southern California, at elevations from 4,000 to 15,000 feet. The expedition was largely at the expense of the Signal Service and a private citizen of Pittsburgh. His observations were directed first to the amount of heat that the sun sends to the earth, and he concludes that the true solar constant is at least one-half greater than that given by Pouillet, and again that the so-called temperature of space must be lower than that assigned by Pouillet, and finally the bolometer observations show a different distribution of solar energy at the upper station from that of the lower, so that without our atmosphere the sun will appear with a strong bluish tint. [The full report of Professor Langley's observations will soon be published by the Army Signal Office.] (*Nature*, xxvi, 316.)

Desains communicates to the Paris Academy of Sciences a memoir on the distribution of heat in the dark regions of solar spectra with glass

prisms. The spectrum is prolonged much further on the side of the rays of great wave length. At the same meeting Egoroff communicated his researches on the absorption spectrum of the terrestrial atmosphere; he observed the electric and other lights as seen at the Paris Observatory. (*Nature*, XXVI, p. 520.)

Egoroff, as the result of some observations made at the Paris Observatory on the absorption spectrum of our atmosphere, finds that dry air and aqueous vapor are the only elements producing sensible effects. His experiments included observations of the absorption of an electric light by the layer of air between the observatory and Mount Valerian. (*Comptes Rendus*, Paris, November 14, 1881.)

C. P. Smyth, in an appeal to physicists not to neglect spectroscopic observations of his so-called rain-band, says: "While in Scotland a rain-band of intensity marked 2 usually produces a little rain and 3 produces much, yet in Lisbon during the same months the so-called rain-band marked 4 and yet no rainfall, but with 5 or 6, the temperature remaining the same, rain will come down even in that dry country. - - - Mr. T. G. Rylands has accumulated much experience as to the advantage of supplementing spectroscopic observations with a polariscope. - - - I rather prefer the spectroscope alone, but greatly increased in size and power." Professor Smyth recommends as that the daily notation of the strength of the rain-band be made at a fixed hour, say 9 a. m., and be recorded, not in absolute measures but differentially in terms of some other band which is not connected with aqueous vapor; for such comparison he recommends a low sun-band which is on the yellow side of the D line. (*Nature*, XXVI, p. 553.)

Ralph Abercromby says there is one case in which the rain-band may give valuable information, namely, when we have a vapor-laden overcurrent with a dry surface wind. This often occurs in winter, and with a warm southwest current over an area of frost and east wind. In practice this almost invariably makes itself visible by the long converging line of cirrus which so often precedes a rain or thaw; but, still, cases may occur where no cirrus is formed or where it is otherwise visible or where it is otherwise invisible. Abercromby further says: "There are strong grounds for believing that an air spectrum may vary not only with the amount of pure vapor quantity, but it seems probable that its employment may be still further extended. There are strong grounds for believing that an air spectrum may vary, not only with the amount of pure vapor, but also with the size, aggregation, and physical condition of the condensed vapor suspended in it. For instance, take the so-called rain lines. These may appear either alone or with a rain-band of any intensity; so that if the band is due to pure vapor only, the lines must depend on some other condition. Again, in sunset tints we have a natural spectroscope whose colors certainly are the product of both the quantity and quality of the total moisture suspended in the air. I have made a large number of observations on the lurid, coppery,

yellow, green, and red skies, which form such a large portion of all weather lore, but without decisive results, for sunset spectra are too complicated and too fleeting to be unraveled by a small instrument. They certainly seem to differ, but their spectra are not so marked as their appearance to the naked eye. But even supposing that this idea is completely verified, and that the spectroscope can be used as a new weapon of research to discover the still unknown nature of clouds, and that we should be able to say that such and such an absorption spectrum belongs to such and such a kind of sky, there are no grounds for believing that we can ever regard these spectra otherwise than as a new set of sky prognostics, or that as such they will be of more use in forecasting than those already known. What the use of any prognostics is in forecasting, and how they are related to synoptic charts, and how isobaric lines map out the shape of rain areas, are other sides of the great problem of weather forecasting which cannot be discussed here." (*Nature*, xxv, p. 573.)

Messrs. Lecher and Pernter have studied the absorption of radiant heat in gases and vapors. They consider "vapor-hesion" to have been an important source of error in Tyndall's experiments. In their own method the thermopile and the heat source were brought into the same vessel. Air-currents were avoided by causing the surface of radiation to be heated in each case suddenly from without, by means of a steam jet, to 100° C. Among other results the absorption of water vapor is found, in opposition to Tyndall, immeasurably small. Violle found on Mont Blanc that a meter of the air absorbed only 0.007 per cent. of the whole radiation; according to this a layer of 300^m length would be necessary to produce, with water vapor saturated at 12°, that absorption which Tyndall obtains in 1.22^m. This and the author's own experimental results are considered to prove beyond dispute the very small absorption of aqueous vapor. The results for gases agree pretty well with Tyndall's. No simple connection between absorption and pressure of the substance was discoverable. The absorption, even for radiation of a heat source of 100° C., is selective. The authors found the absorption of certain substances of the fat series examined to increase rapidly with increasing proportion of carbon. It seems to be otherwise, however, with bodies from other groups; thus, *e. g.*, benzole, notwithstanding its six carbon-atoms, has a fairly small absorptive power. (*Nature*, xxii, p. 543.)

Dr. Lecher has made new observations, especially as to absorption of solar radiation by the carbonic acid in the atmosphere. Experiments with a gas lamp and a glass cylinder first showed that carbonic acid in a length of 214^{mm} gave passage to 94.8 per cent. of the radiation; 536^{mm}, 93.8 per cent; 917^m, 89.0 per cent. At Greifenstein, outside of Vienna (chosen for pure air), the sun's rays were also proved to undergo considerable weakening in passages through carbonic-acid gas. A layer of this gas 1 meter thick absorbed 13 per cent. when the sun had an

altitude of 59° ; the number, however, diminished in proportion as the sun got lower. This shows that absorption of solar radiation by carbonic acid is selective, and that the absorbable wave lengths become more rare the greater the atmospheric layer the rays have already traversed. The author calculates from his experiments the proportion of carbonic acid in the atmosphere, finding it 3.27 in 10,000 parts by volume, a number agreeing so well with results of chemical analysis as to indicate that this is a good way of determining the carbonic acid in the atmosphere and its variations, applicable, too, at heights when direct measurements are impossible. (*Nature*, December 30, 1880, XXIII, p. 209.)

Prof. William Crookes has published some observations on radiation of heat from thermometers inclosed in air at very low pressure. His results have an important bearing on radiation, conduction, and convection of heat. An accurate thermometer, with pretty open scale, was inclosed in a $1\frac{1}{2}$ -inch glass globe, the bulb of the thermometer being in the center and the stem being inclosed in the tube leading from the glass globe to the air-pump. There are two ways in which heat can get from the glass globe to the thermometer: (1) By radiation across the intervening space; (2) By communicating an increase of motion to the molecules of the gas, which carry it to the thermometer. It is quite conceivable that a considerable part, especially in the case of heat of low refrangibility, may be transferred by "carriage," (as I will call it to distinguish it from convection, which is different,) and yet that we would not perceive much diminution of transference, and consequently much diminution of rate of rise with increased exhaustion, so long as we work with ordinary exhaustions up to 1 millimeter. For if, on the one hand, there are fewer molecules impinging on the warm body (which is adverse to the carriage of heat), yet on the other the mean length of path between collisions is increased, so that the augmented motion is carried further. The number of steps by which the temperature passes from the warmer to the cooler body is diminished, and accordingly the value of each step is increased. Hence the increase in the difference of velocity before and after impact may make up for the diminution in the number of molecules impinging. It is therefore conceivable that it may not be till such high exhaustions are reached that the mean length of path between collisions becomes comparable with the diameter of the enclosure that further exhaustion produces a notable fall in the rate at which heat is conveyed from the case to the thermometer.

The above experiments show that there is such notable fall; a reduction of pressure from 5^m to 2^m , produces twice as much fall in the rate as is obtained by the whole exhaustion from 760 millions to 1 million. We may legitimately infer that each additional diminution of a millionth would produce a still greater retardation of cooling, so that in such vacua as exist in planetary space the loss of heat, which in that case

would take place only by radiation, would be exceedingly slow. (*Nature*, January, 1881, XXIII, pp. 235 and 237.)

C. I. McNally, in reference to the heat indicated by thermometers wrapped in hygroscopic coverings and breathed upon by the warm moist breath, writes: "That the effects of friction and compression of air are so slight that they may be disregarded, has been proved, and the rise has been clearly traced to absorption of aqueous vapor. It has yet to be determined how much of this heat may be accounted for by the reduction of aqueous vapor to the fluid state and how much by capillary action and absorption of water, with or without chemical union, and its reduction to the solid state, all of which may be included in hygroscopic action. This determination would involve some intricate investigations which some scientific specialist may find leisure to undertake. That more than simple vapor condensation is concerned in the production of hygroscopic heat is shown by the rise of temperature on adding water to a non-saturated hygroscopic substance." (*Nature*, January 13, 1881, XXIII, p. 244.)

Amagat having repeated his experiments on the elasticity of rarefied gases, asserts that they still follow the law of Mariotte even down to the lowest attainable pressure. (The .01 of an inch was his lowest.) (*Nature*, XXVI, p. 384.)

Maxwell's theory of the viscosity of gases has been elaborately investigated by W. Crookes, who by the perfection of his vacua has been able to fully corroborate Maxwell's views, according to whom the viscosity should be independent of the temperature. (*Nature*, XXIII, p. 420.)

Stevenson states that as a first result of his observations on the law of wind velocities at different heights he finds that the curves traced out by the velocities in relation to the heights were most nearly represented by the formula $V = v \sqrt{(H + 72) \div (h + 72)}$, where H and h represent respectively the heights in feet of the high and low level stations above the ground, and V and v the respective velocities at those levels.

He has since then been making observations with the view of ascertaining the relative resistance of land and water to the aerial currents. These observations are very far from being complete, but the following results in the mean time may be interesting:

	Sand.	Water.
6-inch waves,	12.8	13.8 miles per hour = 1 : 1.08
6-inch waves,	13.65	14.375 miles per hour = 1 : 1.06
3-inch waves,	7.96	9.19 miles per hour = 1 : 1.155

	Grass.	Water.
9-inch waves,	8.4	10.7 miles per hour = 1 : 1.274
3-inch waves,	10.13	14.75 miles per hour = 1 : 1.456

The velocities given are the means of observations taken every five minutes for about an hour.

From this it will be seen that the resistance is least for water, somewhat greater for smooth sand, and greater still for grass. Further observations are not only required on this subject, but also on the velocity of the wind over the water in relation to the height of the waves. (*Nature*, xxv, p. 607.)

Some experiments have lately been made by the Rev. Dr. Haughton and Prof. Emerson Reynolds to evaluate the coefficient of friction (*i. e.*, the "drag") of air upon air and of water upon water. In these experiments a spherical ball of unpolished granite of 22 kilograms weight and 25 centimeters in diameter was suspended freely by a pianoforte wire, and was set rotating in the air or in water, the period of the vibrations and the decrement of their amplitudes being observed by means of indices attached to the brass collar by which the ball was suspended. A discussion of the equations of motion led to a simple working equation for the reduction of results. The mean coefficient of friction found for air upon air was $f = \frac{1}{605} \frac{1}{27}$, though this value apparently differed slightly according to barometric and thermometric conditions. For the "drag" of water upon water the value found was $f = \frac{1}{307}$. These experiments involved friction at low velocities only, for which it could be assumed that the friction was proportional to the velocity. The authors of this research point out that these results tend to negative the theory of Dr. Carpenter that the phenomena of ocean circulation are due to the greater height of the water at the equator as compared with that at the poles. (*Nature*, xxii, p. 207.)

P. Volkmann has made a new determination of the specific gravity of pure mercury, in which he makes allowance for a new source of error depending on the change of volume of the vessel due to the internal pressure of the heavy liquid. Assuming the density of water at 0° centigrade to be 0.999881, he finds the density of mercury at 0° to be 13.5953 ± 0.0001 , which is a little less than the lowest of the values given by Regnault, whose average result, 13.596, is the value ordinarily adopted.

V.—*a* SOLAR RADIATION; *b* TERRESTRIAL TEMPERATURE.

C. W. Siemens has advanced a thoroughly original theory of the conservation of solar energy in a paper read at the Royal Society, March 2, 1882. He supposes stellar space to be filled with highly rarefied gaseous bodies besides solid material in the form of dust. Each planetary body and the sun attracts to itself an atmosphere, and the solar system as a whole contains an interplanetary atmosphere, denser than the extremely rarefied stellar space. He considers that aqueous vapor and carbon compounds are present in stellar or interplanetary space; that these gaseous compounds are capable of being dissociated by radiant solar energy while in a state of extreme attenuation; again, that these dissociated vapors are capable of being compressed into the solar photosphere by a process of interchange with an equal amount of reasso-

ciated vapors, this interchange being effected by the centrifugal action of the sun itself. (*Nature*, XXV, p. 441.)

As this theory has given rise to considerable discussion during the past year, we give the following references: See (1) criticisms, E. D. Archibald (*Nature*, XXV, p. 524), and Siemens's reply to him on the same page; (2) criticisms of Charles Norris and T. Sterry Hunt, and Siemens's reply. (*Nature*, XXV, pp. 601-603.)

Fitzgerald raises several pertinent objections to Dr. Siemens's solar hypothesis, to which a full reply is given by the author. (*Nature*, XXVI, p. 80.)

Crova communicates to the Paris Academy of Sciences the results of a year's experiment by a Government commission at Montpellier with a solar mirror and boiler. (Similar experiments have been made at Constantine.) The maxima of yield generally correspond to the minima of intensity of radiations. The absolute quantity of heat utilized depends essentially on the temperature of the air. In the climate of England it is not possible to reach half the utilization attainable in the most favorable circumstances, and the sun does not shine continuously enough to favor the practical use of the apparatus. (*Nature*, XXV, p. 596.)

Next in order after the attempts to utilize the direct heat of the sun must be mentioned the idea suggested by Mr. Milne, of Tokio, as to the possibility of utilizing the internal heat of the earth. He states that "there is an unlimited supply of energy in the interior of the earth, and which crops out upon the surface in the form of hot springs, volcanoes, &c. The heat of these springs could easily be converted into an electric current." (*Nature*, XXVI, p. 211.)

We see no reason to doubt that ere long it will be found that the cheapest method of warming some cities will be by means of hot water and steam pipes, communicating with a deep artesian well.

Professor Everett has presented an elaborate report on behalf of the underground temperature committee of the British Association, containing a summary of all their results and preceding fifteen reports. This is published apparently in full in *Nature*, XXVI, pp. 564-589.

Passing by the innumerable details, we summarize the following general conclusion: The mean increase of temperature per foot, as deduced from all reliable observations throughout the whole world, is found to be 0.01563, or about $\frac{1}{64}$ of a degree Fahrenheit. This is a slower rate than has been generally assumed. From this he deduces 0.000285 as the rate in degrees centigrade per centimeter of depth. If this be multiplied by the conductivity of the earth's crust, for which 0.0058 is adopted, based on Herschel's and Thomson's results, we obtain $H. 330 + 10^{-10}$ as flow of heat across a square centimeter. If now this be multiplied by the number of seconds in the year, we obtain 41.4 as our estimate of the average number of gram-degrees of heat that escape annually through each square centimeter of the earth's substance. (*Nature*, XXVI, p. 591.)

Pouchet communicates to the Paris Academy of Sciences some obser-

vations on the temperature of the sea water observed on the coast of Lapland. (*Comptes Rendus*, Paris, January 2, 1882.)

Hennessy reviews the work of Ferrel and Hann on the temperature of the northern and southern hemispheres, and finds that they have removed a difficulty in his own theory of climates. (*Nature*, XXVI, p.520.)

Professor Frankland seems to have for many years past been making climatic observations on a uniform system in various parts of Europe. His standard of sun's temperature is that given by a black-bulb thermometer *in vacuo*, laid directly upon a sheet of white paper in full sunshine. His standard of shade temperature is that given by an ordinary thermometer with a clear glass bulb, laid directly upon the same sheet of white paper, and apparently also in the full sunshine, but shaded therefrom by an arch of the same white paper, which latter, however, does not prevent a free circulation of air. He finds that of all materials with which he has experimented white paper reflects solar heat most perfectly, and is therefore the most effective shading material. It will be seen, therefore, that his temperatures are relative only, but that they are comparable with each other, in so far as he has used the same apparatus. He gives a number of observations illustrating the effect on his apparatus of the nature of the surface of the ground and the diurnal changes in sun altitude in various parts of Europe. (*Nature*, XXVI, p. 380.)

C. W. Brooks gives an abstract of a paper which he read on March 21, 1882, giving the temperatures of the ground in the Comstock lode at Virginia City, Nev., taken by Charles Foreman, superintendent. Holes for the thermometers were drilled not less than 3 feet into the rock; the thermometers are inserted and the holes filled with clay. (*Nature*, XXI, p. 592.)

Dines summarizes his observations during the last six years on the temperatures observed near the ground and on the tower of his house. The maxima are always greater and the minima lower on the ground than on the tower. (*Nature*, XXV, p. 619.)

In studying the conditions of temperature of the Russian Empire some time ago, M. Wild found that the irregular distribution of temperature revealed by the isotherms might be elucidated by "isanomals" (or lines of equal temperature anomalies). Among the causes of the isanomals special regard must be had to the wind, which again immediately depends on the distribution of air-pressure, as shown by the isobars. A comparison of the lines of equal pressure with the lines of temperature anomalies thus suggested led M. Wild to recognize an intimate relation between the two systems. Reasoning from the results arrived at, he has attempted, with some success, to rectify the isobars over certain regions where from want of observations their course was somewhat uncertain, and, further, has even suggested the probable existence of a pressure maximum in Northern Siberia, of which region, however, little if anything is positively known, owing to the want of barometric observations. (*Nature*, July, 1881, XXIV, p. 266.)

VI.—*a* EVAPORATION; *b* CONDENSATION; *c* RAINFALL.

Professor Stokes has so modified the Campbell sunshine-recorder as to render its use convenient for any ordinary meteorological observer, and thirty stations in Great Britain have been equipped with it by the council of the London Meteorological Office. (*Nature*, XXIII, p. 113.)

G. M. Whipple has modified Campbell's sunshine-recorder by devising a new form of card-supporter. It consists of a light frame, capable of holding a slip of cardboard, to be burned by the sun, in any position. It is arranged so as to receive ordinary parallel strips of card at all times of the year, and to allow of the instrument being employed on any part of the earth's surface without detriment to its efficiency. The card-holders themselves are movable, so as to permit of the cards being changed indoors, or dried, if wet, before removal, in order to avoid mutilating the record of observation. The instrument also has an appliance for placing the card correctly in position to receive the sun's image. (*Nature*, September, 1881, XXIV, p. 467.)

An evaporimeter with constant level has been recently described by Professor Fornioni. It consists of an oblong wooden case, with a brass spiral descending into it from a micrometric screw. The spiral carries at its lower end a small glass vessel, which acts as a feeder. A glass siphon extends outwards, horizontal from the feeder, and has at its outer end a small cup, in which evaporation takes place. As the water evaporates in the cup the feeder is lightened, and rises by action of the spiral, thus keeping the level constant. The graduation of the instrument is expressed in millimeters of the height of water in the evaporating vessel. (*Nature*, August 18, 1881, XXIV, p. 286.)

Mr. John Aitken has read a paper on Dust, Fog, and Mist, that opens up new lines of inquiry, and, indeed, a new future to what has hitherto been one of the most difficult branches of meteorology. Mr. Aitken maintains that dust particles are essential to the formation of rain. He has continued the prosecution of the inquiry, and finds that at the low temperature of 14 °F., equally as at higher temperatures, there is no cloudy condensation when there is no dust. Cloudy condensation takes place on the dust nuclei, the amount of cloudiness being of course relatively small at such low temperatures on account of the small amount of vapor present. Taken along with Professor Leister's experiments, in which it was shown that a single drop of rain showed organisms in sensitive solutions which would otherwise have remained for months unaltered, it shows that germ-producing matter, or germs themselves, form at least a part of the cloud and fog producing dust. Hence a cotton-wool respirator may form a protection against disease. (*Nature*, XXIII, p. 204.)

In a subsequent communication Aitken finds that Coulier and Mascart had in 1875 arrived at similar results. [And it may be added that since 1871 the present writer has taught his own conclusions, based on general meteorological evidence as well as on chemical and physical

reasoning, that the carbon dust from prairie and forest fires and the smoke of coal fires in cities have a strong affinity for aqueous vapor, which is attracted and held in a little atmosphere around each carbon particle, just as hydrogen is attracted to spongy platinum. These little balloons of vapor with dust centers, as they rise in the air, cool, both by radiation and expansion, more rapidly than the surrounding air, and soon pass from dry yellow haze (as in Indian-summer weather) into fog and rain. Other kinds of dust particles probably produce the same effect, but in a different manner, *i. e.*, they simply cool more rapidly by radiation and condense upon themselves as dew some of the neighboring aqueous vapor; then becoming heavier, they grow by accretion of other dew-laden particles as they descend to the earth.—C. A.]

Mr. Newth showed to the London Physical Society some experiments illustrative of the fact announced by Mr. Mascart in 1875 that solid particles in the air are necessary to the formation of fogs; and, secondly, that certain gases, such as sulphurous-acid gas, also cause fogs in the same way by permitting the moisture to condense upon these particles. The experiments consisted in passing an electric-light beam through large bulbs of glass containing air and a small quantity of water. When the air in the bulbs was washed with the water, and thus freed from motes, the fog produced in the bulb by slightly exhausting it with an air-pump was much less than when the air of the room, or smoke, or sulphurous-acid gas, was admitted into the bulb. The dust on a platinum wire, rendered incandescent within the globe by an electric current, also caused a sensible fog. It follows that with gas fires instead of coal there would still be fogs, though not so black ones. (*Nature*, xxv, p. 475.)

Prof. O. Reynolds has been deeply engaged in the study of the phenomena of the surface tension of water; these bear upon the subject of rain-drops, the union of floating particles of fog into larger drops, and the floating of rain-drops on the clean water of ponds. (*Nature*, xxv, p. 23.)

Prof. J. Elliot, of India, has investigated the rain-fall of Cherrapunji, in the southwest of Assam, and on a small plateau forming the summit of one of the spurs of the Khasia Hills. The rain-fall recorded at this station averages 493 inches per annum, or while the normal wind-fall in the neighboring plains is about 100 inches, he finds that this remarkable rainfall, by far the largest known anywhere on the earth, is simply and solely owing to the presence of a vast mechanical obstruction, namely, the precipitous hill on which the station stands, rising suddenly 4,000 feet, and whose resistance converts the horizontal motion of the air into a vertical motion; the ascending air cools rapidly by reason of its expansion and condenses its moisture into deluges of rain. (*Nature*, xxv, p. 259.)

Mr. Maxwell Hall has published in the Government Hand-Book to Jamaica the best *résumé* as yet given of the climate and meteorology

of that island. With regard to rainfalls he remarks that there has been an evident change during the past two hundred years, or since the time of Sir Hans Sloane, the author of the *Natural History of Jamaica*, but we think it may well be questioned whether the rainfall records of those times are sufficiently full and accurate to form the basis of any comparison. (*Nature*, XXV, p. 153.)

Dr. F. J. Studnicka publishes in the *Abhandlungen* of the Bohemian Association, complete tables on the observations of rainfalls made at about 300 stations in that country. In addition to these, there are about 500 more established by the Bohemian Foresters' Association, so that this country is one of the best provided for in Europe. (The total number of rain-stations in France is about 1,200, and in Great Britain, 2,000.) (*Nature*, XXVI, p. 164.)

The London Meteorological Office has published a rainfall table for the British Isles, prepared by Mr. Symons, and giving the monthly results at 367 stations, for which continuous observations are available during the last fifteen years. (*Nature*, XXV, 140.)

Professor Dufour gives some estimate of the enormous amount of damage done by several hail-storms, notably the terrible one of July 13, 1788. He states that, on the strength of encouraging and credible testimony from Italy and France, lightning-rods were erected in the Canton Vaud about 1825 "for the purpose of hindering the formation of hail by withdrawing the electricity from the clouds," but he considers it very difficult to admit that there can be any such beneficial result, especially when we consider that the hail is formed in tops of clouds a long distance from the scenes of its devastation. A forest may be regarded as a collection of lightning-rods; such also is the mass of sharp-pointed rocks forming the bare summit of a mountain or the chimneys or turrets and steeples that abound in the city, but none of these have been shown to have any influence in diminishing the hail although they do slightly diminish the lightning in thunder-storms. (*Nature*, XXVII, p. 530.)

Professor Loomis has contributed a first and second edition of a memoir on the distribution of rain-fall over the globe. These maps show unquestionably the broad features of the geographical distribution of rain-fall. (*Nature*, XXVI, p. 206; *American Jour. of Science*, Jan., 1883.)

W. J. Black, commenting on Professor Loomis's map, states that to observe rain-fall on a small island is not the same as observing on mid-ocean. The ocean rain-fall can only be made out by observations on board ships, and these require a long time to effect. (*Nature*, XXVI, p. 222.)

VII.—WINDS.

Brault has published charts of the North Atlantic, showing curves of equal average wind velocity for the summer, which curves he calls isanemones. These curves almost exactly reproduce the map of mean

isobars, and Brault believes that a similar coincidence occurs for other portions of the earth and other seasons. (*Nature*, XXVII, p. 20.)

A. Domojirof describes in the *Isvestia* of the St. Petersburg Geographical Society what little is known of anemometric observations at sea. Several series of such observations have been made, notably by Bessels on the *Polaris* (1872), Rykatcheff on board the *Nayezdnik* (1879), and by Domojirof on the *Nordenskjold* (1879) and the *Djighit* (1880). (*Nature*, XXVI, p. 83.)

W. Clement Ley, in studying the relation between wind force and the barometric gradient, gives the following mean wind velocities at Stonyhurst Observatory, obtained by himself from the hourly readings published by the Meteorological Committee for the years 1874 to 1876, inclusive, for different amounts of atmospheric gradient:

Gradient per 15 nautical miles.	Mean velocity of wind per hour in miles from points between S. S. E. and N. W. (inclusive).	Mean velocity in miles per hour of winds from points between N. N. W. and S. E.
.006	4.31	5.53
.009	5.90	6.82
.012	7.79	9.63
.015	11.69	13.97
.018	13.03	15.29

The mean velocities at Kew Observatory for the same period for similar gradients are as follows:

Gradient per 15 nautical miles.	Mean velocity in miles per hour of wind from points between S. S. E. and N. W. (inclusive).	Mean velocity in miles per hour of winds from points between N. N. W. and S. E. (inclusive).
.006	4.14	6.88
.009	6.41	8.63
.012	8.37	10.93
.015	11.21	14.27
.018	13.56	16.98

This shows that for any given (moderate) gradient winds from north and east points are stronger than from south and west points at these stations. (*Nature*, May 5, 1881, XXIV, p. 8.)

Ralph Abercromby has read before the Meteorological Society of London a paper on the diurnal variations of winds and weather in relation to isobars by constructing charts for various hours of the same day. He finds, as has been explained by Koppen and Terrel, that by the same gradient there is more wind by day than by night; and that, again, in cyclones the wind curves inward more by night than by day. The mean diurnal frequency of rain increases during the daytime, and this is explained by the fact that in any given cyclone the area of rainfall is larger by day than by night. (*Nature*, XXVI, p. 95.)

C. A. Stevenson records the velocity of the wind in the southwest gale of November 21, 22, 1881, at Edinburgh: Mean velocity, 62.3 miles

per hour; the highest squall, 71.6 miles. He observed these velocities by means of clouds of smoke rising from chimneys. (*Nature*, xxv, p. 102.)

Whipple and Baker communicate to the London Meteorological Society the results of the discussions of the Kew observations of the wind. They find that the wind force increases arithmetically with the increase of the gradient; and again, that the angle at which the wind crosses the line of gradient averages 52° , and does not vary with the steepness of the gradient or the velocity of the wind. (*Nature*, xxv, p. 319.)

The committee on wind-pressure report to the Brit. Assoc. A. S. that the maximum pressure of wind on small plane surfaces had been ascertained to exceed 90 pounds to the square foot, and it is possible that an average of 56 pounds might hold good for the whole surface of very exposed structures. (*Nature*, xxv, p. 448.)

VIII.—BAROMETRIC PRESSURE.

Mr. H. S. Eaton has published a paper on the average height of the barometer in London. The great value of the paper consists both in the long period of one hundred years for which the monthly averages of each year are given, and in the careful and laborious elimination of instrumental errors and errors arising from breaks of one or more days in the observations of the months. The series is one of the most valuable we possess in dealing with questions of meteorological variations. The mean atmospheric pressure at 32° and sea-level for London is 29.952 inches, the mean monthly maximum, 29.996 inches, occurring in June, and the minimum, 29.900 inches, in November, the mean for October being nearly as low, viz, 29.909 inches. In a discussion which followed a reading of the paper, Mr. Strachan remarked that even another one hundred years' observations would not alter the positions of these points of the London curve, a remark no doubt quite true for London. On advancing, however, to the southwest, the means for June and July approach towards equality, and ultimately the July mean becomes larger as we advance into the region of high pressure, which occupies the Atlantic to the southwest during this month. On the other hand, as we approach northward, the means for May and June approach towards equality, till about the south of Scotland the mean for May becomes the maximum for the year, and the further north the more decidedly is May the maximum, till in Iceland it exceeds the mean of any other month by the tenth of an inch. Attention was drawn to the dips in the curves of pressure for April and July. These, in all probability, are permanent features in the London curve of pressure for March, April, and July, when drawn from a long average, since the former is connected with the east winds of spring, and the latter with the great summer barometric depression, which falls to the lowest point in July in the interior of the Euro-Asiatic continent. (*Nature*, December 23, 1880, xxiii, p. 184.)

An important work by the late J. Allan Broun has been published

by E. D. Archibald, in which the author seems to conclude that heat, moisture, and the "shuffling of atmospheric strata" will not explain the semi-diurnal and other oscillations of the barometer. [Already in 1865 the present writer had occasion verbally to express to several meteorologists and physicists in Europe his conviction that the intricate analytical formulæ deduced by Ferrel in 1858-1860 would eventually be found to demonstrate these oscillations as a dynamic result of the motion of the atmosphere due to the diurnal and annual variations in the action of the sun upon it as a whole.—C. A.] (*Nature*, XXIII, p. 557.)

IX.—STORMS.

The idea propounded by Mr. Oliver that the axis of a cyclone is inclined is no new one, and is controverted by E. D. Archibald, who also quotes Ley and Ferrel as showing that it is far more probable that the axes are inclined a little forward. (*Nature*, XXVI, p. 222.)

Mr. Adams is preparing to communicate by telescopic signals between Mauritius and Réunion, a distance of 134 miles. He uses a heliostat by day, and a petroleum lamp with a flat wick by night. With this method of signaling, if successful, it will often be possible to telegraph the approach of the cyclone twenty-four to thirty-six hours before it has reached Mauritius. (*Nature*, XXVI, p. 612.)

An interesting popular article on tornadoes in *Nature*, after alluding to some characteristics of these storms in America, makes the following remarks relative to similar storms in England.

In examining cyclones phenomena occasionally present themselves which strongly suggest the idea that they include within their circuit, as an independent meteor, the whirlwind or the tornado, the phenomena in question being most frequently met with in those cyclones which present, in close continuity, masses of air differing very widely from each other in temperature and humidity. Of such cyclones the great storm of October 14 last appears to be one. On that occasion the changes of temperature and humidity were sharp and sudden, particularly from the Grampians to the Cheviots, the great fall occurring when the wind changed to northward. As we have already stated (*Nature*, XXIV, p. 585), off the Berwickshire coast the darkness accompanying the changes of wind, temperature, and humidity was denser and more threatening than elsewhere, and almost simultaneously with the approach of these changes a hurricane, or rather tornado, broke out with a devouring energy which bore everything before it. The tornado character of the storm off Eyemouth is shown by the accounts of some of the survivors, who describe the wind as blowing straight down from the sky with an impetuosity so vehement and overmastering that the sea for some extent was beaten down flat into a stretch of seething foam by the wind, while outside this tract the waves seemed to be driven up to a height absolutely appalling; which in their turn engulfed many of the boats yet remaining. Similar seas, with level wastes of seething foam, bounded immediately by waves of a height and threatening aspect never before

witnessed, were encountered by several well-appointed steamers out in the middle of the North Sea during this storm, thus confirming the observations of the Eymouth fishermen. These facts seem to point to one or perhaps two tornadoes with slanting columns, the terrific force of the gyrations of whose lower extremities played no inconspicuous part in the devastation wrought during the continuance of this memorable storm. (*Nature*, XXV, p. 157.)

J. A. B. Oliver, of Glasgow, in a note on the frequency of hail-storms in Great Britain, gives the following data:

Months.	Farmer's Insurance Institute, annual average.	Dalton's total in five years of observation.	Giddy's total in twenty-one years at Penzance.	Thomson's relative proportions.
Winter.....				45.5 to 54.5
January.....	0	11	23	
February.....	1	7	25	
Spring.....				29.5 to 70.0
March.....	2	5	25	
April.....	3	8	27	
May.....	7	11	7	
Summer.....				22.0 to 78.0
June.....	10	6	5	
July.....	17	2	1	
August.....	4	1	0	
Autumn.....				3.0 to 97.0
September.....	2	6	5	
October.....	0	7	17	
November.....	0	7	22	
December.....	0	13	43	

From a comparison of these tables we see that Dalton, Giddy, and Thomson agree in making winter the season of maximum hail-fall, while the insurance statistics point to the opposite conclusion, the hail-storms in June and July being much in excess of those in the other months of the year. Oliver strongly suspects that Dalton, and other observers who have arrived at similar results, included in their enumeration of hail-falls, what we may call, in absence of a better name, winter hail. It is very unfortunate that the word "hail" has, in our language, been used to denote two entirely different phenomena, the French *grêle*, or hail proper, and *grésil*, or that small, round, powdery snow which often falls towards the end of a snow-storm and in the early part of a very frosty night. *Grésil* has nothing in common with *grêle*. The one falls exclusively in winter, and the other, perhaps, as exclusively in summer. (*Nature*, June 30, 1881, XXIV, p. 190.)

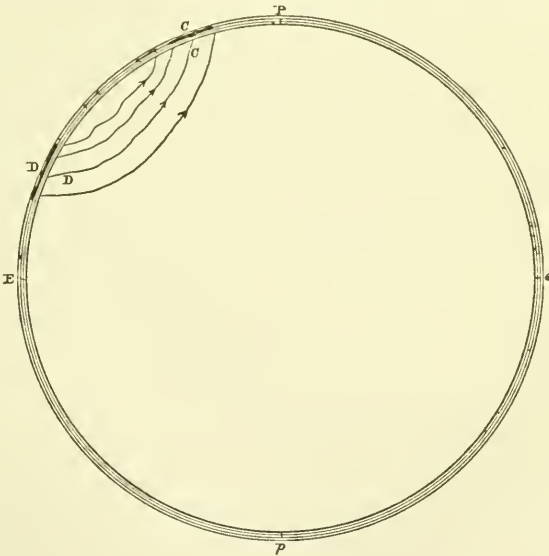
X.—*a* ATMOSPHERIC ELECTRICITY; *b* TERRESTRIAL MAGNETISM; *c* GROUND CURRENTS; *d* AURORAS.

In the first lecture at the South Kensington Museum on solar physics by Professor Stokes, October, 1881, he suggests some new views in regard to atmospheric electricity. He says:

"Where shall we get the electromotive force sufficient to send a discharge through 50, 60, or 80 miles of atmosphere, such as occurs in the case of the auroral streamers? Measurements made upon the Atlantic cable

indicated an electro-motive force equivalent in extreme cases to six Daniell's cells. But a few hundreds of Daniell's cells would be quite insufficient to explain the auroral discharge. There is, however, one instance of electric phenomena where we have tremendous tensions to deal with; and atmospheric electricity of tension sufficient, as in ordinary lightning, to strike across a mile of air at ordinary density would probably be competent to strike across many miles of rarefied air. It has long since been remarked that displays of auroræ seem in some way or other in high latitudes to take the place of thunder-storms in low latitudes. Well, then, I will explain what I imagine takes place. I do not enter into any speculation as to the cause of atmospheric electricity. We know as a fact, from its manifestation, that it exists, and that is sufficient for my purpose. Suppose, now, that the air, especially the higher portions of the air, over a large tract of country, say to the north of us, were more or less highly electrified—positively or negatively as the case may be—we will suppose positively; if the electric tension were sufficient, we might, since dense air is a non-conductor, have a discharge taking place in the higher regions of the atmosphere where the air is rarefied, and accordingly opposes less resistance to the change.

“In the figure the great circle $P E p e$ is supposed to represent a section of the earth by a plane passing through its center. This faint shading outside represents the atmosphere, the height of course being enormously exaggerated.



Meridian section of the Earth.

“Suppose in some way or other a portion of the upper atmosphere, as C , got considerably charged positively or negatively, say positively, it would act by induction on the earth below. The opposite electricity,

negative in that case, would be accumulated underneath, as at *c*, and this portion of the earth would form, as it were, a portion of a Leyden jar, the lower atmosphere being the dielectric or glass of the jar, the upper atmosphere being partly the dielectric and partly also the charged coating. It would be represented more precisely by an imaginary coating outside, composed not of tin-foil but of some badly conducting substance. The positive electricity about *C* would be bound down in part by the negative electricity about *c*, which it induces. In another portion of the atmosphere—it may be at some considerable distance from the former—you may have the atmosphere charged in an opposite way; and of course if this were negative there would be induced positive electricity below, or it might be that the whole of the atmosphere from *C* to *D* is charged positively, but at *D* the negative charge is much feebler than at *C*. The end result would be the same, but for facility of explanation I will suppose that the upper portion in one place is actually charged with electricity of the opposite kind to what the charge is at the other. If the tension were sufficient then there might be a striking across of the electricity of this name in the atmosphere from *C* to *D*, and in the earth in the reverse direction. Compared with the atmosphere the earth would be an exceedingly good conductor, so that the electro-motive force concerned in sending currents from one part of the earth to another would be, comparatively speaking, trifling, and therefore the electro-motive force represented perhaps by a few scores of the elements of Daniell's battery. Thus, then, in atmospheric electricity we appear to have the tension requisite to send the discharge through a considerable space of rarefied air. Now, if a discharge took place, and if it were night and the sky were clear it would, at least where sufficiently concentrated, be visible to us just the same way as the discharge passing through the exhausted tube is visible by the light it produces. It would produce in fact an aurora. The air is not a comparatively good conductor, like a thunder-cloud, from which a great quantity of electricity strikes in one moment, but is a bad conductor, so that the electricity can pass only in a spitting sort of way. We may conceive here that we have a sort of double current, yet not forming a complete circuit; nevertheless a discharge would go on nearly of the same nature as if the circuit were complete, and the electro-magnetic effect of such a discharge on the magnetic needle would be nearly the same as that of a circuit complete.

“Now, if there only be a sufficient quantity of electricity, we have here the elements necessary for producing a disturbance of the magnetic needle. Moreover, those disturbances, as the instruments show, are of the most fitful and apparently capricious character. They resemble in that the fitful character of electric discharges through air. I need hardly say, according to this theory the earth current consists in the return currents produced by the statically-induced charge on the surface of the earth, induced by the charged atmosphere above. When

there is a neutralization of the electricity from one part to another of the atmosphere above, the induced electricity in the earth is set free, and we have earth currents to bring about a redistribution of the electricity on the surface of the earth.

“It seems to me that this theory not only accounts for the connection between the phenomena (which, however, could otherwise be accounted for), but enables us to conceive how it is that electricity strikes across such enormous distances in the upper regions of the air, and I think further it will account for some interesting features of that electric discharge which, no doubt, constitutes the aurora.

“If there is reason to believe that when the sun is in a state of special activity as to vertical currents and sunspots there is then an increased radiation from it, it may be well that the meteorology of the earth is affected by the changes which take place at the surface of the sun, but the meteorology of the earth forms an extremely complicated problem.” (*Nature*, October, 1881, xxiv, pp. 616-18.)

S. H. Freeman communicates to the *American Journal of Science* the result of some experiments on the production of electricity by evaporation; his results are adverse to the theory that any sensible amount of atmospheric electricity can have been produced by evaporation on the earth's surface. (*American Journal of Science*, June, 1882.)

Captain Kerr states that in the severe storm on the Firth of Forth in November, 1881, his vessel was enveloped in a dense shower of hail and electrical discharges. At one time a series of clear balls of lightning, resembling a chain, was observed immediately over the ship, and was succeeded by an explosion in the funnel of the steamer, followed by balls of fire running along the bridge and bounding off into the water; the engine room was filled with smoke, and it would seem as though the lightning had passed down the funnel. (*Nature*, xxv, p. 125.)

Mr. Cruis has communicated to the Paris Academy a memoir on the variation in the annual number of thunder-storms at Rio Janeiro during 1851 to 1876; he finds a close correspondence with the frequency of solar spots. (*Nature*, xxv, p. 24.)

J. Moir states that on February 18, 1882, in Aberdeenshire, Scotland, a severe storm was followed by a specially dark cloud and “a vivid flash of lightning close at hand, but without thunder. At the same time I found myself enveloped in a sheet of pale, flickering, white light. It seemed to proceed from every part of my clothes. I found it impossible to shake off the flickering flames; when I walked on they continued with me for two or three minutes, disappearing only when the violence of the blast was somewhat diminished.” The great variety of methods of manifestation of atmospheric electricity makes it desirable that some one should collect such descriptions as the above and contribute to the elucidation of the subject. (*Nature*, xxv, p. 410.)

Additional cases of similar phenomena are given by two other correspondents in *Nature*, xxv, pp. 427 and 484.

G. M. Whipple communicated to the British Association the results of observations of atmospheric electricity at Kew Observatory during 1880. The author, having spoken about the work already done, stated that he had devised a modification of Professor Everett's method, and had constructed a glass scale by means of which curves could be tabulated with great facility. They had commenced tabulating and discussing the accumulated records, and he was able to state some of the facts derived from the curves of 1880. Having determined the atmospheric tension for every hour during the year when measurement of the trace was possible, the diurnal, monthly, and annual variations were completed. The maximum tension occurred in January and March; the minimum in August and September. During summer the tension is greatest with an east wind and lowest with a north wind. In winter the tension is greatest with north and northwest winds and least with southeast winds. (*Nature*, September, 1881, XXIV, p. 491.)

A report has been published by Messrs. Spon & Co. of the lightning-rod conference which has been in session for three years, and which has collected an enormous mass of information. The conference was formed by delegates from the Meteorological Society of London, the Royal Institute of British Architects, the Society of Telegraph Engineers, and the London Physical Society. The report will contain a simple code of rules for the erection of lightning-rods, which any ordinary individual will be able to understand. (*Nature*, XXV, p. 184.)

Professor Tait, in the course of a lecture on thunder-storms, referring to the beneficial effect of a large number of well-grounded, sharp-pointed lightning-rods, stated that they afford absolute protection against ordinary lightning; thus until lightning-rods became common in Pietermaritzburg, that town was constantly visited by thunder-storms; they still come as frequently as ever, but they cease to give lightning flashes whenever they visit the town, and begin to do so as soon as they have passed over it. (*Nature*, XXII, p. 365.)

Mr. W. H. Preece read a paper before the British Association for the Advancement of Science, *On the best form to give to lightning-conductors*. The question was whether the lightning-conductor should be a solid rod or tubular or flat. Experiments made by heating and deflagrating wires through the different conductors left no doubt that intense discharges do obey the law of Ohm, and therefore that the additional surface of flat and tubular conductors is of no advantage in their conductivity. (*Nature*, XXII, p. 446.)

R. Anderson called the attention of the British Association to the necessity for a regular inspection for lightning-conductors. The author referred to a paper of M. W. de Fonvielle, "On the advantages of keeping records of physical phenomena connected with thunder-storms," read in 1872. Nothing, however, has been done by the association since then. He not only confirmed the conclusions at which M. de Fonvielle arrived as to the desirability of collecting such data, but was

of the opinion that the organization should go further, and arrange for a regular inspection of all public buildings which had lightning-conductors applied. The necessity for this he demonstrated by adducing a number of striking cases where damage, more or less severe, had occurred to buildings, even though having lightning-conductors attached to them. The cases now cited, he explained, were supplementary to those communicated in his paper on a similar subject to the association in 1878. (*Nature*, XXII, p. 446.)

Balfour Stewart, in reference to the subject of terrestrial magnetism, propounds the following working hypothesis: "May there not be a feeble magnetic nucleus in the earth around which the great convection currents, the trades and anti-trades, move, as conductors moving across lines of magnetic force, and the tendency of which will be to swell up and sustain the magnetism of the whole earth to the point of saturation? If this be granted, then the changes in winds and currents must produce corresponding changes (diurnal, annual, secular, and non-periodic) in terrestrial magnetism, so far as we can observe the latter." He adds that, with Mr. Dodgson and Mr. Hiraoka, he has convinced himself of the existence of intimate connection between these phenomena. [The same conclusion has been independently reached by Vines at Havana.] We may look upon the earth as composed of concentric layers: (1) a magnetic nucleus; (2) non-conducting primary rock; (3) the conducting moist earth and ocean; (4) the lower dense non-conducting air; (5) the upper thin conducting atmosphere. We observe earth currents in layer 3, and annual discharges or currents in layer 5. The former are apparently secondary currents induced by magnetic changes; the latter may also have a similar origin. (*Nature*, XXII, p. 146.)

In a lecture on solar physics Professor Stewart stated that he believed one great cause of weather changes to be solar variability, in which we have periods of short length, as well as others extending over many years.

These terrestrial weather changes, it is sufficiently well known, are propagated from west to east after they have once appeared.

Again, there are variations in the diurnal declination range which may be said to constitute magnetic weather.

These are also caused by solar variability, and it is suspected that they are likewise propagated from west to east, although more quickly than the well-understood changes of meteorological weather.

It would thus appear to be at least possible that British magnetical weather of to-day may be followed by corresponding meteorological weather five or six days hence.

Professor Stewart has made a preliminary trial which induces him to think that this is the case, and that it may ultimately be possible to forecast British meteorological weather by means of magnetic weather some five or six days previous to it. (*Nature*, May 5, 1881, XXIV, p. 7.)

Prof. Stewart, in a lecture on the connection between solar and ter-

restrial phenomena, says: "There is more than a general correspondence between these, for it is believed that all inequalities of sunspots, whether of long or short period, are accompanied by corresponding changes of declination range, a large range invariably accompanying a large number of spots. Perhaps I ought to say a large range following a large outbreak of spots, for the solar phenomena lead the way and the magnetic change follows after them at a greater or less interval of time. I may add, likewise, that we have some evidence which leads us to suspect that particular states of declination range, like particular states of weather, have a motion from west to east, the magnetical weather moving farther than the meteorological. From a preliminary investigation which I have made, I even think there may ultimately be a possibility of forecasting meteorological weather by means of magnetic weather five or six days before." (*Nature*, June 16, 1881, xxiv, p. 151.)

Rev. F. Howlett communicated to the British Association for the Advancement of Science a memoir *On the general coincidence between sunspots activity and terrestrial magnetic disturbance*. His object was to inquire how far solar activity more especially as regards sunspots, is wont to be accompanied by magnetic disturbance, as recorded by the automatic declination curves at Kew and Greenwich. The data for such an investigation were furnished by comparisons instituted between the most striking instances of sunspots, gathered out of a long series of solar observations carried on by Mr. Howlett from the year 1859 to the present epoch, and the synchronous conditions of the magnetic curves at the observatories above mentioned.

Out of twenty-four comparisons instituted, the following is the summary of results as showing the coincidence of extensive solar activity, and synchronous magnetic disturbances:

Intensely	5	
Very decidedly	3	
Decidedly	9	
Moderately	3	
Negatively (no spots, no storms)	1	
		— 21 affirmatively.
Questionable	1	
Contradictory	2	
		— 3 contradictory.
		—
		24

Thus, then, from the data collected it would certainly appear that marked periods of solar activity are wont to coincide with marked periods of terrestrial magnetic disturbance; but yet from a careful comparison of the days and hours of the magnetic records appealed to it also appeared that the disturbances were manifested in various ways, not only as regarded the extent of the magnetic excursions of the

needle, the rapidity of the oscillations, or the persistency of the more moderate disturbances, but also they were found to follow at considerably different intervals after the commencement of the observed solar outbursts. (*Nature*, 1881, xxiv, p. 466.)

Prof. W. G. Adams, in a study as to the origin and nature of magnetic disturbances, chose the month of March, 1879, for a comparison of the photographic records of magnetic disturbances, and records for the whole month were sent from Lisbon, Coimbra, Stonyhurst, Vienna, St. Petersburg, and Bombay in the northern hemisphere, and from Melbourne and Mauritius in the southern hemisphere. He finds that an inductive action equivalent to a change of position of the north magnetic pole towards the geographical pole would account for the changes recorded at these places.

In attempting to explain the disturbance of March 15 by currents of electricity or discharges of statical electricity in the air above the needles, we must imagine that at first there is a strong current from the southwest over St. Petersburg, from the west over Vienna, and from the northwest over Kew and Lisbon; that at Mauritius this current is from the north, and at Bombay from the south. Thus we must imagine that a current of electricity passes down from the northwest to the southeast, going on towards the east over Vienna, and towards the northeast over St. Petersburg. This must be kept up very much along the same line throughout the first part of the disturbance, and then the current must be altered in strength in the same manner at all stations.

The study of the great storm of August 11 points rather to solar action as the cause of this disturbance. In the storm of March 12 these magnetic changes are so large as to be quite comparable with the earth's total force, so that any cause which is shown to be incompetent from the nature of things to produce the one can hardly be held to account for the other. (*Nature*, 1881, xxiv, p. 492.)

W. Ellis has compared with the Greenwich records lithographed copies of the photographic traces made at Zi-ka-wei (lat. 31° N., long. 122° east) of the declination and horizontal force magnets, extending from August 11 to 14, and from August 17 to 20, 1880. Some particulars of the comparison are as follows (Greenwich time is used throughout):

A general examination of the two sets of curves shows that the disturbances were usually greater in magnitude at Greenwich than at Zi-ka-wei. Comparing the curves in detail, it is found on August 11, at 10.20 A. M., after a quiet period, the declination and horizontal force magnets at Greenwich both made a sudden start, which was the commencement of a magnetic disturbance lasting until midnight. An apparently equal horizontal force is shown on the Zi-ka-wei curves, occurring in declination at 10.12 A. M., and in a horizontal force at 10.20 a. m. (as nearly as the small scale on which the curves are drawn

will allow measures to be made). This first motion was to decrease the west declination and increase the horizontal force at both places. A bold motion in the two Zi-ka-wei curves at 11.30 A. M. (increase of declination, decrease of horizontal force) has corresponding decrease of horizontal force at Greenwich, not accompanied, however, by much motion in declination. And of numerous fluctuations occurring at Greenwich, between noon and midnight of the same day, some appear to correspond with motions at Zi-ka-wei whilst others do not.

A calm state follows at both places until near noon of August 12. Upon this day at about 11.40 A. M. the magnets at Greenwich made a further start, and until 4 P. M. the movements were large. A corresponding start is also shown in both the Zi-ka-wei curves, commencing, according to the register, some minutes sooner than at Greenwich, the movements following being similarly large. Afterwards, until 6 A. M. of August 13, considerable oscillation was nearly continually shown at Greenwich, there being especially a large change of declination between 7 and 9 P. M. (August 12); but there is no strongly marked motion at the latter time at Zi-ka-wei, and the changes throughout are much smaller than at Greenwich. Later, on August 13, further oscillations occur at both places, but the separate motions are in no particular accordance. This period of disturbance seems to definitely come to an end at both places at 6 A. M., August 14.

A period of quiet is broken at Greenwich August 18, at 1.45 P. M., by a sharp though small movement both in declination and horizontal force (increase of both). There is a corresponding sharp increase (after quietude) of horizontal force at Zi-ka-wei, but no change of declination. A bold increase of declination and decrease of horizontal force at Greenwich, 7 A. M. of August 19, is accompanied by a similar decrease of horizontal force at Zi-ka-wei, but with little change of declination. Bolder changes occur at the latter place at noon, but with comparatively small change at Greenwich. The magnets become quiet at both places at or near midnight, August 19.

The general result of this comparison of Greenwich and Zi-ka-wei curves appears to be that, after a quiet period, the first indication of a disturbance, if sudden (it need not be large), occurs simultaneously or nearly so at both places, but that during the continuance of disturbance the oscillations of the magnets seem to be so locally modified that it becomes difficult to trace correspondence: some movements appear to correspond and some not. A strongly marked bend in the trace at one place may appear, as it were, stunted in that at the other place, or may not be perceptible at all. The disturbances appear to die out at pretty much the same time at both places. All this confirms very much what Mr. Whipple has pointed out as regards Melbourne. (*Nature*, XXII, p. 558.)

M. Dechevrens of Zi-ka-wei, in some remarks which accompany the sheet of curves, notes that the disturbance of August 11-14 is the great-

est experience since the establishment of photographic registration at Zi-ka-wei in the year 1877, and he considers that the changes then observed (those of vertical force included, of which he gives no curves) are similar to such as would be produced by a powerful magnet placed in a certain defined position. It may perhaps be here pointed out that the results given by the astronomer royal in his paper, "First Analysis of One Hundred and Seventy-seven Magnetic Storms" (*Phil. Trans.* for 1863), appear to give no support to a theory of this kind, and indeed seem conclusively to show that at Greenwich the observed disturbances cannot be accounted for in any such a way.

It should be added that M. Dechevrens reports also that strong earth currents were experienced on August 11 and 12, on the submarine telegraph lines connecting Shanghai and Nagasaki and Hong-Kong, as well as on the land lines in Japan, so much so that correspondence was frequently interrupted, but that no interruption appears to have been experienced on the occasion of the generally smaller magnetic disturbance of August 18. (*Nature*, 1880, xxiii, p. 33.)

Admiral Mouchez has resumed magnetic observations in subterranean chambers at the Paris Observatory. The apparatus will be self-registering by photography, but direct observations will also be made with the old instruments used by Arago. (*Nature*, xxvi, p. 207.)

Professor Nipher of Saint Louis has investigated the peculiar distribution of magnetic phenomena in Missouri. In explanation of certain abnormal phenomena originally observed by him in 1878 he finds that the irregularities are not due to minute local causes, but that the perturbing force disturbs the declination of the magnetic needle over an area of 50 or 100 miles square. Thus the line of 8° E. crosses the Missouri Valley in a SW. direction and then bends abruptly to the NE., recrossing the Missouri, and after a wide detour crosses the river again for the third time and returns to its SW. direction. (*Nature*, xxv, p. 40.)

W. II. Preece, in a valuable historical paper on telephony, says: "The discovery of the telephone has made us acquainted with another phenomenon. It has enabled us to establish beyond doubt the fact that currents of electricity actually traverse the earth's crust; the theory that the earth acts as a great reservoir for electricity may be placed in the physicist's waste-paper basket. A telephone circuit when in connection with the earth gives distinct evidence of every visible flash of lightning, however far off the thunder-storm may be. No difference in time has been observed between seeing the flash and hearing the crash. There are certain natural currents flowing through the earth; they are called earth currents, and at times acquire such considerable energy that with a telephone pressed to the ear, I have been told, although I have not experienced it, the noise made is very near." (*Nature*, xxvi, p. 518.)

Professor Stokes, in some remarks on his admirable lectures on atmos-

pheric electricity and solar physics, recalls attention to the important papers by Barlow on earth currents in the London Philosophical Transactions for 1849. (*Nature*, xxv, 30.)

A. J. S. Adams, from observations of earth currents from 1866 to 1882, concludes that these are subject to a diurnal period, dependent upon the position of the moon and the sun, similar to the ocean tides. (*Nature*, xxiii, p. 424.)

One of the best-marked magnetic storms occurred through out the globe on April 16 and April 19, 1882. Mr. W. Ellis of the Royal Observatory, Greenwich, has compared together the full photographic traces made by the self-recording apparatus at that place and at Toronto. He finds that the times or moments of the commencement of the disturbance are in one case two minutes earlier at Greenwich, but in the other case one minute later, indicating that such disturbances are simultaneous at widely distant localities. (There is no evidence that the time-scales of the photographic sheets are reliable to within a minute, or can be read off to within less than a minute. The question of simultaneity will be more thoroughly settled if the International Polar Commission succeed in their proposed effort to look sharply after the seconds.) (*Nature*, xxvi, p. 175.)

Mr. Scuderer has established at Tortosa a simple arrangement of wires stretched between two houses and connected with telephones and galvanometers, so that he observes both ground currents and atmospheric electricity, whether due to condensation of aqueous vapor or to lightning discharge, or the action of the wind or other occult causes. (*Nature*, xxv, 23.)

Warren de la Rue and H. W. Müller have continued their elaborate researches into electric discharges *in vacuo*, and present some of their conclusions as to the nature of the auroral light as follows: "Our experiments on the electric discharge, which have already been published in the Philosophical Transactions and the Proceedings of the Royal Society, enable us to state with some degree of probability the height of the aurora borealis when its display is of maximum brilliancy, and also the height at which this phenomenon could not occur on account of great tenuity of the atmosphere.

"In Part III of our Electric Researches (*Phil. Trans.*, Part I, vol. 171) we have shown that the least resistance to the discharge in hydrogen is at a pressure of 0.642 millimeter, 845 M;* after this degree of exhaustion has been reached, a further reduction of pressure rapidly increases the resistance.

"Although we have not experimentally determined the pressure of least resistance for air, we have ascertained that while the discharge occurs in hydrogen at atmospheric pressure between disks 0.22 inch distance, they require to be approached 0.13 inch to allow the discharge to

* [M is about $\frac{1}{16}$ of a millimeter.]

take place in air. We may therefore assume that the pressure of least resistance for air is $(0.642 \times 13) \div 22 = 0.379$ millim., 498.6 M.

"At a height of 37.67 miles above the sea-level, the atmosphere would have this pressure (neglecting change of temperature), and therefore the display at this elevation would be of maximum brilliancy and would be visible at a distance of 585 miles.

"The greatest exhaust that we have produced, 0.000055 millimeters; 0.066 M, corresponds to a height of 81.47 miles, and as 11,000 cells failed to produce a discharge in hydrogen at this low pressure, it may be assumed that at this height the discharge would be considerably less brilliant, especially in air, than that at 37.67 miles, the height of maximum brilliancy.

"At a height of 124.15 miles the pressure would be only 0.0000001 millimeter; and it is scarcely probable that an electric discharge would occur with any potential conceivable at such a height.

"The color of the discharge varies greatly with the tenuity of air or other gas with the same potential. Thus in air at a pressure of 62 millimeters, 81579 M, the discharge has the carmine tint which is so frequently observed in the display of the aurora; this corresponds to an altitude of 12.4 miles, and would be visible at a distance of 336 miles. At a pressure of 1.5 millimeters, 1974 M, corresponding to a height of 30.86 miles, the discharge becomes salmon-colored, having completely lost the carmine tint. At a pressure of 0.8 millimeter, corresponding to 33.96 miles, the tint of the discharge is of a paler salmon-color, and as the exhaust is carried farther it becomes a pale milky-white. The roseate and salmon-colored tints are always in the vicinity of the positive source of the electric current; the positive luminosity fades away gradually, and frequently becomes almost invisible at some distance from its source. The discharge at the negative terminal in air is always of a violet hue, and this tint in the aurora indicates a proximity to the negative source.

"The following table, with the exception of pressure 0.0000001 millimeter, exhibits deductions from actual observations:

Pressure.	Pressure.	Height.	Distance visible.	Remarks.
<i>Millimeters.</i>	<i>M.</i>	<i>Miles.</i>	<i>Miles.</i>	
0.000001	0.00001	124.15	1,061	No discharge could occur.
0.000055	0.066	81.47	860	Pale and faint.
0.379	499.00	37.67	585	Maximum brilliancy.
0.800	1053.0	33.96	555	Pale salmon.
1.000	1316.0	32.87	546	Salmon-colored.
1.500	1974.0	30.86	529	Do
3.000	3947.0	27.42	499	Carmine.
20.660	27184.0	17.86	403	Do
62.000	181579.0	12.42	336	Do
118.700	56184.4	11.58	324	Full red.

"It is conceivable that the aurora may occur at times at an altitude of a few thousand feet." (*Nature*, 1880, XXII, pp. 33, 34.)

W. S. Jevons, after describing the five auroras of August as seen by him in Norway, adds: After thinking the matter over for three months, and comparing the auroral coruscations above described with the exquisite discoveries of Mr. Crookes, taking into account also some remarks in the article on auroras in the new edition of the "Encyclopædia Britannica," I venture to make the suggestion that these coruscations arise from highly tenuous matter (in what Mr. Crookes calls the *radiant state*), projected through the higher part of the atmosphere. It is not possible in words to give an impression of such a phenomenon in the least degree approaching to that naturally acquired by watching it under favorable circumstances for several hours. My belief is that, during the auroras described, *puffs*, as it were, of radiant matter were discharged at a great elevation above the earth's surface, and the luminosity of these puffs perhaps arises from conflicts between the projected molecules and those already spread about the almost vacuous space. The arch and most of the streamers probably belong to a lower, though still a very high part of the earth's atmosphere; but certain of the streamers, as well as patches of luminous matter seen on the night of the 13th, certainly exist in the lofty regions through which the radiant matter is projected. The explanation of the streamers must probably be approached through that of the coruscations, but they are effects of a very different kind. (*Nature*, December 16, 1880, XXIII, p. 149.)

Prof. W. G. Adams, in a suggestive lecture on magnetic disturbances, auroras, and earth currents, is almost entirely confined to the results of British work. With regard to the aurora he seems to teach that its ultimate cause must lie in the changes of the sun's magnetism, and in tides of the oceans of air above us. The existence of such aerial tides, due to the attraction of the sun and moon, has never been recognized by meteorologists, and it would seem necessary for Professor Adams to establish this hypothesis on a firmer foundation. (*Nature*, XXV, pp. 65-71.)

Dr. Spottiswoode, at the conclusion of one of his brilliant lectures on matter and magneto-electric actions, concludes as follows: "We may even carry the suggestion of a resistance of the second kind a little further, and suppose that there is a resistance due to the passage of electricity from a medium of one density to another, or from layer to layer, of different degrees of pressure. And from this point of view we may regard the striæ as expressions of resistance due to the varying pressure in different parts of the tube. Into the question, whence this variation of pressure, I am not, at present, prepared to enter; it must suffice for this evening to have shown that the conclusions which we have drawn from our experiments are not in disaccordance with other known phenomena of the electrical discharge.

"Before closing I would point out that these laboratory experiments are not unsuggestive in reference to larger questions. It has long been, and still is, a disputed question whether a display of the aurora borealis

ever takes place at any considerable elevation above the earth's surface. On the one hand observations are cited giving a not unfrequent elevation of nearly 200 miles, while, on the other, experiments with vacuum tubes appear to limit the range to less than forty miles. The observation is, perhaps, a doubtful one at best; it is not easy to fix the position of so faint and flickering a phenomenon, and it is perhaps even more difficult to identify a particular phase of it, when seen from two distant positions." (*Nature*, xxv, p. 543.)

J. R. Capron, in some remarks on the aurora and the spectrum, says: "I again plead the necessity for spectrum observation; it is certainly possible that some gas may exist in the upper regions of the aurora giving rise to the citron—perhaps to the red—lines, but it still remains an unexplained fact that such a gas has hitherto failed to be recognized in any other body, celestial or terrestrial. The electrical discharges in vacuum tubes, as tested by Professor Stokes' prism and slit, no more represent the aurora than did the cirrus cloud illuminated by the light of the moon. I would invite all spectroscopists armed with suitable instruments, persistently to retain accurate micrometer readings of the aurora spectrum. The approximate places of the lines are pretty well established; but their actual length of wave positions is much wanted." (*Nature*, xxv, p. 53.)

Nordenskjöld, at the Vega winter quarters, observed but rarely any brilliant auroræ, but the more remarkable phenomenon consisted in a luminous halo-like arc, not distributed into rays, and characterized by its feeble brilliancy as well as by the remarkable quietness of the whole phenomenon; this was nearly always visible on the northeastern part of the horizon, its summit being at an altitude of from 5 to 12 degrees. Hour after hour and day after day this arc remained unchanged; figuratively it was accompanied by one or several exterior arcs. His observations and measurements have led him to the following conclusions as to the nature of auroræ: "Our globe," he says, "even during a minimum aurora year, is adorned with an almost constant crown of light, single, double, or multiple, whose inner edge was usually, during the winter of 1878-'79, at a height of about 0.03 radius of the earth above its surface; whose surface was somewhat *under* the earth's surface, a little north of the magnetic pole, and which, with a diameter of about 0.32 radius of the earth, extends in the plane perpendicular to the earth's radius and passing through the center of this luminous ring." (*Nature*, xxv, p. 321.)

Nordenskjöld concludes that there are five different regions situated around the aurora pole where the glory would appear under quite different aspects. In the *first* circular region within 8° of the aurora pole, the glory is visible only as a luminous mist or a very low bow in a direction opposite to the aurora pole. In the *second* region between 8° and 16° region, the common ring of aurora must be seen as a luminous bow, the upper part of which is opposite the aurora pole. In the *third*

region between 16° and 20° region, the common arc must be in the zenith, but this light is so small in comparison with the ray aurora, that it must draw but little attention. The *fourth* region is a belt between 20° and 28° distant. Here the auroræ usually begin with a luminous bow in the magnetic north, out of which spread radiant beams either into free space or to another ring. The *fifth* region lies between 28° and 36° distant; the interior circles of the glory are not seen in this region. (*Nature*, xxv, p. 372.)

Weyprecht, shortly before his death, published a "Pactical Introduction to the Observations of Auroræ," &c. (Vienna, 1881), in which he repeats the important classification of auroral forms given in his *Nordlicht-Beobachtungen*. For observations on the altitude of auroræ, with a view to calculation of height, he recommends a simple instrument, consisting of a tube with an eye-piece, movable in a magnetic meridian, and with an altitude circle reading to $\frac{1}{2}^\circ$. The tube must be attached to the end of the axis, so as to be capable of sweeping the entire meridian. The observations should be repeated at short and regular intervals, and both the upper and lower edges of the arches should be observed, thus giving at once the mean altitude and breadth of the bands. If the "dark segment" is visible, its mean height and the azimuth of its summit must be observed, as it probably indicates the direction of the origin of the aurora. If a corona is formed the approximate position of its center must be observed. Another method of determining the position of the corona is by measuring the direction of the rays of which the arches are formed. This is best done by measuring their inclination from the perpendicular in two azimuths 90° apart. If the tube we have mentioned be provided with an azimuth circle and cross-wires in the eye-piece, with a position circle reading to $\frac{1}{2}^\circ$, this is readily accomplished, the perpendicular being verified by observation of a plumb line. (*Nature*, July, 1881, xxiv, p. 241.)

The aurora was remarkably frequent at Stykkisholm, Iceland, during the winter of 1880-'81. From September 5, when the first aurora of the season was observed, to February 28, to which date the observations have been received, auroræ were seen on forty-five nights, viz, five in September, eleven in October, four in November, eight in December, twelve in January, and five in February, the phenomena being very brilliant on September 29, December 23, January 31, and February 5. (*Nature*, July, 1881, xxiv, p. 261.)

Prof. Sophus Tromholt has published the results of a discussion of 839 observations of the aurora borealis, at 132 Scandinavian stations on 154 nights, between September, 1878, and April, 1879. These observations are classified under four heads in accordance with (1) longitude and latitude of stations; (2) time of year and age of moon; (3) color, altitude, and form of streamers; (4) sound. Herr Tromholt considers that it may be accepted as certain that the aurora is a local phenomenon, circumscribed by narrow limits, and manifested at inconsiderable

distances from the earth's surface; that the light is generally white and less often red or green, but in latitudes higher than Bergen it not unfrequently presents spectral colors; and that the accompaniment of sound is an indisputable fact. Professor Tromholt still continues his observations of the aurora borealis, to which he has devoted his attention for many years. It is his intention to make a catalogue of every recorded manifestation of the northern light in Norway; and for this purpose he requests the co-operation of other observers, and will be grateful for reference to any foreign sources of information, such as ships' logs, journals, weather tables, almanacs, &c., which might yield materials towards the better elucidation of this phenomenon. (*Nature*, XXIII, p. 84.)

Prof. Sophus Tromholt has published a complete catalogue of auroras observed in Northern Greenland from 1865 to 1880. He says that at Godthaab the auroræ are seen almost exclusively in the southern sky and very rarely in the north, while at the southern part of Greenland he has seen more intense auroræ throughout the whole sky. The number of observed auroræ is directly proportionate to the brightness of the sky, as shown by the following figures:

Cloudiness ...	1.6	1.7	1.8	1.8	..	3.2	3.3	3.4	3.5
Auroræ.....	7.0	7.0	5.0	6.0	....	2.9	2.7	2.5	1.5

After reducing the observed auroræ to what they would have been at a uniformly clear sky he obtains the following series:

No. solar spots	23.5	6.1	18.3	60.1	107.0	133.5	98.6	89.4
No. auroræ.....	86.2	91.3	67.4	80.9	51.7	56.5	32.0	46.0
No. solar spots	51.7	32.1	11.6	13.5	6.8	2.2	16.3	
No. auroræ	71.8	97.0	95.0	102.0	73.0	85.2	83.3	

The author finds that the location of the auroral belt is subject to oscillations moving northward during the minimum solar spots and southward during the maximum. (*Nature*, XXVI, p. 130.)

Prof. Sophus Tromholt has for several years confined himself to the investigation of auroras, and has published a monograph on that of March, 1880, as well as a catalogue of those observed in Norway in 1878 and '79. He states that he will occupy Kautokeino (in Finmark, Norway), during the winter of 1882 and '83, in order to make corresponding observations, and he earnestly advocates the establishment of special aurora observatories. To this central institute, Drontheim, he would have all Scandinavian observers report regularly. (*Nature*, XXVI, pp. 220, 221.)

XI.—*a* REFRACTION AND MIRAGE. *b* HALOS.

Glaserapp of Pulkova communicates preliminary results of study into atmospheric refraction. The want of concentricity of sheets of air of equal density produces a certain variation in the normal refraction

given in the tables; the surfaces of equal density produce a certain variation from the normal refraction given in the tables; the surfaces of equal density being, as a rule, inclined to some degree instead of being horizontal, and the degree of inclination being submitted to a certain periodicity during a whole year, there necessarily arises from this cause a certain correction to be applied to the position of a star, much like that of the annual parallax and aberration, and which might be described as "parallax of refraction." As this correction must obviously affect the values of the annual parallax and of aberration, it is easy to understand the necessity of determining its true value with much accuracy. The values deduced by Glasenapp for the stars of α Ursæ Majoris, α and θ Draconis, are $-0.''04$, $-0.''11$, and $-0.''11$, which figures would explain to a certain extent the negative parallaxes received by M. Nysen ("Nutation der Erdaxe"), and which, respectively, are $-0.''03$ — $0.''05$, and $-0.''06$. The whole work of M. Glasenapp on this subject will soon be published. (*Nature*, XXIII, p. 373.)

Professor Tait communicates to the Royal Society of Edinburgh a valuable communication on the subject of mirage. He has discovered the simple assumption as to the law of the variation of density in a stratum of air near the earth's surface which is necessary and sufficient to explain the simultaneous appearance of erect, inverted, and again erect images which have been frequently observed, but never before explained. (*Nature*, XXV, p. 92.)

Tait, at the subsequent meeting of the Royal Society of Edinburgh, June 5, communicated the second part of his paper on mirage, in which he proceeded to investigate more carefully that distribution of atmospheric pressure which would explain the mirage phenomena.

Two horizontal strata of uniform but different densities, separated by a stratum whose density varies continuously from the one to the other, were found to give results in close agreement with observation. That a stratum of air should remain of practically uniform density, through even a comparatively small height, requires a lowering of temperature to compensate for the diminution of pressure as the height increases; but this rate of change of temperature, Professor Tait showed, was not greater than had been observed in balloon ascents.

With given thicknesses of strata there was a critical minimum distance at which mirage could be obtained. For greater distances there were three images, two direct and one inverted.

The inverted one was always larger than the lower direct one, but only appreciably so when the distance of the object approached this critical minimum value, for which the phenomenon known as "looming" became evident. The second direct image is usually much the smallest, being, except at distances near this same critical distance, so small as to be practically invisible. This seems fully to account for the comparatively few instances in which the three images have been observed. Multiple inverted images, as observed by Scoresby, were explained as

due to thin successive layers of varying density at different heights. (*Nature*, xxvi, 167.)

In a third communication on mirage, Professor Tait called attention to an elaborate memoir by Biot, who had anticipated him in the theory of the curve of vertices, but had not made any further use of it. Other points at issue between Biot and Tait can perhaps be settled by careful measurements of the dip of the horizon taken at different heights above sea-level. (*Nature*, xxvi, 264.)

Fonvielle states that during the month of January, 1882, a large tract of country, including Paris, was persistently covered by an obscure cloud, or nebulosity, such that neither sun, moon, nor stars were visible from the 4th to the 26th. French meteorologists were of the opinion that this was due to a mass of snow suspended in the atmosphere, but as he entertained a different opinion he determined to test the question by ascending in a balloon, which he did on January 25, when he found that not a single flake of snow was present, and that moreover the thickness of the cloud did not exceed 1,000 feet, although it rendered the sun perfectly invisible from the earth. When at a height of 900 feet Fonvielle found the earth in its turn invisible, and at the height of 2,000 feet, the cloud having been passed, and the sun shining in a clear blue sky, this nebulous matter appeared to him perfectly homogeneous and without traces of crystals of snow. The temperature within the cloud was about 41° F., but above the cloud, about 28° F. Hoar-frost formed on the balloon when above the cloud, but not when within it, and he ascertained that the cloud was really formed of microscopic atoms of water in a quiescent state, and he thinks that when such atoms are set in motion they crystallize into minute spiculæ or hairs, and that these observations go far to explain the formation of "cirrus" clouds. (*Nature*, xxv, p. 338.)

Kopp, in reference to Fonvielle's observations of the nature of the nebulous matter floating over Paris, states that he thinks it more probable that the cloud was formed by small drops of liquid water cooled below the freezing point, but not crystallized or even solidified until they come in contact with a solid body, when the surface tension of the drops is immediately diminished, and crystallization ensues. "We know," he says, "from Dufour's observations, that water-drops, if they are not in contact with solid matter and are floating in a mixture of oil and chloroform, and having the same density, may be cooled down to -10 C., and if they are small enough, even to -20 C. Hoar-frost formed during hazy weather and with a temperature below freezing may be due to the solidification of such drops of mist. (*Nature*, xxv, p. 385.)

In reply to the above, Fonvielle states that as he saw no signs of a rainbow he cannot admit that there were any liquid water-drops in the cloud. (*Nature*, xxv, p. 436.)

Kopp replies to the preceding, that no rainbow should have been visible, for the minute particles were not rain-drops, but the minutest.

fog-drops, such as optical theories show cannot possibly produce rainbows. (*Nature*, XXV, p. 527.)

To this Fonvielle replies that when Kratzenstein, in 1744, advocated Halle's opinion with regard to the vesicular state of the particles of fogs and clouds as demonstrated by the absence of rainbows, he was misled as subsequent observers have been by the fact that the intensity of reflected light is not sufficient to show the rainbow, and he quotes an observation by Faye, in 1849, to the effect that an electric or other bright light thrown upon a natural or artificial cloud will prove a convenient method of investigating this subject. (*Nature*, XXV, p. 529.)

In 1872 the present writer sketched out the simple details of a plan for observing the heights of clouds at night time; it consisted essentially in throwing a well-defined beam of electric or calcium light vertically upward and observing from a neighboring station the apparent altitude of the bright spot visible on the under side of the cloud.

To the preceding, Dr. Kopp says, "There may be difficulties in the way of deciding, by direct observation, as to the form of the cloud-particles when their globules are crystals, but since de Saussure and Waller both record the results of microscopic observations it seems possible to carry such investigations still further. (*Nature*, XXV, p. 31.)

The questions at issue between Fonvielle and Kopp have been investigated by Eloy, a young aeronaut, who, after having made an interesting balloon ascent on the 7th of May, 1882, at Paris, has proposed a series of ascents from La Villette gas works, Paris, in order to make special observations on the nature, formation, dimensions, movements, and location of clouds. In the ascent of May 7, starting at mid-day, he reached an altitude of 1,900 meters, where the temperature was higher than at 1,400 meters. He found a southeast current up to 300 meters, and also again above 1,400 meters, but a northeast current in the interior. (*Nature*, XXVI, pp. 67 and 72.)

His subsequent ascent, of May 18th, was made on the eleventh day of a well-defined period, during which the prevailing wind was almost without intermission a strong northeasterly breeze which had been detrimental to agriculture. The sky was clear, deep blue, and the air cold and dry. A large number of dense, small cumuli, dark, well defined, with round edges, were seen carried by with the wind almost without intermission, except during the eclipse, when the weather was magnificent. This period having terminated only on the 20th, by a total change of wind, the observations taken may be considered as giving a fair idea of the atmospheric conditions which prevailed during so many days. These clouds were floating at an altitude of more than 2,000 meters, and very cold, the thermometer having descended abruptly to 4° and 6° centigrade. When crossing this cloud, the aerial travelers perceived no isolated flakes of snow, but the air seemed illuminated by sudden lights, as if rays traveling from the sun had been reflected by minute icy particles. The balloon having ascended to the upper surface

of the clouds, and travelled during more than an hour out of the view of the land, the aeronauts were unable to perceive the aureole round the shade of the balloon, which remained visible during the whole of the excursion on the upper face of the clouds. I explain this circumstance by the fact that the cloud was formed by solid water and that the aureole was less brilliant, the same relation between these two phenomena existing for luminosity as between halos and rainbows. The aeronauts, having remained at an altitude of two to three hundred meters from the clouds, were unable to perceive the colored rings which were visible to me and M. Brissonet, navigating only at a few meters above similar legions of icy particles. It may have also occurred that our friends were blinded by the light from the sun, which at four o'clock was very powerful, and so detrimental to their eyes that before entering the clouds they were unable to look fixedly at the earth to ascertain their path. It is the first time I have heard of aeronauts having experienced the want of colored spectacles to inspect our planet. (*Nature*, XXVI, p. 89.)

The effect of haze upon the telescopic definition of stars has been observed by G. W. Royston-Pigott. He gives several illustrations of the extreme *steadiness* and perfect definition of astronomical objects examined through slight haze, very especially the haze due to the London fog. He suggests that the effect of haze is apparently to diminish the intensity of refraction, but the explanation commonly received is, we believe, that the haze acts by way of equalizing the distribution of heat, thus diminishing the currents of hot and cold air, to which the phenomena of scintillation are largely due. (*Nature*, XXV, p. 77.)

J. J. M. Perry communicates some data on the fitness of the climate of Alnwick, in Northumberland, for astronomical observations. The summary for one year (1881) is as follows (the review is rather an instructive one, as showing the great amount of work accomplished by English astronomers in spite of the climatic obstacles):

Two hundred and twenty-nine nights were completely overcast; 51 were partially so (but of these 4 were too cloudy for observations); and 85 were clear. Thus, 132 nights ought to have been available for observations. Of these the definition on 54 was very bad, on 9 bad, on 14 fair, and on 2 very fine. Wind prevented observations on 16 nights, frost and snow combined on 15, on 2 frost alone, and on 1 snow alone. On 16 I was absent from home, and on 3 engaged. Total, 132. (*Nature*, XXV, p. 317.)

XII.—a PERIODICITY AND SUN-SPOTS.

An anonymous writer in *Nature* gives a table of mean departures of the monthly temperatures from their normal values for a hundred years in England. He concludes that those winters which give a mean temperature 3° in excess were immediately followed by summers warmer than usual. (*Nature*, XXVI, p. 35.)

H. C. Fox has investigated the laws which regulate the succession of temperature and rainfall in the climate of London, with the following results among others:

1. A *cold* spring is very prone to be followed by a cold summer, a cold summer tends to be followed by a cold autumn, and a cold autumn has a slight tendency to be succeeded by a winter of low temperature.

2. *Warm* summers are generally followed by warm autumns.

3. In no fewer than eight out of the twelve months (that is, in every one except February, March, May, and October), very *low* temperature tends to be prolonged into the succeeding month.

4. If June, July, August, or December be *warm*, the next month will probably be a warm one also.

5. Two months, June and July, tend, when very *dry*, to be followed by dry ones. On the other hand, a dry August indicates the probability of a *wet* September.

6. A *wet* December is apt to be succeeded by a wet January.

In addition to the foregoing there are also a few instances in which the rainfall of certain months appears to be definitely related to antecedent extremes of temperature, and *vice versa*. Thus:

7. If August or September be warm, the ensuing September or October inclines to be wet. If, on the other hand, September or November be *cold*, the succeeding October or December is likely to be a dry month.

8. If February, June, or July be very *dry*, the next month has a strong tendency to be warm.

9. If January, March, or April be *wet*, we may also expect the next month to be a warm one. But a wet May or July gives a strong probability of cold weather in June or August respectively. (*Nature*, XXII, pp. 445, 446.)

Buchan has published a paper on the diurnal period of thunder-storms in Scotland. There are two well-marked types of thunder-storms, the one occurring in the summer months, and having its daily maximum frequently from 1 P. M. to 6 P. M., and the other occurring in the winter months, with its maximum from 9 P. M. to 3 A. M. Stations in the eastern division of the country, where the annual rainfall is small or only of moderate amount, have all, or nearly all, their thunder-storms during the summer months; whereas in the west, or where the climate is wet and the rainfall heavy, a very considerable portion of the thunder-storms occur during the winter months, and these are nearly always of short duration, and are the accompaniments of the winter cyclones of Northwestern Europe. (*Nature*, XXII, p. 594.)

In a paper on the secular inequalities in terrestrial climates depending on the perihelion, longitude, and eccentricity of the earth's orbit, read by Rev. Dr. Samuel Haughton, of Trinity College, Dublin, he shows that the two inequalities in question depend upon terrestrial radiation only, and in no way upon sun heat.

Having noticed that the hottest and coldest times of the day *follow*

noon and midnight by an interval, often considerable, and in like manner that the hottest and coldest days in the year *follow* midsummer and midwinter by an interval often of many days, Dr. Haughton saw in these facts a close analogy with the diurnal tides, which follow the sun or moon's meridian passage by an interval of some hours.

Using Ferrel's temperature tables, Dr. Haughton finds the following maximum secular ranges of mean annual temperature for the respective zones around the whole earth :

Maximum secular ranges.

Latitude.	Northern hemisphere.	Southern hemisphere.
°	F.	F.
0	0.185	0.185
10	0.375	0.585
20	1.100	0.875
30	2.065	1.110
40	2.750	0.985
50	3.685	0.710
60	4.610	0.540
70	4.985	.....
80	4.952	.....

This table shows that the average maximum effect of the astronomical causes involved in perihelion longitude can never exceed 5° F. in the northern hemisphere, and barely exceeds 1° F. in the southern. The observed great ranges of climate between the Carboniferous and the Glacial epochs therefore required some other elucidation. (*Nature*, xxiv, p. 93.)

At the Cincinnati meeting of the American Association for the Advancement of Science, held in August, 1881, Mr. W. J. McKee read a paper on a contribution to Croll's theory of secular climatic changes.

Mr. Frederick Chambers summarizes the sun-spot studies of Charles Chambers, Brown, Hill, Archibald, Blanford, and Mildrum, and concludes that the relations with terrestrial meteorology must be studied in greater detail—which work he has himself undertaken. Commencing with the daily abnormal barometric variations observed at several stations in Western India, it was soon found that, as the time over which an abnormal barometric fluctuation extended became longer and longer, the range of the fluctuation became more and more uniform at the various stations, thus leading to the conclusion that the abnormal variations of long duration affect a *very* wide area. To test this inference it became necessary to compare the observations recorded at Bombay with those of some distant tropical station. Batavia was chosen, and, on plotting the daily observations side by side with those of Bombay, the degree of accordance between them was found to be truly surprising considering how far the two stations are apart. The monthly abnormal variations were then plotted and smoothed down by taking nine months' means. The curves obtained in this way for Bombay and Batavia were then found to be almost *identical in form*, but with this

very remarkable difference: *the curve for Batavia was seen to lag very persistently for about one month behind the Bombay curve.* Similar curves were obtained for all of Archibald's tropical stations, and for the sun-spot ones published in *Philosophical Transactions*, 1870.

The general resemblance of all these curves to each other is very remarkable; indeed, if the Mauritius curves for the years 1867 and 1868 be excluded, there is scarcely a single prominent feature in any one of the curves which is not reproduced in the others. It appears, then, that these long atmospheric waves (if such they may be called) travel at a very slow and variable rate round the earth from west to east, like the cyclones of the extra-tropical latitudes.

A glance at the barometric and sun-spot curves is sufficient to show that the irregular and frequent fluctuations of pressure are relatively much larger than those of sun-spots. The prime curves were therefore still further smoothed, and from this comparison it appears that the epochs of maximum and minimum barometric pressure lagged behind the corresponding epochs of minimum and maximum solar-spotted area at an interval varying from about six months to nearly two and a half years, or at an average interval of about one year and eight months. From a comparison with the records of famines in Asia, it appears that widespread and severe famines are generally accompanied or immediately preceded by waves of high barometric pressure.

If the conclusions arrived at from the above comparisons of abnormal barometric variations, sun-spots, and past famines be admitted, it is clear that they at once present the means whereby future famines may possibly be foreseen. The conclusions are, briefly:

1. That variations of the solar-spotted area are succeeded many months afterwards by corresponding abnormal barometric variations.
2. That abnormal barometric variations in the tropics travel at a very slow rate round the earth from west to east, arriving at westerly stations several months before they reach more easterly ones.
3. That famines follow in the wake of waves of high barometric pressure.

Hence, it follows that there are two methods by which early intimation of the approach of these meteorological disturbances, which are attended by famines, may possibly be obtained:

1. By regular observation of the solar-spotted area, and early reduction of the observations, so as to obtain early information of current changes going on in the sun.
2. By barometric observations at stations differing widely in longitude, and the early communication of the results to stations situated to the westward. (*Nature*, December, 1880, XXIII, pp. 84-110.)

E. D. Archibald, remarking on the fact that the British Government has sent an observer to Leh, India, 11,000 feet altitude, for the maintenance of direct daily observations of the sun's heat, quotes the following

table of the departures of the annual averages of certain meteorological elements from their normal values :

Years.	Wolf's No.	Excess of temperature of black-bulb.	Annual mean air temperature.	Mean pressure of water vapor.	Mean proportion of cloudy sky.	Mean annual rainfall.
		°	°	<i>Inch.</i>	<i>Tenths.</i>	<i>Inches.</i>
1875.....	17	- .76	- .29	- .104	- .03	+ .366
1876.....	11	- .33	- .08	- .017	- .20	- .437
1877.....	12	+ .19	+ .17	+ .011	+ .31	- .297
1878.....	3	+ .44	+ .62	+ .020	+ .09	+ .566
1879.....	6	- .36	- .13	- .014	- .06	+ .197

The above figures are based on the meteorological observations for the whole of India, and are therefore free from all minor local peculiarities. The meteorological conditions are evidently subject to much more violent variations than are the solar spots; but Archibald and Professor Hill seem to regard these figures as favoring the hypothesis that the sun radiates most heat to the earth in the years of fewest spots. (*Nature*, XXV, p. 316.)

W. S. Jevons advocates the theory that there is some relation between the solar spots and the commercial crises. He gives in parallel columns the number of bankruptcies and the corresponding year, as follows :

Year.	Bankruptcies.	Year.	Bankruptcies.	Year.	Bankruptcies.
1870.....	8,151	1874.....	9,250	1878.....	13,630
1871.....	8,164	1875.....	9,194	1879.....	15,732
1872.....	8,112	1876.....	10,848	1880.....	12,471
1873.....	9,064	1877.....	11,247	1881.....	11,632

(*Nature*, XXVI, p. 226.)

Dr. Doberck has made a comparison between annual rainfall (C) recorded at Markree observatory during forty years and the relative sun-spot numbers (R) of Prof. R. Wolf. He finds that the following formula approximately represents the connection between these two data :

$$C = 46.492 + 0.05946 (R - 58.91)$$

But this result must be considered to be a purely local matter and to be based upon somewhat insufficient data. The general agreement of the computed and observed rainfalls is not specially satisfactory. (*Nature*, XXVI, p. 367.)

Balfour Stewart reviews the results hitherto arrived at as to the connection between solar spots and terrestrial temperature, pressure, magnetism, &c., and concludes: We thus perceive how strong the evidence is in favor of some connection between the state of the sun's surface and terrestrial meteorology, while at the same time it is unmistakably indicated by all elements that this connection is of such nature

as to imply that the sun is most powerful where there are most spots on his surface. Add to this that the spectroscopic observations of Lockyer and others tend in the same direction, as well as such actinometric results as we have been able to procure, chiefly through the labors of Mr. Hennessy, at Dehra-Dhoon and Mussoorie. (*Nature*, XXIII, p. 237.)

B. Stewart publishes the observations of the height of the river Nile, deduced from a graphic representation of the readings above the zero of the Cairo nilometer, made every five days during the years 1849 to 1878, whence he deduced the following approximate relative quantities of water discharged by the river each year:

Year.	Annual discharge.	Year.	Annual discharge.	Year.	Annual discharge.
1849	2, 130	1859	1, 769	1869	2, 284
1850	2, 080	1860	2, 098	1870	2, 701
1851	2, 077	1861	2, 368	1871	2, 718
1852	2, 078	1862	2, 574	1872	2, 404
1853	2, 434	1863	2, 765	1873	2, 142
1854	2, 425	1864	2, 475	1874	2, 317
1855	2, 175	1865	2, 229	1875	2, 465
1856	2, 141	1866	2, 932	1876	2, 541
1857	2, 016	1867	2, 208	1877	1, 981
1858	1, 736	1868	2, 003	1878	2, 240

Stewart formulates the following conclusions:

1. The curve representing the heights of the river Nile and that representing the dates of maximum height are very like each other, a maximum height corresponding generally to a late date of maximum rise.

2. There is also considerable likeness between the Nile curve and that for the river Thames.

3. There appears to be a maximum in these curves at or somewhat after the date of maximum sun-spots, but they have more than one maximum for one sun-spot cycle.

It would be extremely interesting if this comparison could be still further extended. (*Nature*, XXV, p. 269.)

Prof. Balfour Stewart communicated to the mathematical and physical section of the British Association for the Advancement of Science a paper on the similarity between meteorological and magnetic weather, by which terms he designates the very variable alternations and behavior of the magnetic needles. This is a repetition of a paper read before the Royal Society, and shows that in July, August, and December the declination range fluctuation precedes the corresponding temperature range fluctuation by twelve days, whereas in February, March, and April it precedes by only five days.

In a second paper Professor Stewart deals with a supposed connection between the heights of rivers and the number of sun-spots. He finds that the Nile agrees with European rivers, and exhibits a maximum about the time of maximum sun-spots, and predicts that for the cur-

rent year (1882) the maximum height of the Nile will be attained somewhat late in the season. (*Nature*, XXVI, pp. 448, 449.)

J. P. O'Reilly says: "So far as I can see there will be a famine in the Niger River valley this year, as there has been a complete failure of the first crop from drought, and there has been no chance of putting in the second crop from the same reason.

"The regimen of the waters of such great rivers as the Nile, the Niger, and the Congo, both as to quantity and periods of rise and fall, must be closely related to the meteorological condition of the highlands of Africa, so little known to us, so extensive, and yet so inaccessible to us for observation. May it not be, therefore, assumed that the comparative and continuous study and observation of those rivers, as regards their volumes and periods of rise and fall, would be likely to furnish the most valuable data for the prediction and forecast of weather in Europe? Thinking so, I have suggested to my correspondent the advisability of keeping a systematic record of the rise of the river Niger, and, if possible, of the water, with a view to their utilization for meteorological purposes." (*Nature*, XXVI, p. 597.)

M. Brierley, of Port Said, writes that in looking over data of the rainfall at Bombay and comparing them with the ebb and flow of the Nile for the corresponding years from 1849 to 1880, inclusive, he was so struck by the similarity, almost identity, of magnitudes that he was led to copy them out, side by side. Within a trifling fraction the whole of the annual rainfall at Bombay happens in the months of June, July, August, and September, during which months also the rainfalls occur in the head-waters of the Nile.

The great southwest monsoon which sweeps over the Indian Ocean in summer months produces a like effect in both cases, inducing fertility and plenty alike on the plains of the Concan of India and the Delta of Egypt. It may be mentioned that the lowest ebb of the Nile always happens in June, and the highest flood about the end of September and the beginning of October. Brierley's table includes also Wolf sun-spot numbers and the barometric departures for India. (*Nature*, October, 1881, XXIV, p. 532.)

b HYPSONOMETRY. c GEOLOGY, PHYSICAL GEOGRAPHY, GLACIERS, HYDROLOGY.

M. Faye has lately published in *Comptes Rendus* a remarkable paper on the physical forces which have produced the present figure of the earth. After remarking on the use of the pendulum in determining the figure of the earth from series of measurements of the intensity and direction of the gravitation force at different parts of the earth's surface, he draws attention to the curious fact that while the direction and intensity of gravity are affected perceptibly by the presence of hills, such as Schiehallion and Arthur's Seat, or even by masses as small as

the Great Pyramid of Gizeh, gigantic mountains, such as the Himalayas, and great elevated plateaus and table-lands do not affect the pendulum-indications in any sensible manner, except in certain cases where upon elevated continents there appears to be a veritable defect of attraction instead of the excess which might be expected. Indeed, the observations are sufficiently striking to seem to point to the supposition that not only under every great mountain, but even under the whole of every large continent, there are enormous cavities. More than this, the attractions at the surface of all the great oceans appear too great to agree with the distribution presumed by Clairant's formula, which is exact enough for most purposes. Sir G. Airy's suggestion that the base of the Himalaya range reaches down into the denser liquid interior, and there displaces a certain amount of liquid, so that the exterior attraction is thereby lessened, is one which, inherently improbable, fails to have any application in explaining why the attraction above the seas should be greater than over the continents. M. Faye propounds the following solution of the difficulty: *Under the oceans the globe cools more rapidly and to a greater depth than beneath the surface of the continents.* At a depth of 4,000 meters the ocean will still have a temperature not remote from 0° C., while at a similar depth beneath the earth's crust the temperature would be not far from 150° C. (allowing 33 meters in depth down for an increase of one degree in the internal temperature). If the earth had but one uniform rate of cooling all over it, it would be reasonable to assume that the solidified crust would have the same thickness and the same average density all over it. It is therefore argued that below the primitive oceans the earth's crust assumed a definite solid thickness before the continents, and that in contracting, these thicker portions exercised a pressure upon the fluid nucleus tending to elevate still further the continents. This hypothesis, M. Faye thinks, will moreover explain the unequal distribution of land and sea around the two poles; the general rise and fall of continents being determined by the excess of density of the crust below the oceans, and by the lines or points of least resistance to internal pressure being at the middle of continents or at the margin of the oceans. (*Nature*, XXII, p. 206.)

Professor Geikie has made an interesting contribution to the precise measurement of the rate at which the exposed surfaces of different kinds of rock are removed in the processes of weathering. The important influence of the atmosphere in geological problems needs elucidation from all sides, and it occurred to him that data of at least a provisional value might be obtained from an examination of tombstones freely exposed to the air in graveyards in cases where their dates remained still legible or might be otherwise ascertained. He accordingly paid attention to the older burial grounds in Edinburgh, and has gathered together some facts which have sufficient interest and novelty to render it desirable

that others should make similar studies as to the preservation and destruction of such stones. (*Nature*, XXII, p. 104).

Prof. F. Forel has published in the "Archives" of Geneva several memoirs on the variations in the dimensions of the glacier of the Rhone and shows that very large changes may be due not to any great variations of temperature but to small changes in the local distribution of snow and rain. Again, any change in the latter affects first the thickness of the glacier and eventually its length, but the latter effect is specially felt only when the immense snow-slides that feed the upper end of the glacier have after a long time worked their way down to the lower end, so that the location of the end of a glacier and its thickness depend largely upon the snowfall of fifty or one hundred years ago. (*Nature*, XXV, p. 184.)

Forel has published investigations on the phenomena of glaciers. He concludes that molecular affinity is constantly operating to increase the growth of the so-called crystalline grains of the glacier, at the expense of the water which permeates the capillary fissures; such grains increase from the size of a small nut at the upper end of the glacier to the size of a hen's egg at the lower end, the increase of volume being $4\frac{1}{2}$ per cent. annually. (*Nature*, XXVI, p. 89.)

Naturen, for February, 1882, contains an account of the movements of the Norwegian glaciers during the past two centuries. It would appear that the vast system of Jostedal glaciers have generally been retreating since 1750, whereas up to that time they had been advancing rapidly. In fact, in general the winters were milder during the latter half of the last century. At the present time the glaciers are generally advancing again. (*Nature*, XXV, p. 449.)

Woeikoff has published an interesting paper on the glacial period in the last issue of the *Zeitschrift* of the Berlin Geographical Society (Vol. XVI, fasc. 3). It is well established now that for the formation of glaciers not only a sufficiently low temperature is necessary, but also a sufficient supply of moisture in the atmosphere. Thus, at the Woznesensky gold mine, which lies at a height of 920 meters and has a mean temperature of -9° C., but a rather dry climate, we have no glaciers, nor in the Verkhoyansk Mountains, where the mean temperature is as low as $-15^{\circ}.6$, and the temperature of January is $-48^{\circ}.6$. To show these differences Dr. Woeikoff prepares a table of the temperatures at the lowest ends of glaciers, and we see from his figures that in Western Norway, at the end of the Jostedal glacier (400 meters high), the mean temperature is $4^{\circ}.8$ C.; it is $5^{\circ}.8$ at the end of the Mont Blanc glaciers (1,099 meters); $6^{\circ}.8$ at the end of the Karakorum glacier, in Tibet (3,012 meters high), and even 10° on the western slope (212 meters) of the New Zealand highlands, and 7° on the eastern slope (235 meters). In other countries—as, for instance, on the Mounkau Sardyk Mountains, in Eastern Siberia (3,270 meters)—the mean temperature at the end of the glaciers is as low as $-10^{\circ}.2$, and $-2^{\circ}.4$ in the Daghestan Mountains

of the Caucasus. Thus the difference of mean temperatures at the lower end of glaciers reaches as much as fully 20° . Besides, we see that, provided the quantity of rain and snow is great, glaciers descend as low as 212 meters above sea-level in a country (New Zealand) which has the latitude of Nice and the mean temperature of Vienna and Brussels—that is, higher than Geneva, Odessa, and Astrachan—whilst the average temperature of its winter is higher than that at Florence. Further, Dr. Woeikoff discusses the rather neglected influence of large masses of snow upon the temperature of a country during summer, and by means of a very interesting calculation he shows how much the temperature of summer in higher latitudes is below what it ought to be in consequence of heat received from the sun, and *vice versa* in winter, these differences being due on the one side to the refrigerating power of snow, and on the other side to the heating power of ocean currents. In a following paper he proposes to discuss the other causes which might have influenced the climate of different parts of the earth during the glacial period. (*Nature*, August, 1881, XXIV, p. 364.)

Woeikoff contributes to the *Zeitschrift für Erdkunde* a second memoir on the climates favorable to glacier formation, in which he clearly indicates the principal orographical and meteorological principles involved, in accordance with the recent progress of meteorology. A cursory glance over the present condition of our globe shows us that cold alone will not produce permanent snow and glaciers when vapor of water is deficient. There are no permanent snows nor glaciers in the Verkhoyansk Mountains in Northeast Siberia, yet at the foot of them the mean annual temperature is below 4° F., and that of January below -56° F. The reason is that the snowfall is but small, and thus the snow is easily melted in summer. In New Zealand, on the contrary, owing to the enormous snowfall in the mountains, glaciers descend to about 700 feet above sea-level on the west side (lat. 43° S.).

At this height the mean annual temperature must be about 50° F., and snowfall and frost are of rare occurrence even in winter. The great importance of an abundant supply of vapor being admitted, and thus the necessity of surfaces covered by sea, what temperature of the surface of the seas is the most favorable to the production of glaciers? This depends certainly on the height above sea-level where the névé is formed; but so far as we consider lowlands and moderate heights—say, below 6,000 feet—the surface temperature of the water should not very much exceed the freezing point, otherwise the vapor evaporated from the sea and condensed on the surrounding lands will be rain and not snow; thus contributing rather to melt the existing snow and not to form new snow-layers. For lowlands and very small elevations a temperature of the surrounding seas of about 32° F. is that which is most favorable to the formation of snow, and if the last is falling in sufficient quantities to form permanent snow and glaciers.

The deeper and opener the seas are, the better, for such seas do not

freeze entirely, as the winds and tides always break the ice which is already formed; thus seas of that kind have, even in the midst of winter, a considerable open surface, which evaporates freely. The temperature of the sea surface may be so high that much more rain than snow falls even in winter. Let us take an example: The sea surface between the southwest of England and the south of Ireland has a temperature of above 50° F. even in January. Supposing a saturated stratum of air to rise from these seas, it would have cooled down to about $38^{\circ}.4$ F. at an elevation of 4,000 feet, that is, at the level of the highest peaks of the British islands. The resulting precipitation will be rain and not snow. (*Nature*, xxv, p. 424.)

Woeikof discusses the influence of local topographical conditions on the average winter temperatures observed at meteorological stations, in Vol. xiv of the *Journal of the Russian Chemical and Physical Societies*. He shows from the Swiss and Siberian observations that the temperature of the air is often much colder in the valley than on the mountains, and that in general the annual range of temperatures is less on isolated mountains than the surrounding countries. These peculiarities must be allowed for, in order to obtain a true estimate of the distribution of temperatures. (*Nature*, xxvi, pp. 190 and 209.)

Nordenskjöld has published the scientific observations made on the voyage of the *Vega*, which are made accessible to English readers by means of Leslie's translation, published by MacMillan & Co., 1881. The *Vega* wintered at $67^{\circ} 4' 49''$ north and $173^{\circ} 23' 2''$ west. In this locality the thickness of the ice was measured as follows:

	Centimeters.		Centimeters.
Dec. 1	56	May 15.....	162
Jan. 1.....	92	June 1	154
Feb. 1.....	103	June 15.....	151
Feb. 15.....	120	July 1.....	104
Mar. 1	123	July 15.....(full of holes)..	67
April 1.....	128	July 18 (ice broken up).	
April 15.....	139		
May 1.....	154		

(*Nature*, xxv, p. 204.)

E. D. Archibald, in some remarks on the cold weather of Europe in the spring of 1882, attributes this largely to the influence of floating ice reaching the lower latitudes of the North Atlantic Ocean. (He does not, however, make it apparent but that northerly winds may have been the common cause of the low temperatures and the abundant ice.) He adds, "Though I agree with Hann in attributing more importance to the *tropical* than to the *polar* area in influencing the *general* weather of these latitudes, I think it very probable, on theoretical grounds, that we are more relatively influenced by the *latter* area in summer and the *former* in *winter*, and that just as it has been inferred that the regular recurrence of periods of diminished temperature in

Europe is due to the regular movements of the ice in the polar area, so we may reasonably conclude that abnormal movements of ice, especially in the Spitzbergen area, are likely to produce periods of abnormal coolness, such as that which at present prevails. In any case the moral to be drawn, if we really do intend to solve the weather problem, is by all means, to have a meteorological station in Iceland, and endeavor to study the map, as we are fortunately able to do in India, on a large scale, instead of merely confining our attention to the minute range of conditions we are able to observe within the limited area of these islands." (*Nature*, XXVI, p. 198.)

In a second paper Mr. Archibald states that the cold spring winds usually come from the east and north, whereby the movable ice causes a high pressure and a low temperature. (*Nature*, XXVI, p. 222.)

Mr. James B. Francis, president of the American Society of Civil Engineers, gave the results of his observations, during forty years, of anchor ice. "A frequent inconvenience in the use of water-power in cold climates is that peculiar form of ice called anchor or ground ice. It adheres to stones, gravel, wood, and other substances forming the beds of streams, the channels of conduits, and orifices through which water is drawn, sometimes raising the level of water-courses many feet by its accumulation on the bed, and entirely closing small orifices through which water is drawn for industrial purposes. I have been for many years in a position to observe its effects, and the conditions under which it is formed. The essential conditions are that the temperature of the water is at its freezing point, and that of the air below that point; the surface of the water must be exposed to the air, and there must be a current of water.

"The ice is formed in small needles on the surface, which would remain there and form a sheet, if the surface were not so much agitated that the water at the top and bottom are continually interchanging their places, and intermixing. When resting at the bottom the crystals unite by regelation, and anchor ice is formed a considerable distance down stream below where the ice needles first form." (*Nature*, July, 1881, XXIV, p. 302.)

R. Gordon, the executive engineer of the embankment works of the Irrawaddy, has published a valuable monograph on the hydrography of that river, and the hydraulic works. The book is, of course, mainly occupied with the subject of connection between height of water or total discharge and the peculiarities of the river, and the rainfall. Especially interesting is the series of seventy or eighty consecutive days of complete measurements of the discharge at three sites in the delta. Records of the floods of the Irrawaddy for past years are insufficient to deduce anything like periodic regularity that has been proven in some other rivers. (*Nature*, XXVI, p. 172.)

Professor Harlacher has constructed a current meter, which gives the velocities at any depth in the shortest possible time, making a con-

tinuous record on a sheet of paper, if required. Full details of the apparatus are given in *Nature*, Vol. XXVI, p. 494, and in the *Proceedings of the Institute of Civil Engineers*.

Tillo has published in the Nautical Review (*Morskoï Sbornik*) an interesting paper on the slopes and ranges between high and low water in the rivers of European Russia. For the Volga the range is 12 feet at Astrachan, and the average range throughout the whole length of the river is 33.6 feet. For the Duna the range is 9 feet at Riga, and 25.2 feet on the average for the whole river. (*Nature*, XXVI, p. 543.)

Mr. G. H. Darwin states that a misprint in a tidal report of 1872 has affected all the reductions of tides since that time, and in place of repeating the laborious computations he endeavors to compute the maximum effect which this error can have produced. His memoir is said to have contained suggestions of a new method of procedure of the harmonic analysis of the tides of long periods. (*Nature*, XXVI, p. 465.)

Yornol has published the chemistry of the Norwegian North Atlantic expedition, in which he discusses the quantity of air and carbonic acid gas, and of the salt in the sea water; his apparatus for obtaining samples at any depth was invented by Captain Wills. The apparatus for boiling out the gases was that recommended by Jacobsen, with the addition of a beautiful slide valve invented by Dr. Behrens. Ninety-four samples of air extracted from water taken at various depths give the volume of oxygen varying between 33.7 and 36.7 for the service water. He finds the lowest oxygen 33.64, and the highest 34.14. The results of the "Challenger" observations were 35.01 and 32.35. (*Nature*, XXV, p. 338.)

Dr. Tomoe states, in reference to the effect of depth on the oxygen, "The proportion, which at the surface is 35.3 per cent., diminishes at first rapidly, then slowly, to 32.5 per cent. at a depth of 300 fathoms, after which it keeps constant." Buchanan remarks that the percentage of oxygen must depend largely upon the time elapsed since the water of the respective depths was in contact with the atmosphere. As to the carbonic acid Tomoe finds 52.78 milligrams per liter of water present in the carbonates, and 43.64 milligrams present in the bicarbonates contained in the sea water. He gives an elaborate table of the expansion of sea water with temperature. The quantity of solid residue in sea water is shown upon charts that clearly demonstrate the distribution of the water from the Atlantic and the Polar regions. In general, Tomoe's work must be recognized as giving a great impetus to the chemical study of sea water. (*Nature*, XXV, p. 411.)

d CLIMATE AND BIOLOGY.

Dr. T. L. Whitehead has published his researches based on fifty years' consecutive observation on the climate of Ventnor, in the Isle of Wight, and the diseases peculiar to the climate of that locality, thereby mak-

ing important contributions to the work of the late Dr. Mont. (*Nature*, xxv, p. 34.)

Tyndall's essays on the floating matter of the air have been republished in convenient form, and should serve to stimulate research. In this important field meteorological observers can probably best promote the study of the relations of climate to disease by regarding or preserving daily results of observations upon atmospheric dust. (*Nature*, xxv, p. 6.)

Professor Frankland, in an interesting lecture on climate of town and country, explains the chief things affecting climate, such as the direct sunshine, and especially the fact that the warmth of the air, as distinguished from the sunshine, depends, first, upon the nature of the surface of the land and the presence of the ocean, and, secondly, upon the absorption by the atmosphere, by invisible aqueous vapor, by clouds, fog, dust, and smoke. He especially dwelt upon the nature of London smoke fogs due to the imperfect burning of bituminous coal, and in ordinary grates rather than in the factory furnaces. He says that were aqueous vapor alone in the air it would never produce fog, but condense at once to large particles and at once fall as rain; when, however, dust or smoke particles are present in the air the minute spherules of fog are immediately formed around them as nuclei. He thinks that a law forbidding the importation of bituminous coal, and requiring the use of either coke or smokeless coal or gas, is the only method of preventing the London fogs that seriously injure the health of the inhabitants. (*Nature*, xxvi, p. 382.)

Cyon communicates to the Paris Academy the results of experiments on the action of high atmospheric pressure on the animal organism. He finds that oxygen is not a special poison for the organism. Animals die at high atmospheric pressure simply because the carbonic acid (the chief excitant of the vasomotor and respiratory centers), diminishes considerably the circulation and respiration, stopping the former because of too great lowering of blood pressure, and the latter because of apnea. The heart-beats are accelerated for the same reasons; the oxygen increases the action of the accelerating nerves, while the moderating action of the pneumogastric nerves is lessened through failure of carbonic acid. (*Nature*, xxv, p. 428.)

J. E. Clark states that since 1878 observations have been regularly made at thirty stations in Great Britain on the first appearance of buds, flowers, &c., of a selected series of thirty flowers. The detailed results have been published in the *Natural History Journal*. The averages for all these 900 observations of thirty plants at thirty stations give an accurate method of comparing the climates of the respective years. These averages are as follows, reckoning by days from January 1 onward: For 1878, 93; 1879, 115; 1880, 103; 1881, 111; mean of all, 105.3. He concludes that the weather during a given period is of less effect than that of the preceding months. It is to be earnestly recommended to amateur

meteorologists and lovers of botany that they keep a close and extensive record of the budding and blossoming of plants and buds in their neighborhood. (*Nature*, xxv, p. 553.)

Dr. Church communicates to the Royal Horticultural Society the results of experiments he has had made at Cirencester during the last fifteen years to ascertain the amount of salt in the rain brought by autumnal gales, especially from the southwest. He found from 5 to 7 grains per gallon, while the ordinary amount was only 5 grains. The average winter amount was but slightly in excess of the average summer quantity. He noticed that in Oakley Park one side of the trees was severely injured, and that, if no rain followed for a few days after the gale, the salt sparkled on the trees, even at a distance of thirty-five miles from the sea. The salt abstracted the moisture from the leaf-cells and formed a condensed solution, so that the leaf became completely dried up, and perished. Mr. McLachlan added that salt had been observed on windows at Lewisham, as at Croydon, and elsewhere. Sir J. D. Hooker remarked that Dalton was the first to record a similar fact at the beginning of this century. With regard to beeches withstanding the gale better than oaks, as mentioned at the last meeting, it was elicited that they were unhurt at Kew and Valewood, Haselmere, but at Cirencester, in Dorsetshire, and Cornwall, they suffered severely. Mr. Blackmoor exhibited foliage of pears, &c., from Teddington, some of which was quite unhurt; of other trees growing adjacent to them the leaves were much injured. Vines and peaches showed similar differences. He suggested that it could not be salt in this case. The opinion generally entertained was that such discrimination was due to the trees being relatively hardy and less hardy. (*Nature*, xxvi, 191.)

Rev. G. Henslow at the recent meeting of the Horticultural Society gave an account of the progress he had made in compiling statistics for a report on the meteorological phenomena of severe winters, and the consequent injury to plants. He had obtained particulars of severe winters from A. D. 220 to 1880; but those during which destruction of and injuries to plants had been specially recorded were the following eight: 1851-'52, 1852-'53, 1859-'60-'61, 1864-'65, 1878-'79, 1879-'80, 1880-'81. He had collected all the information he had at present been able to find with reference to these winters, and had drawn up first a short account of the principal meteorological phenomena of the year preceding each winter, as well as of the winter itself, as the behavior of a plant under frost so much depends upon its previous condition; in each case his tables give details of injuries to and losses of plant over as many places in the British Isles as possible. The importance of registering meteorological phenomena and the losses in several winters lay in the fact that the conditions of the winters respectively differed in many ways from one another. The consequence was that the immediate cause of plants succumbing to frost was not always the same. There would be an introduction, dealing with several interesting mat-

ters bearing on meteorology and plant injuries, and he proposed completing it with copious indices, so that no difficulty would be met in finding the exact behavior of every plant in any country and in any winter. A discussion followed, in which the great importance of elaborating the report as fully as possible, and of speedily publishing it, were insisted on. (*Nature*, xxv, 452.)

Professor Hunfalvi, as president of the physical section of the Hungarian Association for the Advancement of Science, made an important address upon the meteorology and forestry of Hungary. Owing to the immense consumption of wood for fuel in that country the destruction of the forest is proceeding in quantity. (*Nature*, xxvi, p. 457.)

Cornu has studied the direct absorption of atmospheric vapors and gases by the epidermis of the leaves and stems of plants, and finds that such absorption takes place directly without the necessity of a previous solution in water. Thus, growing grapes were exposed to the vapors of heavy oils distilled from coal tar, and the sense of taste easily detected the empyreumatic substances in the interior of the pulp and the peduncle. (*Nature*, xxv, 544.)

A. H. Swinton makes out a relation between sun-spot cycles and the appearance of rare species of lepidoptera. His observations are continuous from the year 1832 to 1875. For some species their maxima coincide with the maxima of sun-spots, but for other species the coincidence is with the minima of sun-spots. (*Nature*, xxv, 584.)

The effect of the temperature of the air on the pitch of the cricket's chirp is such that both rise together, and observations of temperature and pitch by Miss M. W. Brook closely verify a rule given by a writer in the Salem Gazette, namely: "Take 72 as the number of strokes per minute at a temperature of 60°, and for every 4 strokes more add one degree more of temperature; for every 4 strokes less deduct the same." We believe this is the newest item of connection between meteorology and entomology. It converts the chirping cricket into a natural thermometer. (*Nature*, xxv, p. 229.)

e VULCANOLOGY AND SEISMOLOGY.

Rev. O. Fisher has published in his work "On the Physics of the Earth's Crust" a valuable collection of facts and theories relative to the structure and history of the earth. Among other things, says Mr. E. Hill, it seems to be fairly well established that the contraction of the earth by cooling is inadequate to the production of its greater inequalities. The earth is not so homogeneous as required by the hypothesis of cooling from a molten globe. A plastic or fluid substratum best explains many facts of the present epoch. (*Nature*, xxii, 434.)

Many of Mr. Fisher's conclusions are, however, controverted by A. H. Green. (*Nature*, xxv, 481.)

The Seismological Commission of Switzerland have published, in French

and German, an excellent text-book on earthquakes, by Professor Heim, and have received a great mass of information in reference to the earthquake of December 29 to 31, 1879. Forel states that it consisted of three chief shocks and a dozen small ones. The first strong shock was experienced over an ellipse 200 miles long and 100 miles wide, whose axis was parallel to the main chain of the Alps. Its intensity at Geneva reached 7 on the scale of 10 proposed by Forel. The accurate observation of time, intensity, and direction of shock is the one thing necessary in order to advance our knowledge of the sources and causes of earthquakes. (*Nature*, xxv, p. 251.)

Prof. John Milne, of the Imperial College of Engineering, Tokio, has read before the Seismological Society of Japan a paper on the distribution of earthquakes in Japan. His work is based on observations of very many correspondents throughout Japan. He shows in a remarkable manner how a large mountain range absorbs earthquake energy, and again if instruments of ordinary sensitiveness could be used throughout Japan there would be on the average at least 1,200 earthquake shocks per year. (*Nature*, xxv, pp. 613, 614.)

Professor Milne publishes in the Japan Gazette a Japanese earthquake chronology extending from 295 B. C. to 1854 A. D. Notwithstanding the frequency of earthquakes in Japan the native chroniclers have always carefully recorded them. (*Nature*, xxvi, p. 17.)

Professor Milne says that, in 1879, he commenced a series of experiments with pendulums, microphones, and other apparatus, and special pains were taken to insure that the noises recorded were due to actual earthquakes, since the apparatus was so sensitive that a small pebble dropped upon the grass at a distance of several feet was easily heard in the telephone and recorded by a swing of the needle of the galvanometer. In fact, one of these pieces of apparatus was converted into a "thief detector" by arranging it so it rang a bell whenever tremors were produced by the footsteps of persons passing through the yard. The Japanese observers seemed to be animated by the hope that the study of these small tremors will ultimately enable them to predict the larger and more important ones. (*Nature*, xxvi, p. 125.)

In a report on the earthquake phenomena of Japan, Professor Milne states besides the several seismic centers within that island there are also several in the open sea outside that island. He describes the results of experiments as to artificial earthquakes, namely, the explosion of dynamite, the falling of a heavy iron ball, &c. (*Nature*, xxvi, p. 464.)

PHYSICS.

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GENERAL.

The year 1882 has witnessed a marked physical progress, which is nowhere so surprising as in the department of electricity. Of the four hundred and thirty titles noted for the preparation of these abstracts, two hundred and four, or nearly one-half, are upon subjects connected with electricity and magnetism.

In his inaugural address as professor of applied mathematics in Owens College, Manchester, Dr. Schuster considers the influence of mathematics on the progress of physics, tracing it from the time of Galileo, the founder of mathematical physics, on the one side, and of Baptista Porta and natural magic on the other, to the union of the two in the science of to-day. He says: "The most important of all the functions of mathematical physics, and perhaps the only one through which mathematics has had an unmitigated beneficial influence on the progress of physics, is derived from its power to work out to their last consequences the assumptions and hypotheses of the experimentalist. All our theories are necessarily incomplete, for they must be general in order to avoid insurmountable difficulties. It is for the mathematician to find out how far experimental confirmation can be pushed, and where a new hypothesis is necessary." (*Nature*, February, 1882, XXV, p. 397.)

Roche, in a memoir upon the internal state of the terrestrial globe, proposes the hypothesis that the earth is composed of a solid nucleus covered with a less dense layer, partially liquid, perhaps, to a certain depth. (*Mem. Acad. Sci., Montpellier*, 1881; *J. Phys.*, October, 1882, II, I, p. 462.)

Sir William Thomson has called attention to a thermodynamic acceleration of the earth's rotation, due to the action of the sun upon the terrestrial atmosphere. He concludes that, in the course of a century, a chronometer B (regulated to sidereal time day by day and year by year) would be in advance of a chronometer A (regulated to sidereal time at the commencement of the century, and keeping absolute time since) by 2.7 seconds in virtue of this thermodynamic acceleration, and behind it by 25 seconds in consequence of the retardation due to the tides, the

final result being a loss of 22.3 seconds, agreeing with that given by Adams. (*J. Phys.*, February, 1882, II, I, p. 61.)

Sherman has studied the effect of the support on the oscillations of a pendulum. The decrement of the arc could not be represented by a smooth curve, and, on examination, it was found to be due to small movements of the stand not synchronous with those of the pendulum. This resulted in one case from the nature of the ground on which the stand rested, in another from the varying tightness of the joints of the stand due to the dryness of the wood, and in a third from the vibration of a clock on the same wall. (*Am. J. Sci.*, September, 1882, III, XXIV, p. 175.)

Jolly has applied the balance to the determination of the mean density of the earth. To each arm of the balance a rod 21.5 meters long was attached, carrying pans at the upper and lower ends. The weights were balls of glass filled with mercury and weighing 5 kilograms. Two of these weights were placed in the upper pans, and equilibrium obtained by adding weights, the displacement being observed by means of a mirror, scale, and telescope. One of the weights being transferred to the lower pan, its weight was found to be increased by 31.713 milligrams. Introducing, now, a sphere of lead 0.995 meter in diameter and weighing 5,775.2 kilograms, beneath the lower pan, the increase of weight was found to be 32.059 milligrams, a mean difference in a series of experiments of 0.589 milligram. From this the mean density of the earth is calculated as 5.692, a number higher than that usually given, but correct probably for the locality (Munich). (*J. Phys.*, May, 1882, II, I, p. 231.)

Wolf has carefully examined and identified the various standards of weight and measure which are deposited in the Observatory of Paris. These are: 1st, the standards known as "la toise du Pérou," and "la toise du Nord," both in excellent condition; 2d, the four compound rules of copper and platinum used for measuring bases, the pendulum rule of Borda and Cassini, a meter and double meter in iron, and one of the four original standard meters of platinum, the others being the meters of the Archives, of the Conservatoire, and of the Commission des Ponts et Chaussées, respectively; 3d, two of the four original platinum kilograms, the others being the kilogram of the Archives, and the kilogram of the Conservatoire; and 4th, the four-meter copper rule of Lenoir used by Lavoisier, Borda, and the Commission of 1798 in comparing the toises and standardizing the meter. (*J. Phys.*, June, 1882, II, I, p. 252; *Ann. Chim. Phys.*, January, 1882, V, XXV, p. 5.)

Wead has suggested a simple mode of changing the gear of an ordinary screw-cutting lathe so as to allow threads of one millimeter pitch to be cut by it. It is based on the assumption that one inch equals 25.4 millimeters; which differs from the fact by only $\frac{1}{110000}$ part. The lathe is first geared so as to cut a screw of 20 threads to the inch, a gear of 100 teeth being on the feed-screw. Then this gear of 100 teeth is re-

placed by one of 127, and the pitch will be one millimeter. (*Am. J. Sci.*, March, 1882, III, XXIII, p. 176.)

Mascart has experimented with a new form of apparatus devised to determine variations in the intensity of gravity at different places by noting the height of the mercury column which balances the elasticity of the same mass of gas at a constant temperature. It resembles a siphon barometer, but the shorter leg is closed, confining above the mercury within it, carbon dioxide gas. The longer leg is open and contains a meter column of mercury. The author believes it will compare favorably in sensibility with the pendulum. (*Comptes Rendus*, July, xcv, p. 126.) In a subsequent communication, Mascart gives the results of some measurements taken with this gravity barometer at various places in the north of Europe, confirming his previous opinion. (*Comptes Rendus*, October, xcv, p. 631.)

An ingenious deep-sea sounding apparatus has been devised by a Russian naval officer. It consists of a piece of lead, a small wheel with a contrivance for registering the number of revolutions, and a float. As the apparatus sinks, the wheel revolves and registers the depth. On reaching the bottom the lead is detached and the float brings the rest of the instrument to the surface. (*Nature*, March, 1882, xxv, p. 471.)

MECHANICS.

1. *Of Solids.*

Greenhill has determined mathematically the greatest height consistent with stability that a vertical pole or mast can be made, and the greatest height to which a tree of given proportions can grow. He finds, for example, that 90 meters is the maximum height for a pine tree half a meter in diameter at the base. (*J. Phys.*, July, II, I, p. 337.)

Colson has observed that the increase of carbon absorbed by a new iron disk when heated in charcoal over one already partially carburized, is only apparent, being due to the reaction of the iron upon the carbonous oxide. Hence, on heating, oxygen is evolved. For a given temperature, therefore, he maintains that the coefficient of diffusion of carbon into iron is constant; at least until the limit for steel has passed. Silicium diffuses with great ease also. A platinum wire, immersed in lampblack which was proved to be free from silica, placed in an earthen crucible, was found to be silicified after the whole had been heated in a forge fire; and the lampblack, on burning, left a residue of white silica. On longer heating, the platinum becomes brittle and acquires the composition Si Pt_2 . If silica be mixed with the lampblack a still higher compound, $\text{Si}_2 \text{Pt}_3$, results, having a density of 14.1, and fusing at the same temperature as ordinary glass. The author believes that the silica diffuses as such and not as silicium. Iron heated with a mixture of silica and carbon gives a crystalline silicide of density 6.6, containing 15 per cent. of silicium. Colson considers that silicium may be gaseous; as

Berthelot supposes carbon to be. (*Comptes Rendus*, January, XCIV, p. 26.) In a note following this paper Violle mentions a fact observed by him in 1878, while melting some palladium, which shows the ready diffusibility of carbon. The crucible used was of porcelain, supported in an outer one of plumbagine. After heating to 1500° , this porcelain crucible was so permeated with carbon as to have exteriorly the appearance of a carbon crucible. The depth to which the plumbagine penetrates is proportional to the time of heating. (*Comptes Rendus*, January, XCIV, p. 28.)

Marsden has made use of this ready diffusion of carbon in his theory of the cementation process. He believes that the carbon in the state of impalpable powder diffuses into the bars of iron during the heating, when they are expanded and softened, thus converting them into steel. (*Ann. Chim. Phys.*, August, V, XXVI, p. 568.)

Spring has submitted to compression the variety of sulphur obtained in vesicles by Saint-Claire Deville, which is insoluble in carbon disulphide. Under a pressure of 8,000 atmospheres at 13° hard pale yellow blocks were produced, 4.21 per cent. of which was soluble in carbon disulphide and had been therefore transformed into the octohedral variety. Hence the density of the vesicular sulphur is less than that of octohedral sulphur. By obtaining the specific gravity of these blocks at different temperatures, Spring measured the expansion and calculated for vesicular sulphur the density 1.960, the same as prismatic sulphur. It expands regularly up to 43° , then contracts again, so that at 80° it has the same specific gravity as at zero. (*Nature*, January, 1882, XXV, p. 231.)

Kayser has studied the condensation of gases on the surfaces of solids, a phenomenon to which he gives the name "adsorption." The gases used were carbon dioxide, sulphurous oxide, and ammonia, and the adsorptive effect was noted (1) in the empty glass vessel, (2) in the same filled with coarsely pounded glass, (3) in the vessel filled with brass and wrought-iron turnings. By noting the pressure produced in the vessel by a given volume of gas, the adsorption was determined. With the solids given it was in the order: empty vessel, iron, brass, glass powder. Sulphurous oxide was least condensed by the empty vessel, most by the glass powder. On the empty vessel, CO_2 was condensed equally with NH_3 ; on the metallic surfaces equally with SO_2 ; and on the glass surfaces less than either. (*Wied. Ann.*, xv, p. 634; *Nature*, June, XXVI, p.139.)

Berthelot has investigated the absorptive action of platinum for oxygen and hydrogen gases, and shows that a suboxide and two hydrides are produced by it. The so-called catalytic action of platinum is therefore due to a definite reduction which takes place in presence of oxygen and of hydrogen, water being formed. The inflammation of a mixture of oxygen and hydrogen by platinum is due to the formation

of the least stable hydride, and its reduction by oxygen, both processes evolving heat. (*Comptes Rendus*, May, xciv, p. 1377.)

Debray has examined certain alloys of zinc with the platinum metals which are peculiar. That with osmium takes fire almost explosively on heating to 300° C. The alloys of rhodium and ruthenium, but especially iridium, suddenly evolve a large amount of heat when raised to the same temperature. The author regards these changes as physical, isomeric modifications being produced with the evolution of heat. (*Comptes Rendus*, June, xciv, p. 1557.)

2. Of Liquids.

Koch has determined the influence of temperature upon the constant of internal friction of mercury, measuring the time required by a given quantity of mercury to pass through a capillary tube from one reservoir to another under a known pressure and at a determined temperature. The result shows that this constant, like that of other liquids, diminishes as the temperature rises, at first rapidly, then more slowly, according to an equation given in the memoir. The numerical values agree with those previously obtained by Warburg. (*Wied. Ann.*, xiv, p. 1; *J. Phys.*, April, II, I, p. 186.)

In the report for 1881, Bjerknæs's hydrodynamic apparatus was mentioned. Bertin has given a much fuller account of it, illustrated with woodcuts. (*Ann. Chim. Phys.*, February, V, xxv, p. 257.)

Decharme has repeated these experiments and has extended them, using in place of pulsating or vibrating bodies currents in air or water, either continuous or interrupted. Modifying the old experiment of Clement Desormes, in which a disk is attracted when placed close to a jet of gas thrown normally against it, by employing a jet of water, the author finds a tin plate a square decimeter in area strongly attracted when placed 2 or 3^{mm} from the aperture. With liquids only one disk is required, and this is fixed, the jet being movable. When held 4 or 5^{mm} from the plate the attraction is very decided. This the author calls a hydro-electro magnet. Using two tubes, one with a thick edge and the other with a thin one, the phenomenon of an electro-magnet with two unlike poles is obtained. Hydro-induction the author has also produced. (*Ann. Chim. Phys.*, April, V, xxv, pp. 554, 570.)

The extremely discordant results of experiments to measure the coefficient of diffusibility of liquids has led to new determinations by Wroblewsky, using a photometric method. Using solutions of chemically pure salt, of three different densities, he finds that for a given time and within the limits of concentration indicated, the coefficient of diffusibility diminishes proportionally to the quantity of salt in solution. (*Wied. Ann.*, xvi, p. 606; *J. Phys.*, January, II, I, p. 39.)

Martini produces diffusion figures by the following means: In a glass vessel two liquids are placed, of nearly the same density; as, for example, water and a solution of salt or sugar. They are left at rest for

an hour. Then a capillary tube entering the bottom of the vessel is connected by a rubber tube with a moveable vessel of colored alcohol. As this alcohol enters the vessel through the capillary tube it rises as a thin spiral thread, spreading into fine tree-shaped figures on reaching the lighter liquid. If the heavier liquid be used in place of the alcohol, umbrella-shaped figures are produced. (*Nature*, July, xxvi, p. 309; *J. Phys.*, November, II, I, p. 520.)

Wrightson and Roberts have communicated further results on the density of liquid metals obtained with their oncosimeter. They obtained for copper 8.217, lead 10.37, tin 7.025, zinc 6.487, silver 9.51, iron (No. 4 foundry, Cleveland) 6.88. (*Nature*, February, 1882, xxv, p. 355.)

The specific gravity of melted steel has been determined by Alexijew by Petruschewsky's method. An open porcelain tube was immersed in liquid steel to a given depth, and air was forced into it until it bubbled up through the melted mass. By means of an attached manometer, the pressure was read off; and knowing this and the depth the density is easily computed. It was found to be 8.05, and therefore greater than solid steel. (*Nature*, June, 1882, xxvi, p. 138.)

Angström has studied the increase in volume produced when water absorbs a gas, using for this purpose air, nitrogen, carbonous oxide, oxygen, hydrogen, and carbon dioxide. For each of these gases the increase in volume was proportional to the quantity of gas absorbed. Calling the increase in volume which a liquid undergoes in absorbing unit volume of a gas—the coefficient of expansion by absorption, he finds this value to be for N 0.00145, air 0.00140, CO 0.00127, O 0.00115, H 0.00106, CO₂ 0.00125, HCl 0.00097, NH₃ 0.00077, and SO₂ 0.00091. (*Wied. Ann.*, V, xv, p. 297; *J. Phys.*, June, II, I, p. 288.)

Leconte has called attention to the very general error in physical text books concerning the attraction and repulsion of small floating bodies, and has given the true theory of the phenomenon founded upon the surface tension of the liquid, and involving the two fundamental principles of capillarity, viz, 1st, that the elastic reaction is inversely proportional to the radius of curvature of the meniscus; and 2d, that the same contractile reaction tends to reduce the perimeter to the smallest which can be inclosed by its actual boundary. (*Am. J. Sci.*, December, III, xxix, p. 416.)

Plateau has described to the Belgian Academy a capillary arrangement which seems at first capable of realizing a perpetual motion. A capillary tube is inserted obliquely in distilled water so that the latter nearly fills it. Into this liquid column at the top dips the small orifice of another tube, which reaches a little way in the same oblique direction, then turns downwards, the vertical portion being wider, and not reaching the water. Suppose this bent tube filled with water. It then forms a siphon, the shorter branch of which is immersed in a liquid in equilibrium, while the longer descends several centimeters below the surface of that liquid. It appears, therefore, as though the water should

flow incessantly through the siphon, and regaining the vessel be engaged in perpetual circulation. As a matter of fact, however, the water is drawn upwards in the vertical portion of the tube, until its free surface reaches a certain portion of the oblique part of the same tube, when it stops. The author accounts for these results by suction, exerted by the small concave liquid surface between the two tubes. (*Nature*, April, xxv, p. 614; *Phil. Mag.*, May, V, XIII, p. 379.)

Wroblewsky has studied the influence which the quantity of gas dissolved in a liquid has on its superficial tension, and concludes that, in the case of carbon dioxide, there is a remarkable relation between the laws of its solubility in water and the superficial tension of the liquid. This relation he expresses thus: 1st. The product of the surface tension α by the pressure P under which the gas is confined, is proportional to the coefficient of saturation S , which corresponds to this pressure. 2d. The pressure remaining constant and equal to n atmospheres (n being greater than unity), it results from the laws of solubility that the quotient

$$\left(\frac{S}{P}\right)_{p=n} \div \left(\frac{S}{P}\right)_{p=1}$$

diminishes with the lowering of the temperature. Experiment shows that in this case the ratio of the tensions corresponding to these pressures diminishes also. (*Comptes Rendus*, August, xcv, 284.)

Sresnevsky has measured the cohesion of aqueous solutions of zinc chloride by the two methods of Quincke: 1st, measuring the height of the liquid in a capillary tube; and 2d, observing the flat bubbles of air on the surface of the liquid, covered with a glass. As a mean he finds that the cohesions respectively of 8.00 mgrms., of 8.77 mgrms., and of 8.71 mgrms. correspond to solutions of 83 per cent., 46 per cent., and 20 per cent. of chloride of zinc. (*J. Soc. Phys. Chim. Russe*, XIII, p. 242; *J. Phys.*, December, II, I, p. 576.)

Elie has contrived an apparatus for studying the laws of the flow of liquids in tubes, which is at once simple and sensitive. It is a sort of Wheatstone's bridge; the liquid coming from a reservoir divides and passes through the two tubes to be compared. At the point where they join the main tube two other tubes pass toward each other and terminate in a flask, a thin film of metal being suspended between their ends. If the two branches are identical in resistance, there is no flow through the lateral tubes, and the film remains motionless. Hence when the film is motionless the same quantity of liquid passes through each tube. The same arrangement acts admirably with gases. (*J. Phys.*, October, II, I, p. 459.)

A rheometer for measuring currents of water, at different depths, has been devised by Scardona. The water current acts on two screw vanes on a horizontal shaft in a case attached to a vertical rod. A flat vane keeps this shaft parallel with the current, and at intervals it actuates, by means of an endless screw and wheel-work, a lever attached to

a rubber capsule at the end of a metallic tube, through which, and the attached flexible tube, the resulting pulses pass to the portable signal bell. The apparatus is compact and easily adjusted. (*Nature*, January, 1882, xxv, p. 290.)

3. *Of Gases.*

Hannay has made an extended series of experiments to obtain an absolutely vacuous space and to test the hypothesis that ordinary matter, and not the ether, is the medium by which radiation is propagated. He finds that not only is there a closely adherent layer of gas on every surface, but that the gas seems, even at ordinary pressures, to penetrate into or combine with the surface of the glass, and that it is with extreme difficulty that even a portion of this gas is driven off, the greater portion remaining fixed even to the softening point of the glass. In order to avoid the very appreciable tension of mercury vapor, fusible metal was substituted, the barometric height of which was 41 inches. Various forms of Springel pump were constructed for use with this alloy, the fusing point of which was 94° C. After the highest possible vacuum had been attained, one of the bulbs was surrounded with calcium chloride and snow, and the other interposed between a standard candle and a radiometer; but no effect was perceptible. In a mercury vacuum of $\frac{1}{230000000}$ measured by the McLeod gauge, the Holtz spark passed; but when fusible metal was used it failed, even when 12 Leyden jars were used. The 12-inch spark of an induction coil also failed to pass. Nevertheless, such a vacuum still contained air obstinately retained by the glass. To obtain a real vacuum the author proposes glass bulbs formed of hard glass without and soft glass within, so that they can be heated up to the softening point of the latter and preserve their shape. (*Phil. Mag.*, April, 1882, V, XIII, p. 229.)

Kraievitch has sought to establish the hypsometric formula by direct observation, and at the same time to ascertain whether gases have a limit of elasticity. Two baro-manometers were used, one on the ground and the other on the top of a high building, or even on the summit of a neighboring hill, their manometric branches being connected by a long metallic tube. On rarefying the air in this tube the lower instrument will always indicate a higher pressure than the other. (*J. Phys.*, December, II, I, p. 577.)

The same author has communicated to the Russian Physical Society the results of his researches on the elasticity of air, showing that rarefied air does not obey the Boyle-Mariotte law, its elasticity diminishing more rapidly than its density in proportion as it becomes more rarefied, becoming equal to zero while yet the density has a measurable value. It results from these experiments; first, that the earth's atmosphere is limited; and second, that our weights of gases contain an error, since, however perfect the pneumatic machine, it cannot pump all the air

from a vessel if the vessel is lower than the machine; *i. e.*, if the air is pumped from above. The author, by the advice of Mendeleeff, is continuing his researches upon heavy gases. (*Nature*, December, XXVII, p. 183.)

Amagat also has experimented upon the elasticity of rarefied gases and comes to a different conclusion. He says: "All that can be said is that under the feeblest pressures that can be produced (one millimeter or less, though I have obtained 0.2 millimeter) there does not appear to be produced any sudden change in the law of the compressibility of gases; they follow still the law of Mariotte, within the limits of experimental error." (*Comptes Rendus*, August, XCV, p. 281.)

Delacy has invented a barometer which records automatically the variations on an enlarged scale. The tube, which has a capacious reservoir at the top, is fixed, and opens into a cistern nearly as long, made of a somewhat wider tube. This cistern carries on one side an index, and on the other a pencil working on a moving cylindrical surface. It forms the upper part of a kind of areometer, the lower part being closed and floating in mercury in a still wider tube connected with a reservoir kept at constant level. The variation of pressure is marked by the variation of the height of the mercury in the reservoir, and this latter is to that of the total height in the barometric cistern (or to the path of the float or of the pencil) in the ratio of the section of the cistern to that of the reservoir (about a sixth in the author's instrument), thus realizing an amplification. (*Nature*, January, XXV, 1882, p. 290.)

Dafour and Amstein have devised a registering barometer, now in use in the Lausanne Meteorological Observatory, depending on the displacement of the center of gravity of a glass tube containing mercury. The form of the tube may be described as that of an **L** leading down to a **U** by a vertical portion, the lower end being open. The tube swings in the plane of its angles on a horizontal axis placed above the center of gravity; with increased barometric pressure it inclines to the right, with decreased pressure to the left, and these movements are recorded by means of a style attached to the **U** part and applied to a moving strip of paper. By a simple contrivance the pendulum of a clock is made to impart a slight shock every second to the tube so as to destroy any adherence of the mercury. (*Nature*, February, XXV, p. 374)

Joly has described a barometer, the readings of which may be made electrically at a distance from the instrument. It requires but two wires and reads to one-fiftieth of an inch. (*Nature*, April, XXV, p. 559.)

Brown has given a *résumé* of the progress of the barometer and the various forms it has undergone, in which, however, the excellent form of instrument designed some years ago by Daniel Draper, and used in the Central Park Meteorological Observatory, is not mentioned. (*Nature*, July, XXVI, p. 282.)

Cailletet has suggested a new pump for condensing gases, in which

the cylinder is inverted and the solid piston is covered at top with mercury, thus avoiding all waste space. At each stroke it compresses one-third of a liter of gas, and its capacity is such that a condensation to two hundred atmospheres may be attained. Lubrication is effected by vaseline. (*Comptes Rendus*, March, XCIV, p. 626; *J. Phys.*, October, II, I, p. 449.)

Amagat has plotted the curves of the compressibility of nitrogen, obtained in his experiments and in those of Cailletet, with pressures as abscissas and the products pv as ordinates. That of Amagat is a smooth curve, while that of Cailletet has a deep point of inflection at a pressure of sixty meters of mercury. Amagat criticises the apparatus of Cailletet as inaccurate. (*Comptes Rendus*, October, XCV, p. 638.)

Hautefenille and Chappuis have liquefied ozone by subjecting it, mixed with oxygen, in a Cailletet pump, to a pressure of 125 atmospheres, the tube being recurved and immersed in a jet of liquid ethylene, which cooled it probably below -100° C. The ozone was obtained in liquid drops of a dark indigo-blue color, which may be preserved for some time even under atmospheric pressure. (*J. Phys.*, November, II, I, p. 493.)

Neyreneuf has extended the formula of Bernouilli for the flow of gases through orifices in thin plates to the case where the flow is simultaneous through two orifices at different levels. He has obtained a very sensitive gas level in this way, a new sort of chemical harmonicon, as well as new sensitive flames. (*Ann. Chim. Phys.*, February, V, XXV, p. 167.)

Ville has devised a gas regulator which is independent of the pressure. It consists of a U tube containing mercury, communicating on one side with the space where the pressure is to be kept constant, and on the other with the reservoir where the gas is compressed. If the pressure falls in the former, the mercury rises in the tube and makes electrical contact by means of a nickeled-steel wire, thus sending a current through an electro-magnet which controls a valve, thus lifting the valve and allowing gas to pass from the reservoir into the other vessel. Then the column of mercury falls, the contact is broken, and the valve closes. The apparatus used by the author will withstand a pressure of 15 atmospheres and controls the pressure within one-quarter of a millimeter of mercury. (*Comptes Rendus*, March, XCIV, p. 724; *J. Phys.*, July, II, I, p. 327.)

Berthelot and Vieille have determined the velocity of gaseous explosion through tubes. They find as a mean that in a mixture of electrolytic oxygen and hydrogen this velocity is 2,810 meters, and in a mixture of carbonous oxide and oxygen 1,089 meters per second. Curvature of the tube did not change the value, nor did alteration of the material of which it was made. The velocity was the same whether the tube was open or closed, is uniform throughout its length, and is inde-

pendent of the pressure. (*Comptes Rendus*, January, March, XCIV, pp. 101, 822; *Nature*, May, XXVI, p. 44.)

Colladon shows to his classes the resistance of the air in guns in the following way: The reservoir of an air-gun is fully charged with compressed air, and the gun is loaded as usual, the ball nearly fitting the bore. Placing the barrel vertical, and closing the mouth firmly with his thumb, the gun is fired by an assistant; the thumb remains in position and the ball is heard to fall back in the barrel. Then, using the same ball, he fires with the same gun and pierces a pine board 0.4 inch thick. If the barrel of the gun is more than 32 inches long, and the ball is spherical and nearly fills the tube, and if the operator is sure of the strength of his thumb, the experiment is without danger. (*Nature*, August, XXVI, p. 353.)

Melsens has made a study of experimental ballistics, with a view to determine the influence of the air. He finds that the air which accumulates in front of the projectile forms a layer there capable, in the case of high velocities, of preventing the immediate and absolute contact of the two solid bodies, especially at the point of impact, the incidence there being normal. (*Ann. Chim. Phys.*, March, V, XXV, p. 389.)

Stroh has repeated the experiments of Bjerknæs on vibratory attraction and repulsion, but has made use of air instead of water as the medium. Moreover, he has investigated the condition of the air between the vibrating drums by inclosing these in a closed space furnished with an alcohol manometer. When the phase of vibration was the same for the two drums, the manometer showed an increase of pressure, the air being expelled from between them; while when the phase was opposite, the alcohol rose in the manometer tube. Further, the space between the drums is crossed by lines of pressure practically identical in direction with those which Faraday showed in a magnetic field by means of iron filings. (*Nature*, June, XXVI, p. 134.)

Kraievitch has shown that the rarefaction obtained by means of a mercury pump is limited, the air being replaced by mercury vapor, the tension of which is a function of the temperature but at ordinary temperatures is 0.02 millimeter. To show the influence of cold on the vacuum he made a Geissler tube with a cylindrical appendage of glass, the whole being exhausted by means of steam, as in the case of the water hammer. At ordinary temperatures the spark passed as a luminous line; but on cooling the appended cylinder to -20° the light became stratified and filled the tube. He doubts the possibility of getting a vacuum as high as 0.00004 meter, as Crookes claims, since the McLeod gauge measures only the elasticity of a permanent gas. The author describes some improvements which he has made in Mendeleeff's pump. (*J. Soc. Phys. Chim. Russe*, XIII, p. 335; *J. Phys.*, December, II, 1, p. 578; *Nature*, February, XXV, p. 377.)

Chancel has contrived a simple apparatus for determining the density of gases in order to fix their molecular weight as a control in chemical

operations. It consists of a flask of 200 to 250 c. c. capacity, whose neck carries a lateral tubulure of small diameter, and is closed by a hollow stopper carefully ground, which terminates in a straight tube carrying a stopcock. From the side of this hollow stopper a tube passes, attached to its interior, and long enough to reach to the bottom of the flask. By rotating the stopper the opening into this tube may be brought opposite the lateral tubulure. The volume of the flask having been determined, the gas is introduced by the lateral tubulure until all the air is displaced. The stopper is then turned, the barometer and thermometer noted, and the balloon weighed, a similar flask being used as a counterpoise. The results given show very considerable accuracy. (*Comptes Rendus*, March, xciv, p. 626.)

ACOUSTICS.

Martini has studied the production of sound by the flow of liquids. He used in his experiments long tubes of glass, two to six centimeters in diameter, closed at the lower end by metallic disks two to three millimeters thick, each pierced with a hole in the center, the diameter of which was equal to the thickness of the plate. On filling such a tube with water and allowing it to flow out through the plate, sounds are produced like those of an organ pipe. As the water falls the sounds do not fall uniformly in pitch as with the syren; only a certain number of definite sounds are produced, as is the case with an organ pipe. Martini's results, which confirm essentially those of Savart, furnish a method for determining the relative velocity of sound in two liquids. By noting the lengths of two columns which yield the same note, the velocities are obtained, since they are proportional to these lengths. For alcohol of 36° the velocity was 1,288.5 meters; for absolute alcohol, 1,232.05 meters; for ethyl ether, 1,144 meters; and for petroleum of density 0.800, 1,354 meters. (*J. Phys.*, November, II, I, p. 574; *Nature*, December, xxvii, p. 183.)

Leconte has discussed the question of the production of sound shadows in water, which, as proved by the classic experiments of Colladon in 1826 in the lake of Geneva, are more sharply defined than when produced in air. In 1874 a series of experiments was made by his son, L. I. Leconte, during the blasting upon Rincon rock, in the harbor of San Francisco. He found that soda-water bottles plunged in the water about 40 feet from the explosion were invariably protected when in the geometric shadow of a vertical pile about a foot in diameter, while they were as uniformly broken when placed on the opposite side. Stout glass tubes placed horizontally showed by their fracture the lines of this shadow. The author supposes, in accordance with theory, that the waves produced by such an explosion must be very short in order to produce these sharp shadows. (*Am. J. Sci.*, January, III, xxiii, p. 27; *Phil. Mag.*, February, V, xiii, p. 98; *J. Phys.*, September, II, I, p. 420.)

Decharme has applied the principles of attraction and repulsion pro-

duced by the flow of liquids from orifices according as the walls are thick or thin, to the construction of a tuning fork which he calls a hydrodiapason. It is formed of a tube of brass 0.5 meter long, 6 millimeters in interior diameter, and 1 millimeter thick, curved into an elongated U, the branches being 6 centimeters apart. On the convexity of the curve is an opening through which connection is made with the water supply. The extremity of each branch is bent so that the ends open exactly opposite each other. To these, disks or ajutages of any form may be attached. When the current of water flows, the fork takes a regular rate of vibration and gives a clear note. In water the tone given was *la* (217.5 vibrations), and the first harmonic was plainly heard. (*Comptes Rendus*, October, xcvi, p. 597.)

Pinto has studied the function of two ears in determining the direction of sounds, and concludes, 1st, that we are able to judge of the direction from which a sound comes because it reaches one of the ears first and then the other, the interval of time being longer or shorter according to the position of the sounding body; and 2d, that the second ear enables us to determine the direction in which the intensity of the sound perceived is a maximum without turning the head. (*J. Phys.*, December, 11, 1, p. 561.)

Stanley has presented to the London Physical Society a paper on tuning-fork vibrations. He showed that disks on the prongs of a heavy fork do not produce as loud a sound when the fork vibrates as does its resonator; that vibration down the stem of the fork does not, as Chladni supposed, depend on a vibrating ventroid, since a fork cut in the end of a solid steel bar communicated sonorous vibrations equally well to the resonator. Since to set a fork vibrating only one prong need be bowed, it is evident that the vibration must proceed along the prongs. A light fork, a meter long, shows the passage of the vibrations down one prong and up the other. When the prongs of a powerful fork are tipped with pieces of metal dipping in mercury, the mercury is thrown into ripples which can be thrown on a screen. (*Nature*, June, xxvi, p. 166.)

Koenig has published in book form the valuable researches in experimental acoustics which he has made during several years past. The most recent and one of the most important of his investigations is that undertaken to determine the influence of phase on the quality of tone. He finds that, contrary to the theory of Helmholtz, there is a distinct difference in tones containing identically the same upper partials when the phase differs. The sound is louder and more forcible when this difference is one-fourth, gentler and softer when three-fourths. By means of a specially-constructed wave-siren he has elaborately studied these phenomena. (*Quelques Expériences d'Acoustique*, Paris, 1882; *Nature*, June, July, xxvi, pp. 203, 275; *J. Phys.*, December, 11, 1, p. 525.)

Neyreneuf has contrived a sensitive flame without an inclosing tube. This is attained by causing two flames to impinge the one upon the

other, or a single flame to strike upon a current of air. To avoid tedious adjustment, however, he prefers the following: A brass tube 25 centimeters long and 33 millimeters in diameter is supported vertically. By an opening at bottom a flame from a jet, having an opening which is 2 millimeters in diameter, is projected horizontally across the tube. By impact against the opposite wall of the tube, aided by the air current, very pure sounds are produced. (*J. Phys.*, October, II, I, p. 461.)

Decharme has studied the vibratory forms of circular liquid surfaces, and finds very close analogies between these and those of soap films. They are excited and observed similarly, and have the same system of nodal points. The determination of internodal distances is more difficult with liquids, since they are only one-sixth as great. But the laws are the same; the distances of the internodes are inversely proportional to the number of vibrations. (*Ann. Chim. Phys.*, January, V, XXV, p. 112.)

Kolacek has investigated mathematically the theory of resonance, and has demonstrated that the conductivity of gases for heat has only an exceedingly minute influence on the number of vibrations made by the gas confined in a resonator. With a Helmholtz resonator, making 198 vibrations a second, the sound is lowered only 0.152 vibration, an unimportant amount. (*Wied. Ann.*, XII, p. 353; *J. Phys.*, January, II, I, p. 58.)

Hurion has proposed to determine the position of the nodes and loops in an organ pipe by means of a tube introduced into the pipe, this being in communication with a manometric capsule. (*J. Phys.*, March, II, I, p. 136.)

Serra-Carpi has made use of the microphone for fixing the position of the nodes and loops in vibrating columns of air. Upon a membrane stretched on a metal ring a small carbon microphone is placed. When at a node a loud rattle is heard in the connected telephone; when at a loop the sound is feeble. (*Comptes Rendus*, January, XCIV, p. 171.)

Lecote Stevens has combined the organ pipe with the sonometer, forming an instrument which he finds very convenient for the exhibition of Bernoulli's laws, and for the study of upper partial tones and musical scales. (*Am. J. Sci.*, June, III, XXIII, 479.)

Bourbouze has proposed the use of a sounding board furnished with strings, upon the back of which is a carbon microphone, as a telephone transmitter. (*Comptes Rendus*, January, XCIV, 76.)

Hartmann has devised several new pieces of acoustic apparatus. The *motorophone* consists of a shaft carrying an eccentric communicating by means of a rod with a membrane. It converts rotary motion into sound, the pitch being determined by the speed, and the intensity by the throw of the eccentric. A bell mouth strengthens the tones. The *phonomotor* acts on the opposite principle, producing rotary motion from vibration. In the *electromagnetophone* a piece of sheet-iron under an electro-magnet has a point dipping in mercury; a current passing through the coils and the point is rendered intermittent, and the membrane sounds. The *electro-magnetic membrane syren* is similar, but has a solid sliding contact

in place of the mercury, a driving wheel producing rapid interruption. When a tuning fork is supported so as to be capable of rotation before a resonance case, it gives a strong resonance or a weak interference tone according to its position, the latter being higher. On rotating, the former becomes the higher and the dissonance increases. A *resonance interference pipe* is made by connecting the nodes of an open pipe with a rubber tube. By pressing this tube the pitch of the pipe is altered. (*Wied. Beibl.*, No. 3; *Nature*, June, XXVI, p. 138.)

HEAT.

1. *Production of Heat ; Thermometry.*

Haga has investigated the variations of temperature which are produced when metallic wires are submitted to traction. The wire was stretched horizontally, one end being attached to the vertical arm of a bent lever, the tension being produced by weights on the horizontal arm. The temperature was measured by a thermo-electric couple, one of whose elements was the wire itself, and the other a wire of another metal wound round the first. A steel wire 1.6^{mm} and a wire of German silver 1.5^{mm} in diameter were used, the auxiliary wire being of platinum 0.08^{mm} thick. With a tension on the steel wire of 21.715 kilograms the increase of temperature was 0.1054°; the tension of 17.134 kilograms on the German silver wire gave 0.1429°. The heating with the latter wire was proportional to the stretching weight. From the data thus obtained, Haga determined the mechanical equivalent of heat and obtained for the steel wire 437.8, and for the German silver 428.1. (*Wied. Ann.*, V, XV, p. 1; *J. Phys.*, September, II, 1, p. 425.)

Holman has suggested a simple, accurate, and ready method of calibrating thermometers, which requires one-third to one-half the time of the method of Neumann, with equal accuracy, and is fully one-third shorter and somewhat more accurate than that of Piekering. Two calibrations of a Baudin thermometer, using threads of mercury of 3 and 5^{cm} respectively, each with only one series of observations, requiring an hour and a half for completion, gave results whose average difference at 9 points was 0.04^{mm}, the arithmetical sum of the extreme differences being 0.12^{mm}. (*Am. J. Sci.*, April, III, XXIII, p. 278.)

Michelson has described an air thermometer whose indications are independent of the pressure of the air. It consists of a glass bulb 4^{cm} and a stem 2^{mm} in interior diameter, the bulb containing dry air at a pressure of about 100^{mm} of mercury, this air being separated from the upper portion of the tube by a column of mercury about 100^{mm} in length. This mercury remains above the air, notwithstanding the large diameter of the bore, owing to the resistance of the meniscus to deformation. The space above the mercury is a vacuum. The pressure of the air in the bulb is constant and equal to that of the column of mercury above it. (*Am. J. Sci.*, August, III, XXIV, p. 92.)

Michelson has also devised another form of thermometer of great sensitiveness, based on the high expansion coefficient of hard rubber. A very thin strip of this substance is fastened to a similar strip of brass 5^{mm} long, 1^{mm} wide, and about 0.1^{mm} thick. The lower end of the compound strip is fixed, and on the upper end is fixed a fine thread of glass, the end of which is bent at right angles, and impinges upon a light mirror of silvered glass suspended by a vertical silk filament. When the temperature changes, the compound bar curves and the glass thread rotates the mirror. The displacement is observed with a telescope and scale. The whole is inclosed in a double box, to avoid air currents. In another form of the instrument the curvature of the compound bar is made to bring the end near a metallic rod immersed in liquid, thus shortening the column and diminishing the resistance. (*J Phys.*, April, II, I, p. 183.)

Govi has made use of the fact that the expansion coefficients of mercury and hard rubber are very nearly equal, for the purpose of illustrating the effect of expansion on the bulbs of liquid thermometers. A capillary tube of glass has a bulb of ebonite, the bulb and a part of the stem being filled with mercury. No change is observed in the height of the column when the temperature gradually changes. When the variations are rapid the mercury descends with heat and rises with cold, the original level being soon restored. The ebonite responds first, and being a bad conductor, transmits its heat slowly to the mercury. (*Nature*, December, XXVII, p. 209.)

Crafts has studied the conditions in mercurial thermometers which produce a lowering of the zero point. He considers that the glass after it has been softened in the blowing preserves for an indefinite time at ordinary temperatures a condition of strain, as in the Prince Rupert's drop. When the glass is reheated, the mobility of its particles increases and a contraction takes place, the result of it being the more effective in proportion as the original temperature is the more nearly approached. In constructing the thermometer this contraction produces a permanent elevation of the zero point, which may amount even to 26°. When heated to the boiling point of mercury, as in filling, there is a similar effect, but the depression rarely amounts to more than 2° for lead glass. To remove this error, therefore, the author heats the thermometers to the required high temperatures and then cools slowly. (*Comptes Rendus*, May, XCIV, p. 1298.) Subsequently Crafts has given the results of his comparison of fifteen mercury thermometers with the hydrogen thermometer, all immersed in the vapor of naphthalene. Seven of these thermometers were made by Baudin and seven by Alvergriat. They were all of flint glass containing 18 per cent. of lead. One was made of soda glass, by Müller, of Bonn. These results are given in tabular form, showing the correction required for every ten degrees from 100° to 330°. For comparison, the corrections for thermometers made of Choisy le Roy glass and ordinary Paris glass, from Regnault's

data, for the same intervals, are given in the same table. When corrected, the maximum error for the fifteen thermometers is $0^{\circ}.3$ at 200° , $0^{\circ}.5$ at 300° and $0^{\circ}.8$ at 330° . (*Comptes Rendus*, November, xcv, p. 836.) In a third note, Crafts discusses the exactitude of the measurements made with the mercurial thermometer. (*Comptes Rendus*, November, xcv, p. 910.)

Siemens has communicated to the Royal Society the results of the experiments made with his deep-sea electrical thermometer on board the United States Coast and Geodetic Survey steamer Blake, Commander Bartlett, in the summer of 1881, forwarded to him by J. E. Hilgard, the Superintendent. The apparatus was specially ordered for the Government by Alexander Agassiz, and seems to have proved its reliability. (*Nature*, June, xxvi, p. 190.)

Brown has given an extended *résumé* of the various devices brought forward as temperature regulators. (*Nature*, June, xxvi, p. 114.)

2. Expansion and Change of state.

Russner has determined the expansion coefficient of several substances by means of the weight thermometer. Sulphur gave from 0° to 10° , .000147; 0° to 20° , .000160; 0° to 30° , .000170; to 40° , .000178; to 50° , .000183; and to 60° , .000186. Soft rubber of commerce, from 0° to 10° , .000657; 0° to 20° , .000665; 0° to 30° , .000670. Hard rubber has a coefficient between that above given for caoutchouc and that for sulphur. Different specimens varied between .00023 and .00041. (*Carl. Rep.*, xviii, p. 152; *J. Phys.*, April, II, I, p. 193.)

Lebedeff has sought to ascertain whether the apparent contraction of stretched caoutchouc by heat takes place in all directions or only in that in which it is stretched. He finds the latter to be the true hypothesis. He has found the cubic expansion coefficient of the rubber to be .000687 when stretched and .000675 when in its natural condition. (*J. Soc. Phys. Chim. Russe*, xiii, p. 246; *J. Phys.*, December, II, I, p. 576.)

Hertz has studied the conditions of the evaporation of liquids, and has measured with great care, by means of a special apparatus, the pressure of the saturated vapor of mercury at different temperatures. The values obtained are lower than those of Regnault. Between 0° and 40° the elastic force of mercury vapor varies from 0.00019 to 0.0063^{mm}. Hence, at ordinary temperatures the elastic force of the vapor of mercury is less than one-thousandth of a millimeter. (*Wied. Ann.*, xvii, pp. 173, 177; *J. Phys.*, November, II, I, p. 512.)

Cailletet has suggested the use of liquefied gases, especially ethylene, for producing low temperatures. Ethylene liquefies at 10° C. under a pressure of 60 atmospheres, at 8° under 56, at 4° under 50, and at 1° under 45. Its critical point is near $+13^{\circ}$. When a thermometer containing CS_2 was immersed in the liquid it indicated a temperature of -105° , much lower than that of hyponitrous oxide, which boils at -88° . Spe-

cial devices to collect and use the liquid ethylene are necessary, which are described in the paper. (*Comptes Rendus*, May, XCIV, p. 1224.)

Demarçay has studied the volatility of metals at low temperatures in a vacuum. The metal was placed in a glass tube 12^{mm} in diameter, closed at one end, and heated in a bath of the vapor of sulphur, mercury, methyl sebate, aniline, methyl oxalate or water, giving temperatures of 440°, 360°, 292°, 184°, 161°, and 100° respectively. A thin U tube of glass was placed inside the first, passing to within two centimeters of the metal, and kept cold by a current of water. The space containing the metal was exhausted by a Springel pump. In a longer or shorter time after the heating begins, a black deposit appears on the bend of the U tube, which soon becomes metallic. Cadmium, zinc, antimony, bismuth, lead, and tin were thus examined, and it was found that they were volatile, cadmium at 160°, zinc at 184°, antimony and bismuth at 292°, lead and tin at 360°. When the experiment continued for 24 or 48 hours, the deposit was considerable enough to be weighed, being 5 to 15 milligrams. Cadmium at 184° gave in 20 hours a deposit weighing nearly 10 centigrams. (*Comptes Rendus*, July, XCV, p. 183.)

Konowaloff has investigated the tensions produced by the vapors of mixed liquids, including those which are miscible in all proportions as well as those which are only partially soluble the one in the other. (*Wied. Ann.*, V, XIV, pp. 34, 219; *J. Phys.*, April, II, I, p. 188.)

Chistoni has given a historic sketch of the different theories of dew. In his opinion the most efficient cause of the production of dew is the evaporation from the surface of the ground, which has been superheated during the day and the temperature of which is maintained during the night above that of the air. After a longer or shorter time, of course this air becomes saturated. Contrary to the general impression, nocturnal radiation plays only a secondary part in the phenomenon. (*Il Nuovo Cimento*, III, x, p. 58; *J. Phys.*, December, II, I, p. 566.)

Troost has given a method for determining vapor densities at high temperatures in glass by using for the purpose a bath of selenium vapor, which boils at 665°. The glass must be difficultly fusible, the capacity of the balloons being about 300 c. c. The author obtained for the density of mercuric chloride thus determined 9.37; theory requiring 9.38. For iodine, 8.57 and 8.53 were obtained, showing that its expansion coefficient does not differ from that of air, while its compression coefficient at 440° is notably different, and at this temperature the density diminishes with the pressure from 8.7 to 7.35. Sulphur vapor gave 2.94 and 2.92, while at 440° it is 6.6, and at very high temperatures it is 2.2, showing a gradual decomposition like ozone. (*Comptes Rendus*, June, XCV, p. 30.)

Wiedemann has described a new form of apparatus for illustrating geyser phenomena. It consists of a globe of glass of half a liter capacity, surmounted by two tubes, one a centimeter in diameter and 70

centimeters long, passing just through the cork and narrowed above. The subterranean canals bringing water to the bottom of the geyser are represented by the other tube, narrower than the first, which descends into the globe where it is a little recurved upward. The upper end of this tube passes from the bottom of a lateral jar half filled with water, which is about on a level with the top of the vertical tube. The whole being filled with water to a level a little below the narrowed point of the large tube, it is only necessary to heat the globe with a Bunsen burner to obtain projections of boiling water to a height of 2 or 3 meters. (*Wied. Ann.*, V, xv, p. 173; *J. Phys.*, June, II, 1, p. 290.)

Violle has measured with great care the boiling point of zinc. Deville and Troost some years ago gave it at 1048° , while Becquerel's determination makes it 932° . In the course of other experiments, Violle observed that silver, which melts at 954° , did not fuse in zinc vapor. He then undertook to determine the boiling point of zinc by means of a special apparatus, and has found it to be $929^{\circ}.6$, or practically 930° . (*Comptes Rendus*, March, XCIV, p. 720.) In a note, Troost says that this value was redetermined by Deville and himself, and fixed at 942° as a mean of 27 experiments. (*Comptes Rendus*, March, XCIV, p. 788.)

Troost has determined the boiling point of selenium with a view to use this substance for determining vapor densities by the method proposed by Deville and himself in 1880. The temperature was measured by air thermometers, with both porcelain and glass bulbs, and was found to be 664° to 666° , or 665° as a mean. The author proposes selenium vapor, therefore, because glass bulbs can be used in it without softening. (*Comptes Rendus*, June, XCIV, p. 1508.)

3. Conduction and Radiation.

Thoulet has determined the thermic conductivity of rocks, defining the coefficient of conduction to be the quantity of heat which enters or leaves a homogeneous wall of indefinite extent during a unit of time, traversing a unit of surface, when the thickness is unity, and the difference of temperature on the faces is 1° C. He has given the preliminary results obtained with his apparatus, which show the coefficient for glass to be 2.66, for wrought iron 10.26, and for Vizille anhydrite 4.56. (*Ann. Chim. Phys.*, June, V, xxvi, p. 261.)

Grätz has investigated the conductivity for heat of gases and its relations to temperature. He concludes: (1) that heat conduction in the gases—air, hydrogen, and (at low temperatures) carbon dioxide,—consists in the transference of progressive energy only, intramolecular energy contributing immeasurably little; (2) that the relation of heat conduction to temperature is found by experiment to be such as Clausius's theory requires; (3) that all results for gases and vapors showing divergences from the values calculated from theory are without evidential force since they give only the apparent heat-conducting power in consequence of the absorption of radiant heat; (4) that the divergence

of the temperature coefficient of friction from that calculated from theory cannot have for its cause (at least not alone) the decrease of the molecular diameter with rising temperature. (*Wied. Ann.* XIV, 232; *Nature*, January, XXV, p. 290.)

Dahlander has ascertained that the velocity with which a body cools in a liquid is: (1) nearly independent of its depth below the surface; (2) is independent of the nature of its surface; (3) is dependent on its excess of temperature; and (4) for the same body in the same liquid with the same excess of temperature it increases rapidly with the temperature of the liquid. (*J. Phys.*, September, II, I, p. 435.)

Hill has calculated from data obtained by actinometric observations in India, that the true absorbent of solar heat in our atmosphere is aqueous vapor, the absorbing power being identical with that obtained by Violle from measurements taken by himself in the Alps. (*Proc. Roy. Soc.*, XXXIII, p. 216; *J. Phys.*, June, II, I, p. 290.)

Heine has measured the absorption of radiant heat by gases by means of the expansion produced. The gas is contained in a brass vessel, whose sides carry plates of rock salt, through which pass the radiations of a Bunsen burner. A very delicate manometer registers automatically the variations of interior pressure. If air be used purified from water vapor and carbon dioxide no change of pressure takes place, but if carbon dioxide be employed there is an increase of pressure resulting from the absorption of heat by the gas. On mixing definite quantities of carbon dioxide with air, definite curves were obtained, which were sufficiently well marked to permit of the solution of the inverse problem; *i. e.*, the determination of the carbon dioxide in the air from the absorption curves. The results agree well with those of chemical methods. (*J. Phys.*, August, II, I, p. 380.)

Ferrini has experimented with the Crookes phenomenon, using two similar tubes, one of which was exhausted only moderately, the spark passing direct from one electrode to the other, while the other contained air at the extreme of rarefaction. A Holtz machine furnished the electricity, tubes of rubber filled with mercury being the conductors. One of these was directly attached to the machine. The other was adjustable near the surface of mercury in circuit with the machine, so that when it was immersed a continuous current was sent to the bulbs, and when out of the mercury a longer or shorter spark could be obtained. When these discharges passed through the low vacuum tube, the phenomena varied like those observed by Hittorf, who used a constant current, but varied the rarefaction; being due to the increase of the resistance in the vicinity of the negative electrode as the potential rises. The resistance of the second globe was very much greater; but the phenomena from one globe to the other, vary in the same direction in which they vary for the first globe when the difference of potential is increased. The author rejects, consequently, the hypothesis of a fourth state of matter. (*Il Nuovo Cimento*, III, IX, p. 179; *J. Phys.*, November, II, I, p. 521.)

Tyndall has delivered a lecture at the Royal Institution on the action of free molecules on radiant heat, and its conversion thereby into sound, in which he gave a *résumé* of the discussion on the question of the absorptive action of aqueous vapor and then showed the apparently incontrovertible proof by means of the photophone of the correctness of his early experiments. (*Nature*, January, XXV, p. 232; *Ann. Chim. Phys.*, April, V, XXV, p. 177.)

Dufour has confirmed the hypothesis that in the radiophone the radiant energy acts on the layer of air in contact with the solid body without expanding sensibly this body. A wire of blackened brass, stretched on the mounting of a lens, pressed against the lens a thin glass, which gave Newton's rings; and it was observed that no change took place in the rings when the wire was subjected to an intermittent beam of light. A very thin spiral of blackened zinc terminated in a small carbon cone connected with the positive pole of a battery and rested on a plate of carbon connected with the negative pole, a telephone being in circuit. No sound was perceived when an intermittent beam was thrown upon the spiral. The increased effect with increased absorption in a gas was well shown by putting carbon dust in dry air; a strong sound was heard when the tube was shaken. That short waves also produce the result was shown by using a bulb as a receiver in which hydrogen and chlorine were set free by electrolysis. (*J. Phys.*, April, II, I, p. 196.)

Kalischer has observed that by using simply a selenium cell in the circuit of a telephone, and without battery, a sound is produced whenever intermittent light falls on the selenium whose pitch corresponds to the rate of intermittence. The result appears to be due to light, since it is not modified by alum or by water, and it is destroyed by colored glass, except yellow. The cell should have a low resistance. (*Carl. Rep.*, p. 563; *J. Phys.*, April, II, I, p. 197.)

4. Specific Heat.

Strecker has determined the ratio of the specific heat at constant pressure to the specific heat at constant volume, of chlorine, bromine, and iodine, all in the condition of gas, by comparing by Kundt's method the wave lengths produced by the same sound in air and in the gas, at temperatures between 20° and 390°. The constants do not vary sensibly with the temperature, and approach closely the theoretic values, 1.323 for chlorine, 1.290 for bromine, and 1.300 for iodine. The experimental values are:

	Velocity.	Ratio.	Sp. heat. const. press.	Sp. heat const. vol. ref. to air.
Chlorine.....	205.3 ^m	1.323	0.1135	0.2139
Bromine	135.0	1.293	0.0550	0.2358
Iodine.	107.7	1.294	0.03489	0.2350

(*Wied. Ann.*, V, XIII, p. 20; *J. Phys.*, April, II, I, p. 187.)

Thoulet and Lagarde, desiring to obtain the specific heat of small frag-

ments of minerals weighing from one to five decigrams, have devised a simple apparatus for the purpose, the minute rise of temperature, when the body, previously heated, is placed in a liquid, being determined by means of a thermo-electric couple. (*Comptes Rendus*, June, XCIV, p. 1512.)

Louguinine has described a new and improved form of calorimeter, the results of which appear to be very satisfactory. (*Ann. Chim. Phys.*, November, V, XXII, p. 398.)

Violle has proposed an apparatus for applying the cooling method to the determination of the specific heat of bodies when the initial temperature of the body is between 100° and 500° . It consists of a small bottle of thin glass, with double walls and a straight neck, a good vacuum being made in the annular space. An agitator is introduced through the neck by the side of the thermometer. (*Comptes Rendus*, June, XCIV, p. 1570.)

Schuller has redetermined the heat of combination of water, in consequence of certain criticisms of Von der Than. The oxygen and hydrogen meet in a combustion chamber formed of two parts; they unite in the upper part, which is at 225° , evolving (1) M_1 calories employed to heat them, (2) their heat of combination E , and (3) M_2 calories corresponding to the condensation of three volumes to two. The vapor of water formed passes into the lower part at 0° , where it gives up M_2 calories. Hence $E_p = -M_1 + E + M_2 + M_3$. In this way the author finds $E = 28810$. (*Wied. Ann.*, V, XIV, p. 226; *J. Phys.*, April, II, I, p. 192.)

Louguinine has published an extended memoir on the measurement of the heat of combustion of organic bodies, giving a description of the apparatus employed, the mode of using it, and some of the results which have been obtained with it. (*Ann. Chim. Phys.*, November, V, XXVII, p. 347.)

LIGHT.

1. Production and Velocity.

Kruss has called attention to the fact that if the screen of a Bunsen photometer be moved between two fixed sources of light, there are two positions of this screen in which the fatty spot disappears. Both theory and experiment show that the true ratio of the intensities from the two sources is the geometric mean of the ratios calculated from both measurements. (*J. Phys.*, April, II, I, p. 201.)

A new photometer has been constructed by Sabine, in which a wedge of neutral tint glass is used to measure the intensity of a given light by equalizing it with a standard paraffin flame. To secure greater range a set of diaphragms is used to regulate the amount of light coming from the standard. (*Nature*, December, XXVII, p. 201.)

Crova and Lagarde have made an improvement in the spectrophotometer whereby the illuminating power of simple radiations may be compared. The illuminating power of a simple light they regard as the

property which it possesses of rendering distinguishable upon a white screen illuminated with it minute details, as lines, etc. If, now, the light be weakened till they vanish, the ratio of the initial intensity to this limit of intensity will be sensibly constant and is a function only of the wave-length used. The light to be tested is therefore received normally on the slit of a spectrophotometer covered with a strip of glass, on which is photographed a series of fine and close dividing lines, their direction being perpendicular to the direction of the slit. A pure spectrum is seen furrowed by fine longitudinal striæ. If, now, the eye-piece slit be made to include any particular region, and the nicol prism be rotated till the striæ cease to be perceptible, a method is secured for comparing intensities. (*Comptes Rendus*, XCIII, p. 959; *J. Phys.*, April, II, I, p. 162; *Phil. Mag.*, January, V, XIII, p. 72.)

Brücke, finding that objects cease to be visible at a greater visual angle the more they differ in color but not in brightness from the background on which they are seen, has made use of this principle in photometry. A board, black at one end and white at the other, he calls a brightness table. It has successive shades of gray between. To determine the brightness of a colored paper, for example, he places a bit of it before different parts of the board and notes the place where with the shortest interval it becomes invisible. (*Nature*, June, XXVI, p. 138.)

Koenig has reported to the Physical Society of Berlin on a new instrument designed and constructed by Helmholtz, which he calls the leukoscope. It consists essentially of a calc-spar rhomboid, a plate of quartz, and a nicol prism. When a luminous pencil enters the calc-spar it is split into two rays polarized in planes at right angles, which traverse the quartz plate and the nicol. When analyzed by a prism these rays give two spectra containing absorption bands, those in the one being the complement of those in the other. The instrument is used by putting in a quartz plate of the proper thickness and then rotating the nicol until white light is produced. When different sources of light are employed, different degrees of rotation are necessary to effect this result, the relative quantity of different colors in different lights being different. The angle of rotation for stearin candles was $71^{\circ}.20$; for gas light, $71^{\circ}.5$; for electric arc, 79° ; magnesium light, 86° ; solar light $90^{\circ}.5$. The calcium light and burning phosphorus gave angles between gas and the electric light. Experiments with the Edison and the Swan incandescent lamps showed that the luminosity increases much more rapidly than strength of current, the illuminating power being increased sixty-fold by doubling the current. The angles of the leukoscope increase as the light rises; so that a curve plotted with light intensities as abscissas and angles as ordinates is concave towards the axis of abscissas, approaching asymptotically a maximum near 78° ; an angle approximately equal to the angle of the arc. (*Nature*, November, XXVII, p. 95.)

2. Reflection and Refraction.

Chardonnet has made a series of experiments on the actinic transparency of certain media, especially of the mirrors of Foucault. Two methods were used: the first consisted in exposing sensitive paper to the solar rays after traversing the medium; the second required a lens of quartz and Iceland spar and a prism of spar, the spectrum being received on a photographic plate or a fluorescent screen. In this way the various kinds of optical glass were studied, the results of which are given. Silvered-glass mirrors transmit the more refrangible rays, giving on the photographic plate a band from O to T; thus acting as a filter, allowing obscure rays only to go through. In this way the author obtained photographs in absolute darkness. (*J. Phys.*, July, II, I, p. 305.)

Subsequently Chardonnet has examined the spectrum of light reflected from various bodies, and comes to the conclusion that absolute elective absorption does not exist; lampblack itself, deposited as an opaque layer on a plate of enamel, giving a complete spectrum. The substances tried were: white and black enamel, uranium glass, rough hematite, polished hematite, diamond, compressed carbon, rough and polished, vermilion, gold, lead, nickel, Arcet's alloy, copper, rough and polished steel, Prussian blue, green leaves, and mercury. Among liquids distilled water, fuchsine, acetosulphate of quinine, ammonia, copper sulphate, potassium dichromate, milk, ink, alcohol, ether, benzene, olive oil; all of which gave a complete spectrum. The author concludes (1) every surface reflects in variable proportions all the colors of the spectrum; (2) the reflecting power of a liquid is independent of the substances which it holds in solution or in suspension; and (3) specular polish increases only the total quantity of reflected radiations, the relative intensity of the different regions of the spectrum depending upon the material employed. (*J. Phys.*, December, II, I, p. 549.)

Piltshikoff has suggested the use of a hollow lens for measuring the refractive index of small quantities of liquid. After filling the lens with the liquid to be examined, the focal distance of the image of a monochromatic flame, placed at a given distance from the lens, is exactly measured by means of a graduated rule. The constants of the apparatus are determined once for all, and then, by means of a simple formula, the index of the liquid is easily calculated. The results are exact, the index of glycerin thus determined being $1.47298 \pm .00001$. (*J. Phys.*, December, II, I, p. 578.)

Boys has suggested a method of measuring the curvature of lenses with a view to determine their refractive index. The principle of the method is illustrated as follows: Fix an ordinary spectacle lens in a clip with its principal plane vertical; in front of it place a card with a small hole in it, and illuminate the hole with a candle flame. It will be found that, when the lens is at a certain distance from the card, there is an inverted image of the hole formed on the card. When this is the

case the light leaving the hole and meeting the front surface of the lens is refracted and meets the back surface normally. Most of the light passes through; but a small portion is reflected back along the path whence it came, and is sufficient to produce an image easily visible in the day. By fixing a plane surface of glass behind the lens it will be found that another image may be produced when the lens is about twice as far from the card as it was before. The card is then at the principal focus. (*Phil. Mag.*, July, V, XIV, p. 30.)

Bedson and Williams have experimented to ascertain whether the specific refraction of a solid body can be obtained from that of its solutions by applying the law of mixtures. Rock-salt, borax, boric acid, and sodium-metaphosphate were the substances used. The indices corresponding to the three lines of hydrogen were measured for the three bodies first named by cutting prisms from them; for the fourth by immersing it in a more refractive liquid, and adding a less refractive one until equality was obtained. The results show a satisfactory accordance. (*J. Phys.*, August, II, I, p. 377.)

Crova has given the formula of a varnish for glass, given to him by Guinand, so that drawings may be easily made upon it for purposes of projection. It consists of ether, 500 grams; sandarac, 30 grams; mastic in tears, 30 grams. When dissolved add benzene until the varnish flowed on a plate of glass gives it a depolished appearance. To give a fine grain and a homogeneous layer, pour upon it a little petroleum ether, let it partially evaporate, and rub with a piece of muslin until perfectly dry. The coating may then be written upon either with ink or a lead pencil, and is ready for use. (*J. Phys.*, January, II, I, p. 42.)

Demeny has given an account of the application of instantaneous photography to the study of animal locomotion as practiced by Marey at the physiological station of the Parc des Princes. The exposure is made by a rotating opaque disk, having an opening in the form of a sector. With a strong light it may be reduced to one thousandth of a second. An image is obtained with each turn of the disk, and since the object has moved in the interval these will be neither identical nor superposed. A white stone thrown by hand when thus photographed gives the image of a parabolic curve. A white point attached to a carriage wheel gives the cycloid described. (*J. Phys.*, November, II, I, p. 504.)

Stokes has studied the phenomena of the light border frequently noticed in photographs just outside the outline of a dark body seen against the sky. The sunlight, being reflected horizontally into a dark room, is passed through a lens and allowed to fall on a phosphorescent screen of calcium sulphide, previously exposed to light, placed nearer to the lens than its principal focus. There is seen a circular disk of blue light much brighter than the general ground, separated by a dark halo from this ground, due to the action of the less refrangible rays which discharge the phosphorescence. But, since the first effect of these rays is to produce light, there is seen, when the exposure is very

brief or the intensity of these rays is sufficiently reduced, a greenish light where they fall on the screen, which faded much more rapidly than the deep blue, and after a short time became relatively dark. In photography, as in phosphorescence, there may be in certain cases an antagonistic action between the more and less refrangible rays, so that the withdrawal of the latter might promote the effect of the former. In a camera corrected for chemical rays, when directed to a dark object on a bright ground, there is a sharp transition from light to dark for rays in focus, but a gradual one for rays out of focus. Just at the outline of the object there would be half illumination for rays out of focus, and the illumination would go on increasing until the full intensity is reached at a distance equal to the radius of the circle of diffusion. If, now, the rays of low refrangibility tend to oppose the action on the sensitive plate of those of high refrangibility, acting negatively, just outside the outline, the active rays, being sharply in focus, are in full force while the negative rays have not yet acquired their full intensity. At an equal distance from the outline on the dark side the positive rays are absent, and the negative rays, having nothing to oppose, do nothing. (*Proc. Roy. Soc.*, May 25; *Nature*, June, xxvi, p. 142.)

3. *Dispersion and Color.*

Ayrton has presented a paper to the London Physical Society describing the latest form of his dispersion photometer. A concave lens is used to disperse the stronger light, thus obviating the necessity of putting it at a distance. The illuminating powers are compared by Rumford's method, the intensities of two shadows of a rod thrown on a white screen of blotting paper being adjusted to equality. A sperm candle is used as the standard, placed on a stand sliding on a graduated rod at an angle with the frame of the instrument which carries the lens and is also graduated. The stronger beam is reflected to the lens by a small mirror inclined at 45° to a horizontal axis, about which it can rotate. Collateral observations are taken through red and green glasses to get a better estimate of the power of the light. (*Nature*, March, xxv, p. 426; *Phil. Mag.*, July, V, xiv, p. 45.)

In order to show the focus after refraction through a prism, Crova replaces the slit of a spectroscope by a plate of silvered glass having two lines at right angles drawn through the silvering, the quadrants being filled with fine lines drawn in various directions. When illuminated with sodium light, and viewed in the observing telescope, a sharp image is obtained by these lines, both horizontal and vertical, when at minimum deviation, but if the prism be displaced, the image of the lines perpendicular to the principal section becomes indistinct. These phenomena may be projected on a screen by suitable modifications in the method. (*J. Phys.*, February, II, I, p. 84.)

Chappuis has examined carefully the absorption spectrum of ozone, which he says characterizes this gas better than any other of its phys-

ical or chemical properties. He gives the wave-lengths of eleven ozone bands, the strongest being the two near D, of wave-lengths 609.5-593.5 and 577-560 respectively. He finds these bands also in the spectrum of liquid ozone. He discusses the question of telluric lines in the solar spectrum, and regards the blue color of the sky as due, in part at least, to the presence of ozone. (*J. Phys.*, November, II, 1, p. 494.)

Cimician has carefully examined the spectrum of acetylene and finds that it differs from that of hydrogen much more than do the spectra of ethylene and marsh gas. In these the characteristic carbon bands show the spectrum to be that of a hydrocarbon gas; while in that of acetylene the red, orange, and yellow portions resemble much more closely the spectrum of carbon dioxide than of hydrogen. (*Wied. Ann.*, No. 10; v; *Nature*, January, xxv, p. 290.)

Livinge and Dewar have continued their researches on the spectrum of carbon, and in a paper presented to the Royal Society give the wave-lengths of twenty ultra-violet lines measured photographically by means of a Rutherford grating. In studying the spectrum of a Swan incandescent lamp, they came to the conclusion that the temperature of the incandescent thread heated by fifty Grove cells is not far different from that of sodium heated in a cyanogen flame burning in air, but is less than that of an oxyhydrogen flame. (*Proc. Roy. Soc.*, March 9; *Nature*, April, xxv, p. 545.)

Thollon has published in parallel columns the wave-lengths of the bands of the carbon spectrum as observed by Bigourdan in the arc of the electric lamp of Jamin, by Salet in the condensed spark in cyanogen or illuminating gas, by Lecoq de Boisbaudran in the blue flame of illuminating gas, and by himself in the spectrum of comet *b*, 1881. (*Ann. Chim. Phys.*, February, V, xxv, p. 287.)

Abney has published minute directions for performing work in the infra-red region of the spectrum, including the preparation of the silver bromide emulsion, and the method of development. (*Nature*, November, xxvii, p. 15.)

Johnson has quoted Wollaston's paper in the *Philosophical Transactions* for 1802, and Newton's "Opticks," 1704, in proof of his assertion that Newton did employ a slit and did obtain a pure spectrum. Wollaston says: "If a beam of daylight be admitted into a dark room by a crevice 1-20th of an inch broad and received by the eye at a distance of 10 or 12 feet through a prism of flint glass, free from veins, held near the eye, the beam is seen to be separated into the four following colors only: red, yellowish-green, blue, and violet." Newton says: "Instead of the circular hole, 'tis better to substitute an oblong hole, shaped like a long parallelogram, with its length parallel to the prism. For if this hole be an inch or two long and but a tenth or twentieth part of an inch broad or narrower, the light of the image will be as simple as before, or simpler, and the image will become much broader and therefore more

fit to have experiments tried in its light than before." (*Nature*, October, XXVI, p. 572.)

Living and Dewar have studied carefully the lines in the spectra of different elements which have been supposed to be coincident, and conclude, from the results that they have already obtained, that the coincidences as yet unresolved will yield to still higher dispersive power or are purely accidental. (*Ann. Chim. Phys.*, February, V, XXV, p. 190.)

Langley has given the results of experiments made with the bolometer to determine the distribution of energy in the normal spectrum. This curve has its maximum ordinate very near the line D, the measurements extending from a wave length of 0.00035 to 0.00300^{mm}. Taking the bolometric indications when the sun was nearest the zenith, and when at a distance from it, the author has been able to calculate the form of the curve of solar radiation without the earth's atmosphere. This curve has its maximum ordinate near the line F, whence he concludes "that the total radiations of the solar photosphere, if they could reach us, would give us the sensation of a compound color resembling a dark blue." (*Ann. Chim. Phys.*, February, V, XXV, p. 211.)

At the Southampton meeting of the British Association, Langley gave the results of his bolometric measurements made upon the summit of Mount Whitney, in Southern California, at an altitude of 13,000 feet. These, combined with the results obtained at Allegheny, gave the data for two charts, one of the prismatic, the other of the normal, spectrum. The extension of the spectrum by these measurements is remarkable. Between H in the extreme violet and A in the furthest red lies the visible spectrum, its length being about 4,000 of Angström's units. The chart shows that the region below this extends through 24,000 units more, so much of it as lies below wave-length 12,000 being here mapped for the first time. Moreover, the bolometer shows this region to be crossed by Fraunhofer lines; and, with the aid of one of Rowland's concave gratings, their wave-lengths have been measured. The terminal ray of the solar spectrum whose presence has certainly been felt by the bolometer has a wave-length of about 28,000. He concludes with the remark that "while all radiations emanate from the solar surface, including red and infra-red, in greater degree than we receive them, that the blue end is so enormously greater in proportion, that the proper color of the sun as seen at the photosphere is blue—not only bluish, but positively and distinctly blue." (*Nature*, October, XXVI, p. 586.)

Several new forms of direct-vision prisms have been suggested. Ahrens uses a bisulphide prism cemented between two flint-glass prisms giving a wide dispersion with but little loss of light. Fuchs employs a single isosecles glass prism at minimum deviation, a silvered mirror being attached to the basal face of the prism to rectify the ray after emergence. Ricco has described a similar combination, in which a total-reflection prism is substituted for the mirror. The second prism of the

combination is four-sided, so that it not only rectifies the ray which has been deflected by the first prism but also increases by a nearly equal amount the dispersion of the first prism. (*Nature*, December, XXVII, p. 182.)

Wead has proposed a method of combining color disks by the rotation of a plane mirror slightly inclined to the axis around which it rotates. If the angle of inclination, the distances of the eye and the disks from the mirror, and the sizes of the mirror and the disk are properly proportioned, a good combination of the colors may be effected and the necessary adjustment of colors may be made without stopping the rotation. (*Nature*, January, XXV, p. 266.)

For the mixture of spectrum colors, von Frey and von Kries illuminate two neighboring surfaces, one with a mixture of two spectrum colors, the other either by a mixture of white light and a given spectrum color, or by white light alone. Their results for complementary colors confirm those of Helmholtz. If a curve be constructed with the wave-lengths of certain colors as abscissas and wave-lengths of their complementaries as ordinates, the two branches of an equilateral hyperbola are obtained. But the curves obtained by the two observers under the same conditions are not identical, but intersect in the yellowish-blue. Analogous differences appear in the experiments made to reproduce the different tints of the spectrum by the mixture of two spectrum colors. Thus, when the red of C and the green of *b* are used to reproduce intermediate tints, von Kries must employ more green than von Frey, and less when the green of *b* is mixed with the violet of G. These results show the eye of one of these authors to be more sensitive to yellow than the other. They attribute it to unequal absorption by the pigment of the yellow spot. (*J. Phys.*, November, II, I, p. 513.)

Hastings has published a paper on the color correction of double objectives, in which, after a review of the methods heretofore employed for attaining this end, he gives a theoretical solution of the problem, shows how the results may be applied to the practical construction of an objective, and, finally, gives the results of some practical tests of the theory. Two forms of test were applied. In the one three objectives were constructed from the theory and their performance studied. In the other objectives of the most approved makers were examined and their practice compared with theory. The results in both cases were regarded as a decisive proof of the correctness of the theory. (*Am. J. Sci.*, March, III, XXIII, p. 167.)

4. *Interference and Polarization.*

Michelson has investigated the interference phenomena observed in the form of refractometer employed by him in his experiments to determine the relative motion of the earth and the ether. He finds satisfac-

tory accordance of experiment with theory. (*Am. J. Sci.*, May, III, XXIII, p. 395.)

Rowland has published a preliminary notice of the results accomplished in the manufacture and theory of gratings for optical purposes. Having devised a plan for making a practically perfect screw, which proved successful, the ruling machine was at once constructed. No error as great as the one-hundred thousandth part of an inch has been detected in any part of this screw, and it has no appreciable periodic error. Gratings have been ruled on the machine having 43,000 lines to the inch, and a ruled surface has been made with it having 160,000 lines, 29,000 to the inch, in size $6\frac{1}{4} \times 4\frac{1}{4}$ inches. Rowland then made an investigation of the theory of concave gratings and found their laws to be very simple. Draw the radius of curvature of the mirror to the center of the mirror, and from its central point, with a radius equal to half the radius of curvature, draw a circle. This circle thus passes through the center of curvature of the mirror and touches the mirror at its center. If the source of light is anywhere in this circle the image of this source and the different orders of the spectra are all brought to focus on this circle. This leads to a mechanical contrivance by which we can move from one spectrum to the next and yet have the apparatus always in focus. It consists simply in attaching the slit, the eye-piece, and the grating to three equal arms pivoted together at their other ends. The most interesting case is when the bars carrying the eye-piece and grating are attached end to end, forming a diameter of the circle, the eye-piece being at the center of curvature of the mirror, and the rod carrying the slit alone movable. In this case the spectrum viewed by the eye-piece is normal; and when a micrometer is used, the value of a division on its head in wave-lengths does not depend on the position of the slit, but is proportional simply to the order of the spectrum. Moreover, all the superimposed spectra are in exactly the same focus, and it is a beautiful sight to see the lines appear colored on a nearly white ground. A list of some of the flat and the concave gratings is given, together with the results obtained with them. (*Nature*, June, XXVI, p. 211; November, XXVII, p. 95; *Phil. Mag.*, July, Suppl., V, XIII, p. 469.)

Frolich has studied the light which is reflected from very fine metallic gratings, comparing it with that reflected from the non-striated surface. When the light was polarized, the plane of polarization making an angle of 45° with the plane of incidence, he observed that the two portions of the black fringe of the compensator did not coincide, and that the plane of polarization, being restored, is not the same for the two halves of the field, the difference being 10° for an incidence of 70° , the lines vertical. If the angle of polarization of the incident light φ be varied, for the light reflected by the ruling the angle ψ of the restored plane of polarization does not satisfy the equation $\tan \varphi \cot \psi = \text{const}$. If φ be taken as 0 , $\psi = 5^\circ 40'$ when $i = 60^\circ$, the lines vertical. If a lens of 10 meters radius be superposed on the grating, the center

of the rings produced coinciding with the edge of the striated surface, it is observed that the diameter of the rings is different on the polished and the striated portions. These phenomena are inexplicable in the present state of optical science. (*Wied. Ann.*, V, XIII, p. 133; *J. Phys.*, January, II, I, p. 50.)

Lommel some time ago showed that a plate of magnesium platino-cyanide perpendicular to the axis polarizes completely in the plane of incidence blue rays which fall upon it at an incident angle greater than 2° . He has now constructed a polariscope with plates of this salt, analogous to the tourmaline pincette; but a layer of copper sulphate must be placed before the polarizer so that blue rays only shall pass. For dichroic substances with superficial colors, polarization by refraction is not due to absorption, but results from the fact that the light reflected from such a surface is completely polarized in a plane perpendicular to the plane of incidence. Hence the transmitted rays are polarized in this plane. (*Wied. Ann.*, V, XIII, p. 347; *J. Phys.*, April, II, I, p. 199.)

Govi has proposed to rotate the analyzing nicol prism of a projection apparatus, to which a direct-vision prism is attached for the purpose of determining the direction of rotation of the polarized ray produced by a plate of quartz placed between the nicols. The spectrum will be circular, the red being at the center and the violet at the circumference. When the quartz plate is interposed, two black archimedean spirals will appear, moving toward or from the center, according to the direction of rotation of the quartz. (*J. Phys.*, August, II, I, p. 372.)

The saccharimeter of Laurent has hitherto required monochromatic light. A new modification of this instrument, using ordinary light, has recently been introduced by the maker, in which the rotation of the sugar solution is balanced by a quartz compensator, as in the Soleil instrument. Dufet has given the theory of the new instrument, and shows that this modification restricts the use of the instrument to solutions of sugar, the law of rotation of which is sensibly the same as that of quartz. (*Comptes Rendus*, XCIV, 442; *J. Phys.*, December, II, I, 552.)

ELECTRICITY.

1. *Magnetism.*

Eaton has investigated the conditions of maximum magnetization of diamagnetic and feebly paramagnetic bodies, using an experimental method analogous to that of G. Wiedemann. The results obtained with ferric chloride show that the magnetism of a solution of this salt is exactly proportional to the magnetizing force; hence a maximum of magnetization does not exist for feebly magnetic substances, at least up to the limit given by seven Bunsen cells. With diamagnetic bodies, the author comes to the same conclusion. (*Wied. Ann.*, V, XV, 225; *J. Phys.*, July, II, I, p. 333.)

Schuhmeister has determined several magnetic and diamagnetic con-

stants in absolute measure, by the method of oscillations, the magnetizing forces being from 300 to 2,500 Gaussian units. For a solution of ferric chloride of density 1.40, $K \cdot 10^6 = 35$. The constants of diamagnetic liquids diminish when the magnetizing force increases; in gases the reverse is true. Oxygen charged with ozone is two or three times more magnetic than pure oxygen. For a magnetizing force of 1,308, the following values were obtained for $K \cdot 10^6$: water, -0.453 ; alcohol, -0.416 ; carbon disulphide, -0.290 ; oxygen, $+0.059$; oxygen ozonized, $+0.181$. (*J. Phys.*, April, II, I, p. 201.)

Berson has made a study of the effect of temperature on the magnetic properties of metals by comparing the magnetic moments of different bars at different temperatures, when placed in a magnetic field of uniform intensity. With iron the total and temporary magnetizations both increase up to 260° , above which the latter falls off rapidly, the former slowly. In steel, the maximum of total magnetization is obtained at 260° also, but the permanent magnetization reaches its highest value at 240° . A steel bar magnetized cold loses magnetism on heating, while one magnetized hot loses it on cooling. With nickel the total magnetization increases up to 240° and diminishes so rapidly above 280° as to be 0 at 330° . If magnetized at 280° , the magnetic moment first increases on cooling and then diminishes slightly; though it still remains greater than at the temperature of magnetization. (*Nature*, December, XXVII, p. 183.)

The elongation of a bar of iron when magnetized was determined by Joule in 1847 at 1-200000th of its length, and by Mayer in 1873 at 1-277000th. Hard steel was noticed by both observers to contract when magnetized. Barrett has now extended these investigations to cobalt and nickel, and finds that in his apparatus iron elongates 1-260000th, and cobalt 1-425000th, while nickel contracts 1-130000th, the contraction being instantaneous. On heating the bar to 50° , the retraction is only three-fourths of its former value. (*Nature*, October, XXVI, p. 585.)

Gray has called attention to the converse of these results of Barrett's, obtained in some experiments made by his brother and himself under Sir William Thomson's direction. Barrett finds that the effect of longitudinally magnetizing a bar of iron is to increase its dimensions longitudinally and to diminish them laterally, so that the volume remains constant; while Thomson shows that the effect of increasing longitudinal dimensions in an iron bar is to increase, and of increasing transverse dimensions to diminish its longitudinal magnetization. (*Nature*, October, XXVI, p. 625.)

Cheesman has investigated, under Kohlrausch's direction, the effect of mechanical hardening upon the magnetic properties of steel and iron, the results of which are in entire accordance with those obtained by Ruths and others with magnets hardened by heat. (*Am. J. Sci.*, September, III, XXIV, p. 180.)

Clemandot, in a communication to the French Academy, maintains

that steel submitted to great pressure, and cooled under this pressure, possesses coercitive force, and may be permanently magnetized. Moreover, steel thus treated may be heated, and even forged, without losing this property. Instead of being ephemeral and transitory, as coercitive force is in steel hardened in a bath, that produced by compression is permanent, unalterable. In proof of this, the author broke in pieces the magnets of a magneto-electric machine, forged them into a bar, compressed this bar, reformed the magnets, remagnetized them, and found them to have, on testing, the same magnetic force as before. (*Comptes Rendus*, October, XCV, p. 587.)

Goolden has contrived a convenient form of dip circle, which is constructed by C. Casella, of London, and which is sufficiently accurate for class instruction. (*Nature*, December, XXVII, p. 127.)

Kohlrausch has described some portable instruments for measuring variations in the intensity of terrestrial magnetism. They include (1) a bifilar magnetometer, in which the magnet is inclosed in a rectangular box $12.5 \times 5 \times 5$ cm, made of copper and having a glass front. The cover carries a tube 2.5 cm in diameter and 25 cm high, furnished with a torsion circle, supporting a bifilar suspension consisting of two brass wires 0.05 mm in diameter, 8 mm apart. The magnet is 10 cm long, 1.4 cm in diameter, with a hole 9 mm in diameter through the axis. It weighs 83 grams, and is supported by a stirrup which carries a mirror. (2) An instrument for measuring variations by means of directing magnets, consisting of a compass, the needle of which is maintained at 90° to the magnetic meridian by four magnets carried by a metallic circle, with which is a second circle graduated. The author claims that these instruments will give the variations to 1-10000th of their total value. (*Wied. Ann.*, V, xv, p. 550; *J. Phys.*, October, II, I, p. 467.)

2. Electromotors.

The theory proposed by Exner, that electrification does not result from contact of metals, but from the chemical action of the air, producing oxidation, the layer of oxide remaining there permanently, has been criticised by several physicists. Exner's experiments tended to prove, as he thought, that the superior limit of the difference of potential of the metal and its oxide is proportional to the heat of oxidation of the metal. In contact with platinum, which he supposes incapable of oxidizing, the other metal with its layer of electrified oxide forms a condenser, the charge of which, measured by an electrometer, will be one half the electromotive force belonging to the metal in question. Stolew has taken up in order the eleven experiments which Exner cites in his second memoir as contradictory to the contact theory as ordinarily admitted, and shows that, considering the earth as a metallic conductor, all the eleven may be very simply explained in conformity with the contact theory. Sokoloff has examined mathematically the condenser

theory of Exner, and found it in error. (*J. Phys.*, December, II, I, p. 574.)

Ewing and Jenkin have observed that a wire of iron or steel submitted to the action of a magnetizing helix yields, when twisted, an instantaneous longitudinal current directed from the north to the south end when the torsion is in the direction of an ordinary screw, and from south to north when the torsion is in the other direction. On reversing the longitudinal magnetization of a wire submitted to torsion, a momentary energetic current is produced; but the interruption or re-establishment of the current produces only a trifling effect. A magnetized wire not under the action of an external magnetizing force also gives a current when twisted, in the same direction as before. The authors give the name "polarization" to the state produced in a wire by the superposition of a torsion and a longitudinal magnetization, a state which persists after the magnetizing force ceases; it is measured by the momentary current which accompanies its production. The molecular condition opposing magnetization, ordinarily called coercitive force, the authors call hysteresis. (*Proc. Roy. Soc.*, XXXIII, p. 21; *J. Phys.*, July, II, I, p. 332.)

Felice shows to an audience the fundamental fact that in the interior of a battery the current goes from the zinc to the copper by using a cell of considerable length and suspending a needle just above the liquid. (*J. Phys.*, December, II, I, p. 571.)

Bennet has constructed a cheap form of battery which can be made for sixpence. An iron meat or milk can forms at the same time the negative plate and the containing vessel. In it is a porous cup containing a zinc plate passing through a paraffined cork as cover. The liquid used is caustic soda, which is electronegative to zinc, and in which iron does not rust. Its electromotive force is 1.23 volts. Iron filings round the porous cup facilitate depolarization. At a subsequent meeting of the London Physical Society, Lecky stated that the electromotive force of the Bennet cell as determined by Guthrie was 1.14 volts, the internal resistance being 0.8 ohm; both quantities varying somewhat. McLeod also gave the results of his tests. On charging, the electromotive force was 1.005 volts, but on standing three days it rose to 1.213 volts. The internal resistance was 1.007 ohms. (*Nature*, May, June, XXVI, pp. 71, 119.)

Wright, in a paper presented to the London Physical Society, gives the results of his investigations on the Daniell cell, as a part of his more extended research on the determination of chemical affinity in terms of electromotive force. He concludes that when a Daniell cell is made with equal-sized plates of pure zinc and pure copper, immersed respectively in solutions of pure zinc and copper sulphates of the same density, and is made to generate a current not exceeding in density 8 microamperes per square centimeter, an electromotive force is set up always lying fairly close to 1.115 volts, and practically identical with

the electromotive force corresponding to the energy gained in the net chemical change ensuing. By taking suitable precautions in the construction of a cell, one may be obtained the electromotive force of which does not differ more than ± 0.25 per cent. from 1.114 volts. But such a cell cannot be kept for many hours without altering in value materially, and is in practice, therefore, a far less convenient standard than the Clark mercurous sulphate cell. (*Nature*, February, xxv, p. 403; *Phil. Mag.*, April, V, XIII, p. 265.)

Potier has given a description of the various classes of dynamoelectric machines exhibited at the Electrical Exposition in Paris in 1881. The Gramme, Edison, Siemens, Burgin, Gülcher, and Brush machines are figured. The ring of the Brush machine is criticised as giving rise to injurious Foucault currents; so that while the Gramme and the Siemens machines give above 90 per cent. efficiency, that of the Brush machine is below 80. (*J. Phys.*, September, II, I, p. 389.)

Lacoinc has investigated the increased resistance in dynamo-electric machines due to increased velocity of rotation, and finds it to be due to variations in contact between the commutator and brushes. Using a copper cylinder 5^{cm} in diameter, having longitudinal grooves cut in its surface, two steel springs were made to press on opposite sides of it, which were in circuit with a battery, telephone, and galvanometer. When at rest, the resistance of the circuit was 68 ohms; at 2,000 rotations, 183; at 4,000, 900; at about 5,000, 1,567; at a higher velocity not measured, 2,900. Each spring touched the cylinder over three grooves, and increasing the pressure diminishes the resistance. Using a smooth cylinder, the results were the same except that a little higher velocity was necessary to obtain the same resistance. (*Comptes Rendus*, xciii, p. 958; *Phil. Mag.*, January, V, XIII, p. 76.)

Sir William Thomson has devised two dynamos, one giving continuous, the other alternating currents. In the former, a drum-armature in the form of a barrel is used, the staves being of copper and insulated from one another. At one end of the drum these copper bars are all united to one metallic plate, and at the other their prolongations serve as commutator bars. Inside this armature is a stationary electro-magnet, its poles facing those of the nearly circular field magnets placed outside. The armature is supported on friction rollers, the lower pair made of non-conducting material, the upper of copper, to take off the currents. The alternating current machine is a disk dynamo, in which the rotating armature has no iron. The disk is made of wood, having projecting wooden teeth upon its sides, around which the copper wire or strip is carried alternately backwards and forwards, going finally to the axle. The field magnets are placed round the circumference of a circular frame with their poles alternating and facing inward. They are formed of a cast-iron ring with lugs screwed upon its face, around which, backward and forward, the zigzag conductors pass. (*Nature*, November, xxvii, pp. 58, 78.)

Gordon's dynamo has attracted considerable attention because of its size, being more than 9 feet high and weighing 18 tons. The armature is a disk of boiler-iron having upon its faces 64 circular coils. Upon the fixed framework are 128 "taking-off" coils, sector-shaped, alternately connected to two circuits. There are 32 groups in parallel circuit, each group containing 4 coils in series. The current is taken from the fixed coils, the movable coils being excited by two Bürgin machines, through the commutator. With 140 revolutions the electro motive force is 105 volts, and the current sustains 1,300 Swan lamps, but is expected to run 5,000 to 7,000 with increase of driving power. (*Nature*, November, XXVII, p. 60.)

Lodge has given an ingenious geometrical construction, giving the relation between the waste and the useful work in a shunt dynamo. (*Nature*, July, XXVI, 311.)

In a lecture at the Electrical Exhibition, Ayrton has considered the question of the economy of gas-engines in the production of electricity. Using the highly purified gas employed for illumination, even at 75 cents per thousand cubic feet (which is twice the Paris price), the gas-engine cannot compete with the steam-engine in economy. But using some form of the newer and cheaper water gas, such as is made by the Dowson process, by passing air and steam through a mass of burning fuel, the reverse condition obtains. While the calorific power of a cubic meter of coal gas is 5,590,399 heat units, and the calorific intensity $2,554^{\circ}$ C., that of the Dowson gas is 1,558,358 and 2,268, respectively. The figures taken from a gas-engine of 30 horse-power driven by means of the Dowson gas for 300 days of nine hours each showed that the cost was about $45\frac{1}{2}$ per cent. less than when worked with gas at 75 cents per thousand feet, and $47\frac{1}{2}$ per cent. less than a portable steam-engine. A steam-engine consuming 6 pounds of coal per indicated horse-power per hour requires 217 tons of coal to give the same power as 39 tons of coal converted into gas by the Dowson process. In a series of trials made with $3\frac{1}{2}$ horse-power gas-engines, it appeared that one indicated horse-power is obtained from a consumption of gas derived from 1.46 pounds of coal, after allowing 10 per cent. for impurities as well as for the gas burned in the manufacture. As the cost is less as the engine is larger, the author believes that an engine indicating 40 horse-power would require 90 cubic feet of Dowson gas per indicated horse-power per hour, requiring a consumption of coal of only 1.2 pounds per indicated horse-power per hour. (*Nature*, January, XXV, p. 281.)

Bouty has suggested a striking analogy of thermo-dynamic with thermo-electric phenomena and with the phenomenon of Peltier. (*J. Phys.*, June, II, I, p. 267.)

In 1856, Sir William Thomson showed that magnetization of iron and steel modified their thermo-electric properties. Strouhal and Barus have repeated the experiments for the case of longitudinal magnetization and have reached the same conclusion. Relatively to the hardness, the

influence of magnetization is extremely feeble. (*Wied. Ann.*, V, XIV, p. 54; *J. Phys.*, June, II, I, p. 291.)

The Thomson effect, or the transference of heat by an electrical current, has been investigated by Trowbridge and Penrose, both in nickel and carbon. The strip of nickel was 45^{cm} long, 2.6^{cm} wide, and 2^{mm} thick. The transference of the heat was found to be negative; *i. e.*, heat is absorbed by a current which passes from hot to cold, and evolved when it passes from cold to hot. On testing the question whether the phenomenon is reversible, the results were quite inconclusive, though tending to prove rather than to disprove it. No effect upon the Thomson effect was produced by a magnetic field. Repeating with copper the first experiment with nickel, the relative values for the two metals were obtained. Calling copper 2, the effect for nickel is 2.25, but of opposite sign. The carbon employed was that of a Faber pencil, and the direction of the Thomson effect was found to be negative, like nickel. (*Am. J. Sci.*, November, III, XXIV, 379.)

Elster and Geitel have investigated the electrical properties of flame, using the Thomson quadrant electrometer. They find that as long as either of the electrodes is outside the flame and the other inside, the outside one is positive and the other negative. The film of hot air outside the flame is always positive and the flame inside relatively negative. The result is the same with gas flames, candle flames, alcohol flames, and even in air flames burning in coal gas, the difference of potential being from $1\frac{1}{2}$ to $1\frac{3}{4}$ times that of a Daniell cell. If in place of two platinum wires, the upper one is copper, the E. M. F. rose to 2 Daniell cells, with aluminum it rose to 3, and with magnesium to 3.2 cells. With a lump of clean sodium it even reached 5 cells. Using 25 spirit lamps in series, a curved piece of platinum wire passing from the base of one flame to the tip of the next, a flame battery was produced. Finally, a difference of potential was observed between an incandescent platinum wire heated by a current and a second wire whose tip entered the hot-air currents from the former, no flame or combustion products being present. Hence a flame in itself is not a source of electrification at all. The authors conclude, (1) that the production of electricity by flames is independent of the size of the flame; (2) dependent on the nature and state of the surface of the electrodes; (3) dependent on the nature of the gases that are burning in the flame; and (4) dependent on the state of ignition of the electrodes. Hence it is a thermo-electric phenomenon and analogous to the counter E. M. F. of the arc. (*Wied. Ann.*, V, XXVI, p. 193; *Phil. Mag.*, September, V, XIV, p. 161; *Nature*, August, XXVI, p. 321.)

3. Electrical Measurements.

In his address as president of the British Association at the Southampton meeting, Dr. C. W. Siemens gave a *résumé* of the progress made in the establishment of electric units, culminating finally in the

adoption by the International Congress of Electricians, held in September, 1881, of the volt, ohm, coulomb, ampere, and farad. To these, however, he suggested that some others should be added. For the unit of magnetic quantity he adopted Clausius's suggestion, and proposed the name "weber." For the unit of electrical power or rate of work, *i. e.*, the power conveyed by the current of an ampere through the difference of potential of one volt, he proposed the name "watt." For the unit of intensity of magnetic field he suggested the name proposed by Thomson, of "gauss," the gauss being the intensity of field produced by a weber at the distance of one centimeter, and a weber the absolute c. g. s. unit strength of magnetic pole. Two poles, each of one weber strength, at one centimeter distance, will attract with the force of one dyne. For the unit of heat, produced in one second by one ampere of current flowing through one ohm resistance, he proposed the name "joule." Its value in absolute measure is 10^7 c. g. s. units, and therefore, taking Joule's equivalent as 4.2×10^7 units, it is the heat necessary to raise 0.238 gram of water one degree centigrade. (*Nature*, August, XXVI, p. 390.)

The Congress of Electricians delegated to an International Conference (1) the final determination of the ohm, (2) the investigation of earth currents and atmospheric electricity, and (3) the standard of light. This conference met in Paris, in October, 1882. As regards the ohm, *i. e.*, the length of a mercury column one square millimeter in section, whose resistance is equal to 10^9 c. g. s. units, several values were before the conference. These are, Kohlrausch's, 1.0593 meters; Rayleigh's (by B. A. method), 1.0624; (by the method of Lorenz) 1.0620; Glazebrook's, 1.0624; H. Weber's, 1.0611; W. Weber and Zöllner's, 1.0552; Rowland's, 1.0572; Dohrn's, 1.0546. But opposed to these is F. Weber's value, 1.0471, which is very near the B. A. ohm. So that the conference postponed further action, and recommended experimentalists (1) to compare their resistances with the standard of resistance which the French Government will furnish; (2) to compare the induction coils by Kohlrausch's method with the wire circuit; and (3) to use in their measurements the modified and improved method of Lorenz. The second section resolved that the various Governments be requested to favor regular and systematic observations of atmospheric electricity upon their systems of telegraph; that the study of storms should be undertaken in every country; that wires independent of the telegraph system should be provided for the special study of earth currents; and that, as far as practicable, the great subterranean telegraph lines, especially those running from south to north and from east to west, should be utilized for the same purpose, the observations in the different countries taking place on the same day. The third section expressed the opinion that the light emitted by a square centimeter of melting platinum would furnish an absolute standard. The conference

adjourned to meet on the first Monday in October, 1883. (*Nature*, November, December, xxvii, pp. 18, 144.)

Several excellent expositions of the absolute or c. g. s. system of electrical units have appeared since the adoption of these units by the International Congress of Electricians. Of these may be especially mentioned a lecture by Levy, delivered before the Société d'Encouragement (*Ann. Chim. Phys.*, May, V, xxvi, p. 85), and a paper by Pellat (*J. Phys.*, June, II, I, p. 255).

Clausius has published a paper on the different systems of measures for electric and magnetic quantities, in which he maintains that Maxwell has committed an error in his formula for the static magnetism unit. (*Phil. Mag.*, June, V, xiii, p. 381; *J. Phys.*, June, II, I, p. 273.)

To this paper there have been many replies: Everett (*Phil. Mag.*, V, xiii, pp. 376, 431); J. J. Thomson (*Ib.*, xiii, p. 427; xiv, p. 225); Larmor (*Ib.*, xiii, p. 429); Lodge (*Ib.*, xiv, p. 357); Wead (*Ib.*, xiii, p. 530); Sargant (*Ib.*, xiv, p. 395); and finally von Helmholtz (*Ib.*, December, xiv, p. 430). The latter says: "In all this I cannot perceive any mistake of Maxwell's; and his equations, derived from the formulation of the fundamental phenomena chosen by him, are altogether as consistent with each other and as correct, if understood in the sense of their author, as those of Professor Clausius."

Von Helmholtz has devised an electrodynamic balance, in which two coils are suspended, with their axes vertical, from the ends of the beam. Above these coils, which can rotate about their axes, are fastened two larger coils. These are so connected that one of the movable coils is attracted, the other repelled. The movable parts are connected with the fixed parts by bands of Dutch metal 8.3 meters long, 6 to 7 millimeters wide. The instrument will measure to 1-2000th a current balanced by one gram. (*Wied. Ann.*, V, xiv, 52; *J. Phys.*, January, II, I, p. 52.)

Sir William Thomson has contrived two new forms of galvanometer, which he calls graded galvanometers, which have for their object the determination of the value sought without calculation. One of these is for measuring differences of potential in volts, and is called a potential galvanometer. The other measures current strength in amperes, and is called a current galvanometer. The plan of both instruments is essentially the same. Each consists of a coil and a magnetometer. The coil of the former instrument is a ring of circular section, 14^{cm} in outside diameter and 6^{cm} inside; the diameter of its section, therefore, is 4^{cm}. It is made of German silver wire covered with silk, of No. 32 B. w. G., and contains 2,200 yards wound in 7,000 turns, having a resistance of 6,000 ohms. It is saturated with paraffin and served with silk ribbon. This coil is firmly attached to one end of a horizontal wooden platform, its plane being vertical. The magnetometer consists of a system of magnets properly supported so as to be free to

turn round a vertical axis. Each magnet is 1^{cm} long, made of glass-hardened steel wire, No. 18. Four of these form the needle, and the sides of the mounting are prolonged so as to form an index, moving over a graduated scale, the whole inclosed in a quadrantal shaped box. A semicircular magnet placed vertically over the angle of the quadrant intensifies the field when necessary. The magnetometer box is placed on the platform so that the axis of the needle passes through the center of the coil and can be moved to and from it at pleasure. The coil of the current galvanometer is made of stout copper strip 1.2^{cm} broad, 1.5^{cm} thick, wound in six turns and insulated with asbestos paper. It will measure currents up to 100 amperes; and with a single coil of still heavier copper, currents of 1,000 amperes. (*Nature*, September, XXVI, p. 506.)

Gray has published a valuable article upon the graduation of galvanometers for the measurement of currents and potentials in absolute measure, in which he discusses the method of determining the horizontal component of the earth's magnetism, the theory and construction of the standard galvanometer, the theory and relations of electric units, and the method of graduating and using Sir William Thomson's graded galvanometers. (*Nature*, XXVII, pp. 32, 105, 319, 339.)

Boys has suggested a current meter based on a new principle. The rate of a pendulum clock depends on gravity and is proportional to the square root of its strength. That of a watch depends on the strength of the hair-spring and is proportional to the square root of its strength. The force due to an electric current is proportional to the square of the current strength. Hence if a portion of a circuit is capable of vibrating under electromagnetic force, the speed of vibration will be proportional simply to the current strength. If, now, such a contrivance takes the place of the balance of a pendulum clock, the clock will measure electric current instead of time. A meter of this kind has been constructed in which the controlling power depends on iron crescents and solenoids, and in which a portion of the main current is shunted through secondary solenoids giving an impulse at each swing, when the balance is in its neutral position, thus producing no effect on the rate of oscillation. (*Nature*, February, XXV, p. 355.)

Wartmann has contrived an apparatus which he calls a "rheolyzer" for varying the strength of a derived current from zero to a maximum, indicating at the same time the ratio of these variations. A graduated metallic ring, round a column carried by a tripod, incloses a thick disk of glass or ebonite resting on six radii of the ring. In the upper surface of the disk is a circular trough of mercury receiving two copper electrodes at the bottom, 180° apart. A cross-bar on the top of the column, on which it turns as an axis, acts as a movable Wheatstone bridge; it has two terminal verniers, and two screws dipping in the mercury. These latter are insulated, but communicate through central

binding screws with a mirror galvanometer. The strength of the shunt current varies as the bridge is displaced. (*Nature*, June, XXVI, p. 139.)

Von Fleischl has claimed this apparatus as having been constructed by him in 1877, and described under the name "rheonom." He says it has been in Prof. E. Du Bois Reymond's cabinet for more than five years. (*Nature*, December, XXVII, p. 127.)

Stone has constructed an electro-dynamometer, in which the suspended coil was made of aluminum wire, was $1\frac{1}{4}$ inches internal diameter, contained forty-two turns of wire in five layers, weighed $6\frac{1}{4}$ grams, and had a resistance of half an ohm. Its performance was satisfactory. (*Nature*, June, XXVI, p. 201.)

Slotte has given a method for calculating the length of the platinum wire belonging to the Wheatstone bridge (which cannot always be determined by direct measurement), which is founded on that of comparing and exchanging resistances. (*Wied. Ann.*, V, XV, p. 176; *Phil. Mag.*, March, V, XIII, p. 227.)

Sloguinoff has contrived a simple form of compensator for use with the method of Du Bois Reymond for measuring electromotive forces by the method of compensation. Two wires of equal length are stretched parallel to one another and connected together at one end. To the other ends a standard cell is connected. To one of these same ends one wire of the battery to be tested is connected, a galvanometer being in the circuit, the other battery wire being attached to the end of a third wire parallel to the others. Across the three wires is a slider for adjusting the distance. (*J. Phys.*, March, II, I, p. 138.)

The International Electrical Congress adopted the ohm as the unit of resistance and defined it to be 10^9 c. g. s. units. But they left to a special commission the determination of the length of a prism of mercury one millimeter in cross-section which should have this resistance. In consequence a large number of important papers has been published upon the best method of making this measurement; or, what is practically the same, of determining the actual value of the B. A. unit called the ohm. Before the meeting of the Congress, Rayleigh and Schuster had repeated the original determination, using Thomson's method and the identical apparatus with which the B. A. Committee worked. They find that the standard called an ohm by the committee is 0.9893×10^9 c. g. s. units; a value near that obtained by Rowland, 0.9911×10^9 . (*Proc. Roy. Soc.*, April, 1881; *J. Phys.*, January, II, I, p. 43.)

Joubert has suggested a method for the determination of the ohm founded on the measurement with the electrometer of the electromotive forces in an induced circuit. (*Comptes Rendus*, June, XCIV, p. 1519.)

Lippmann has proposed a thermoscopic method for the determination of the ohm, which requires no measurement of amount of heat, nor an exact value of Joule's equivalent. (*Comptes Rendus*, October, XCV, p. 634.) The various other methods which have been proposed have been discussed by Lippmann (*J. Phys.*, July, II, I, p. 313); by Lorenz (*J. Phys.*,

November, II, I, 477); by G. Wiedemann (*Electrotechnische Zeitschrift*, July; *Phil. Mag.*, V, XIV, p. 258); and by Rayleigh (*Phil. Mag.*, November, V, XIV, p. 329.)

Naccari and Guglielmo have studied the electromotive forces of batteries which are not constant, and find that the nature of the plate on which the hydrogen is evolved affects the value of the electromotive force of a single liquid cell; and that the electromotive force of such a couple varies always inversely to the intensity of the current, and that this variation does not appear to be produced by the oxygen dissolved or by the zinc sulphate produced. (*Il Nuovo Cimento*, III, IX, p. 162; *J. Phys.*, November, II, I, p. 521.)

Mazzotto has examined the constants of various cells, the internal resistance being determined by Mance's method, and the electromotive force being calculated from this and the current strength. He finds that in all the batteries tested the electromotive force diminishes continuously when the current strength increases, and conversely. The internal resistance is greater as the battery is longer in action and as the current is weaker. (*J. Phys.*, November, II, I, 522.)

Minchin, in a paper on the determination of electromotive force in absolute electrostatic measure, has discussed the theory of and given the results obtained with his absolute sine electrometer (referred to in this report a year ago). He finds, for example, the electromotive force of a Daniell cell with his instrument to be 0.00352 absolute electrostatic unit; while the value as obtained by Sir William Thomson, was 0.00374. (*Nature*, January, XXV, p. 278.)

Rayleigh, in a paper read before the Physical Section of the British Association upon the absolute measurement of electrical currents, said that the measurement of current strength in absolute measure was more difficult than that of resistance. All the methods hitherto employed require either accurate measurements of the horizontal intensity of the earth's magnetism or of coils of small radius and many turns. This latter is difficult to evaluate. Kohlrausch's method is free from this objection, but it requires a knowledge of the moment of inertia, a quantity not easy accurately to determine. Mascart's method is simple to think about but not calculated to secure precise results. (*Nature*, September, XXVI, p. 465.)

With the aid of a Mascart electrometer, Berthelot has studied the polarization of a zinc-carbon couple. When first set up, the electromotive force surpasses that of a zinc-platinum couple in the ratio 1 : 1.76, and a Daniell cell in the ratio 1 : 1.29, or even 1 : 1.37. It falls, however, very rapidly on closed circuit, becoming equal to that of a Daniell in a few minutes, and falling to 0.83 of a Daniell in a few hours. After thirty-six hours it became only half that of the Daniell. If the plates be now washed several times in water frequently renewed, they give the original electromotive force again. (*Ann. Chim. Phys.*, September, V, XXVII, p. 106.)

Edlund has discussed the phenomena which bear on the question of the electrical resistance of vacuum, and comes to the conclusion that they all indicate that a vacuum is a good conductor of electricity, the resistance commonly experienced taking place between the electrode and the vacuum. "It seems to me," he says, "that in drawing, from the known impossibility of an electric current traversing the most perfect vacuum between electrodes, the conclusion that a vacuum is absolutely non-conducting, the same mistake has been made as when from the circumstance that the sun rises in the east and sets in the west, it was believed that one might infer that the sun in reality goes round the earth." (*Phil. Mag.*, V, XIII, p. 1,200; *J. Phys.*, May, II, I, p. 235.)

Rayleigh in conjunction with Mrs. Sidgwick, has determined the specific resistance of mercury. Four tubes were used to contain the mercury, from 87 to 194 centimeters long. Tube I gave the value 0.95416, tube II 0.95419, tube III 0.95416, and tube IV 0.95427. Hence the mercury unit is 0.94130×10^9 C. G. S. (*Nature*, May, XXVI, p. 94; *J. Phys.*, July, II, I, p. 327.)

S. P. Thompson has made a series of measurements to prove that the change in electric resistance produced by pressure on carbon is solely due to an increase in the perfection of the superficial contact. The carbon used was Carré's electric light carbon. (*Phil. Mag.*, April, V, XIII, p. 262; *Nature*, March, XXV, p. 427.)

Mendenhall, using the soft carbon buttons made for the Edison telephone, finds not only that the resistance is diminished by pressure, but also that this decrease in the resistance continues for some time. When, for example, a carbon button having a resistance of 11.67 ohms was pressed by a weight of 50 grams, this resistance fell at once to 3.52 ohms; but it continued to fall for an hour and a half, and even for 24 hours. In one case pressure was continued for a week; but upon removing the pressure the original resistance was at once recovered. (*Am. J. Sci.*, July, III, XXIV, p. 43.)

4. *Electric Spark and Electric Light.*

Nipher has put into practice at the observatory of the Washington University, Saint Louis, a simple device for the transmission of clock-beats upon telegraph lines. In it two platinum plates attached by a light framework fastened to the lower end of the pendulum cut alternately a globule of mercury just below them. As the break is determined by the distance apart of the plates, and as these are adjustable, the length of the break may be made whatever is desirable. (*Am. J. Sci.*, July, III, XXIV, 54.)

Baille, by means of a special apparatus, has measured the differences of potential corresponding to a given distance of the explosive discharge. He concludes, (1) for the same length of spark, the potential is a maximum when the two electrodes have the same curvature; (2) the potential varies from the maximum in proportion as the difference be-

tween the curvature of the electrodes is greater and the potential itself higher; (3) for a given length of spark, taken between electrodes of equal curvature, the potential varies with the diameter of the sphere, so that a sphere can be found of such diameter that the potential shall be a maximum; (4) the diameter of these equal spheres corresponding to the maximum is as much smaller as the potential is itself smaller. These two values increase together, but not proportionally; (5) the potentials V corresponding to the explosive distances δ between two planes can be expressed by the empirical hyperbola $V^2 = 10500 (\delta + 0.08) \delta$. (*J. Phys.*, April, II, I, p. 169; *Ann. Chim. Phys.*, April, V, XXV, p. 486.)

Reitlinger and Wachter explain the Lichtenberg figures by a disgregation of the electrodes by the passage of positive electricity. Those positive figures which are radiating in form, are attributed to the transportation electrically of particles of dust torn from the positive electrode; while those positive and negative figures alike, which have rounded contours, are attributed to the transport of the dust by the gases shaken by the discharge. (*J. Phys.*, April, II, I, p. 203.)

Goldstein has investigated the question of the influence of the shape of the cathode on the distribution of the phosphorescent light in Geissler's tubes, and figures some remarkable forms obtained. (*Phil. Mag.*, December, V, XIV, p. 455.)

Spottiswoode, in a lecture at the Royal Institution upon matter and magneto-electric action, gave a *résumé* of the work accomplished by himself and Moulton in studying the electric discharge in rarefied gases, especially with the use of alternating currents. (*Nature*, April, XXV, p. 539.)

Jacquelain has presented a memoir to the French Academy on the purification of graphitoidal carbons, either natural or artificial, with special reference to the electric light. He concludes that the luminous power and the steadiness of the voltaic arc from a pure carbon, obtained either directly or by a method of purification, increase with the density, the hardness, and the purity. The natural graphitoidal carbon from Siberia has the unexpected property of giving when purified double the light of the unpurified material. Its light-giving power surpasses by one-sixth that of the purest artificial carbon, although a very hard and brilliant pure artificial carbon has given an illumination equal to 236 carrels. Though the hardness of gas carbon is greater, its density is less than that of the Siberian graphite, the former ranging from 1.90 to 1.99, while that of the latter is from 2.28 to 2.41. To this its superior light-giving power is ascribed. (*Ann. Chim. Phys.*, December, V, XXVIII, p. 537.)

Foussereau has published an article on electric lighting, in which the subject is divided as follows: 1st. Preparation of the carbons. The carbons most in use in France are those of Carré, made of coke, calcined lampblack, and thick gum-water; of Gauduin, made of the coke from

tar or petroleum, mixed with lampblack, and of Napoli, made of gas coke and tar. 2d. Voltaic arc lamps, monophotal, like those of Foucault, Serrin, Jaspar, &c. 3d. Polyphotal lamps, as the Gramme, which is a shunt lamp; the Siemens and the Brush, which are differential, and the Brockie, which is periodic in its action. 4th. The distribution of lights (1) all in multiple arc, as in the Gülicher system; (2) all in series, as in the Brush, and (3) upon the different circuits of a multiple machine, as in Mersanne's system. 5th. Electric candles, as the Jablochhoff, Jamin, and Soleil. 6th. Incandescent lamps, divided into (1) those in air or an inert gas, as the Reynier, Werdermann and Sawyer, and (2) those in a vacuum, like the Edison, Swan, Maxim, and Lane Fox. 7th. Intensity of the light and its distribution in space. (*J. Phys.*, February, March, II, I, pp. 72, 125.)

Ayrton and Perry have presented to the London Physical Society the results of their experiments on the resistance and counter-electromotive force of the arc. The latter was measured by a voltmeter placed between the terminals of the lamp. When the distance between the carbons was constant the electromotive force diminished as the current increased. With a constant current, the electromotive force increased rapidly at first with an increasing length of arc, afterward more slowly. To produce an arc one-third of an inch long, 80 volts are required. For further increase, the electromotive force is proportional to it. (*Nature*, December, xxvii, p. 215.)

Tommasi has shown that when the arc is made to pass between two metallic tubes, of copper for example, so arranged that a rapid current of cold water may flow through them, and placed horizontally, the illuminating power is very much weakened, the arc is very unstable, it does not set fire to paper, it appears to be formed of a luminous globule moving up and down between the rheophores, it is extinguished by the presence of a magnet, being attracted or repelled according to the pole presented, and a large amount of ozone is produced. (*Comptes Rendus*, xciii, p. 716; *Phil. Mag.*, January, V, xiii, p. 75.)

Jamin has studied the effects produced when the alternating current of a Gramme machine passes between carbon points in a vacuum. Gramme machines with alternating currents resemble both batteries and induction coils, but they differ from batteries by the great intensity of their currents. Hence, the effects will be those of batteries, with an intensification due to the high tension, and those of the induction coil, with the advantage of increased quantity. In place, therefore, of a single arc in air several can be maintained; the author has maintained 60 from a machine which originally supported only 8. When, now, this alternating current is used to maintain an arc in an electric egg, as soon as the exhaustion reaches 12^{mm} the light begins to spurt out spontaneously from the entire surface of the carbons, both of them being enveloped with the blue aureole noticed in Geissler tubes around the negative pole. The carbons become heated to bright redness throughout, and are rapidly

volatilized. The vessel becomes filled with a blue gas similar to iodine vapor, which deepens, becoming like indigo. The vapors condense on the sides of the globe, making it opaque. The deposit resembles finely divided carbon, but dissolves with effervescence in nitric acid. The luminous effect is more striking when copper electrodes are used. (*Comptes Rendus*, XCIV, pp. 1271, 1615; *Phil. Mag.*, July, Supplement, V, XIII, p. 538.)

Abfank has invented a new arc lamp, which was described by Preece at the Southampton meeting of the British Association, in which the regulating arrangement is separated from the lamp. The lower carbon is fixed, the upper attached to a brass rod movable in the core of an electro-magnet and lifted by a clutch when the magnet is charged. The magnet and carbon holder are fastened to the end of a rack, the pinion of which is controlled by an electro-magnetic brake. The regulator is differential in its action, and throws a shunted current on to the electro-magnet of the brake whenever the resistance between the carbons becomes too great, thus allowing the carbons to approach. A cut-out is attached, by which the lamp is taken out of circuit when necessary. (*Nature*, September, XXVI, p. 526.)

In his address as chairman of the Council of the Society of Arts, Siemens took for his subject electric lighting and the transmission of force by electricity, considering the more practical side of the electrical question. He made a calculation of the cost required to light the parish of St. James, with its 30,000 people, 3,000 houses, and 784,000 square yards of area, and concludes that an expenditure of 12 horse-power per house would be required. The cost of the electricity he assumes to be in London one shilling per 10,000 watts (ampere-volts). Hence, to maintain 64,000 Swan lights it would cost £16 per hour. The total cost of the plant he puts at £177,000. At the same rate the plant necessary for the entire city would cost £14,000,000. The cost of each lamp per year he estimates at 21s. 9½d.; while the same light by gas at 2s. 8d. a thousand feet would cost 29s. (*Nature*, November, XXVII, p. 67.)

In a lecture before the Royal Institution, Swan has discussed the subject of incandescent lighting with special reference to its economy. The great economy of high incandescence he strikingly illustrated by passing through one of his lamps one unit of current. The light obtained was equal to two candles. When one and a half units of current was sent through the lamp, it gave thirty candles; so that for an increase of current of one-half, involving a doubling of the energy expended, fifteen times the light was produced. In conjunction with Mr. Stearn, in 1878, he reached the result that "when a well-formed carbon filament is firmly connected with conducting wires and placed in a hermetically sealed glass ball perfectly exhausted, the filament suffers no apparent change even when heated to an extreme degree of whiteness." "The first lamp having this elementary character (a simple bulb pierced by two platinum wires supporting a filament of carbon)

ever publicly exhibited was shown in operation at a meeting of the Literary and Philosophical Society of Manchester, in February, 1879." On the question of cost, he claims 200 candles per horse-power; but calling it 150, we have for the 50 horse-power obtainable from 1 cwt. of coal, 7,500 candles, as against 3,000 from an equivalent value of gas. (*Nature*, August, XXVI, p. 356.)

The experimental committee of the jury of the Paris Electrical Exhibition, of which Tresca was president, appointed the following sub-committee to make the tests on incandescent lamps: Barker (chairman), Crookes, Hagenbach, Kundt, and Mascart. They examined the Edison, the Swan, the Lane Fox, and the Maxim lamps, the only four exhibited. The following are their results: At 16 candles, the candles produced per horse-power of current were, for the Edison lamp, 196.4; for the Swan, 177.9; for the Lane Fox, 173.6; and for the Maxim, 151.3. At 32 candles the Edison lamp gave 307.25 candles per horse-power of current; the Swan, 262.49; the Lane Fox, 276.89; and the Maxim, 239.41. Subsequently a committee, consisting of Tresca, Allard, Le Blanc, Joubert, and Potier, made tests of these lamps as collateral to their tests of machines. Four Swan lamps, six Lane Fox lamps, one hundred Maxim lamps, and five hundred and twenty-eight Edison lamps were tested in the same circuit, the following results being the mean of all these lamps. The results of the tests made by the first committee refer to the light emitted in a horizontal plane, the direction being 45° to the plane of the loop. Those of the second are expressed in terms of mean spherical intensity calculated from the measurements. For comparison, therefore, the results of both measurements are given below, the mean spherical intensities being calculated for the former measurements, the first and second referring to the two committees:

	Maxim.		Edison.		Lane Fox.		Swan.		
	1st.	2d.	1st.	2d.	1st.	2d.	a.	b.	
Mean spherical intensity..	1.25	2.80	1.36	1.57	1.16	1.64	1.16	2.32	2.19
Candles per H.P. of current	118.0	151.0	145.3	172.0	119.8	130.6	122.7	211.1	204.7

"Although the two sets of experiments were made with a different object, and by methods entirely different, it will be observed that the figures of the one approach closely those of the other, thus characterizing very clearly each of the four systems of lamps by their electrical data." (*Comptes Rendus*, November, XCV, p. 946.)

5. *Electro-Chemistry.*

The weight of water decomposed by a current whose strength is one electro-magnetic unit, passing for one second of time, has been variously stated. Weber gives it as 0.9376 milligram; Bunsen, as 0.9265; Casseilmann, 0.9387; Joule, as 0.9222; and Cazin, as 0.9372. Mascart has undertaken a new determination of this value. To this end he submitted to electrolysis water acidulated with phosphoric acid and solutions of silver nitrate and copper sulphate. For the measurement of current

he used an electro-dynamometer of special construction, consisting of two flat coils, in the center of which a cylindrical coil was suspended from the scale-pan of a balance, the axes of the three coils being coincident. As a result the author finds that a current whose strength is equal to one C. G. S. unit decomposes 0.9373 milligram of water per second, and, therefore, a fraction equal to $0.9373 \div 9$, or 0.10415 of the equivalent of any other substance expressed in milligrams. Conversely the current capable of producing in one second the electrolysis of one equivalent of a body expressed in milligrams is 96 amperes. Taking the gram as the unit of weight, the electro-chemical equivalent of water is 9.373×10^{-4} . (*J. Phys.*, March, II, I, p. 109.)

Streinitz has assigned to voltaic polarization the production of the oxygen and hydrogen gases which appear at each of the electrodes when the discharges of a Leyden jar are passed through water. By the aid of a quadrant electrometer he has measured the difference of potential of the electrodes. He finds that when the electrodes are narrow this difference changes sign if the number of discharges does not exceed a certain limit. The same inversion appears after a few minutes with voltaic currents of short duration and disappears when the voltmeter is completely polarized. (*J. Phys.*, April, II, I, p. 202.)

Tommasi has given experimental evidence to disprove Bourgoïn's statement that water is not an electrolyte. He maintains that water can be electrolyzed by the current of a very feeble battery, provided that the heat liberated by the battery is equal to that absorbed by the water in decomposing into its elements (69 calories). (*Comptes Rendus*, April, xciv, p. 948; *Phil. Mag.*, May, V, xiii, p. 377.)

Berthelot has given the results of a large number of electrolytic experiments in two important papers—one on the limits of electrolysis, and the other on the electrolysis of hydrogen peroxide. In both he gives the thermo-chemistry of the action which appears to control the results. (*Ann. Chim. Phys.*, September, V, xxvii, p. 110.)

Gore has investigated minutely the phenomena of the electrolysis of copper sulphate, and finds that in this, as in nearly all cases of electrolysis, chemical and electro-chemical forces coexist and operate independently at the same surfaces of liquid and metal. The greatest obstacle in finding the electro-chemical equivalent of copper is the difficulty of determining how much the ordinary chemical corrosion is decreased at the anode or increased at the cathode by the electric current. The method does not admit of a great degree of accuracy, because the chemical corrosion of copper, even in a cold neutral solution of copper sulphate, causes a loss of that metal, and prevents the true weight being obtained. Hence the method of measuring the strength of a current in electric lighting by the electrolysis of a solution of copper sulphate must be more or less inaccurate. (*Nature*, March, xxv, p. 473.)

Bartoli and Papasogli have discovered that when dilute sulphuric acid is electrolyzed with gas carbon positive electrodes, there is formed

a solid black amorphous substance, having the composition $C_{11} H_2 O_4$, and which, from its characteristic property of being transformed into mellitic acid by oxidizing agents, they call mellogen. If phosphoric acid be electrolyzed, a similar body is formed, which, since it contains phosphorus, they call phosphomellogen. (*J. Phys.*, December, II, 1, p. 571.)

Krouchkoll has experimented to determine whether the variation of the friction produced in the electromotograph of Edison by the passage of a current is a result due to electrolysis. His apparatus consisted of a shallow glass dish, having a piece of polished glass at bottom, placed on a horizontal metal disk, rotated about a vertical axis by means of a small Gramme machine; a rubber made of a series of small brushes of platinum wire, fixed in ebonite, rubbed against the glass during the rotation, tending to carry with it the needle of a sensitive balance, to which it is fastened. In the dish was sulphuric acid diluted with five parts of water, which moistened the brushes. One pole of the battery was connected to the brushes; the other was fastened to a copper strip immersed in copper sulphate solution to avoid polarization. This solution was contained in a porous cup, immersed in a second porous cup containing water and standing in the acid in the dish. On starting the movement of rotation and adjusting the balance to equilibrium, it is easy to show by the inclination of the needle that the polarization by oxygen increases the friction and that polarization by hydrogen diminishes it. Half a Daniell cell is quite sufficient for the experiment, though the effect increases with an increase of the electromotive force used. (*Comptes Rendus*, July, xcv, p. 177.)

Planté has found that the long process of forming his accumulators is shortened if they are warmed during charging. The temperature best for this purpose is between 70° and 80° C., at which limit the opposing electromotive force is somewhat less than when cold, and the resistance very much less. He does not find it advantageous to exceed this limit. Thompson suggests that the reason may be that at the above temperature the gases are evolved under normal conditions, no ozone being formed. (*Nature*, February, xxv, p. 376.)

Gladstone and Tribe have published a series of valuable papers on the chemistry of the Planté and Faure accumulators, in which they have considered (1) local action, (2) the charging of the cell, (3) the discharge of the cell, and (4) the function of sulphate of lead. (*Nature*, xxv, pp. 221, 461; xxvi, pp. 251, 268, 342, 596, 602.)

A sub-committee of the experimental jury of the Electrical Exhibition has tested in the Conservatoire des Arts et Métiers the efficiency of the Faure secondary battery. Thirty-five accumulators of the spiral form, each in a stoneware pot 35^{cm} high and 25^{cm} in diameter, were charged in series by the current from a Siemens dynamo driven by a steam engine. The working electromotive force of an accumulator was found to be from 2.08 to 2.17 volts. The battery was charged for 22 hours 45 min-

utes with a current of the average strength of 8.5 amperes, requiring 1.558 horse-power. The total work expended in charging, therefore, was 6,020,000 kilogrammeters. The battery was then discharged through eleven Maxim lamps, and required eleven hours. From this it appeared that 60 per cent. of the energy stored in the accumulators could be recovered as electric current. (*Nature*, January, March, XXV, pp. 299, 476.)

Ayrton and Perry have published an account of their experiments on the Faure accumulator, using a single cell containing 81 pounds of red lead. It gave on discharge a mean current of 18 amperes for eighteen hours, or a total work of 1,440,000 foot-pounds, equivalent to a horse-power for 43 minutes; thus giving a capacity of 18,000 foot-pounds per pound of red lead. They find that up to a million foot-pounds the loss in storage need not be greater than 18 per cent., provided the charging and discharging be slow. (*Phil. Mag.*, July, V, XIV, p. 41.)

Ayrton, in a lecture delivered at the London Institution in March upon the storage of energy, discussed at length the economy of the accumulator for commercial purposes, as lighting and power. (*Nature*, March, XXV, p. 495.)

De Kabath has devised a new form of secondary battery which is practically a Planté, but which has been specially devised for exposing a very great surface. Corrugated strips of lead are packed closely together to form the plates. The forming is done with the current as in the Planté battery. (*Nature*, June, XXVI, p. 180.)

At the Montreal meeting of the American Association, Barker presented a paper giving the results of his experiments with the Faure and the Planté secondary batteries. He takes the ground that the action of the battery is a purely chemical one, "the amount of electricity obtained from a given secondary battery being proportional to the amount of electrolytic products deposited upon its plates." The Faure cells used were of the type exhibited at the Paris Exhibition, each exposing about 1.5 square meters of surface, and weighing 17 kilograms. The electromotive force was about two volts as a mean, and the internal resistance 0.02 ohm. In charging the 32 cells employed, the current strength was generally 15 amperes, a specially-devised cut-out being put in circuit to prevent the discharge of the battery through the machine if from any cause the electromotive force of the latter fell. The author concludes that to the very considerable local action which takes place in these batteries, and to the want of uniformity in the different cells, is due in large measure their low efficiency. (*Proc. Am. Assoc. Adv. Sci.*, 1882, XXXI, 207.)

CHEMISTRY.

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The year 1882 is marked by great industry in all departments of chemistry; no startling announcements have been made, but several extremely interesting syntheses of organic bodies have been accomplished, viz, tyrosine and uric acid, both of the animal organism. Great activity is noted in the revision of the atomic weights. Progress has been made in unraveling the knotty problem of the rare earths in cerite, samarskite, and gadolinite, but no satisfactory conclusions have been reached as to the existence of the larger number of elementary bodies announced since 1877.

In the brief space at our disposal we can barely note the salient features of the year's work in a series of short abstracts, and these we confine chiefly to pure chemistry, paying little attention to analytical and industrial chemistry. Periodical literature, devoted exclusively to chemistry and its applications, is becoming voluminous; the fifteen principal journals of America, England, France, and Germany publish annually about 18,000 pages; in this rough estimate journals of physics and transactions of societies are not included, and both classes of serials contain much chemical material. We need hardly say that no attempt is made in the following pages to chronicle the prodigious amount and variety of work contained in these and other sources of information.

PHYSICAL AND INORGANIC CHEMISTRY.

On the Reciprocal Solutions of Liquids.—Wladimir Alexejeff has devoted eight years to a study of the mutual solutions of mixed liquids, and he finds that the hypothesis proposed by Dossios is subject to exceptions. The latter stated that the mutual solubility of liquids increases with the rise in temperature, but Alexejeff finds that in certain bodies (isobutyl alcohol, for example) the solubility diminishes with an increase of temperature. He also discovers that the solubility decreases to a definite point and then increases again, or, in other words, that a *minimum* of solubility exists, just as certain solids have a maximum of solubility.

When phenol and water are brought together two layers form; the lower is a solution of phenol in water, the upper a solution of water in

phenol. Now the mutual solubility of these liquids increases with the temperature, and at a certain point (68° for *pure* phenol) the two liquids mix in all proportions. Many liquids, such as aniline and water, follow the same law; solids, too, obey the same law, as is shown by the mutual action of water and salicylic acid. The author claims that the solutions of solid and of liquid salicylic acid exhibit a true physical isomerism. (*Bull. Soc. Chim.*, XXXVIII, p. 145.)

Molecular Structure and Physical Properties.—That a close connection exists between the structure of molecules and the physical properties of the substances composed of these molecules is becoming more and more evident. Pawlewski finds that the "critical temperatures" of isomeric ethers are very nearly identical, and that isomers containing doubly-linked atoms of carbon have a higher critical temperature than those in the molecules of which the carbon atoms are singly linked. (*Berichte d. chem. Ges.*, XV, p. 460.)

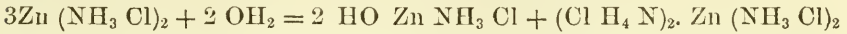
Determination of Gas Densities.—H. Goldschmidt and Victor Meyer have devised a simple method for determining gas densities in an expeditious manner. The process was employed at first in connection with experiments made on the density of cyanogen at various temperatures, but is applicable to many bodies. The vessel employed is first filled with pure, dry air of the temperature at which the density is to be taken; the air is then displaced by hydrochloric acid gas (free from air), collected over water and measured. The hydrochloric acid gas is in turn replaced by air. The gas to be examined is then introduced until all the air is expelled, and this gas is again displaced by hydrogen, or by air, and collected in a potash bulb containing a liquid capable of completely absorbing it. The increase in weight of the potash bulb gives the weight of the gas; the weight of an equal volume of air at the same temperature is determined from the volume collected, and the quotient gives the density sought.

The apparatus consists of a glass cylinder 200^{mm} long, 30^{mm} in diameter, with a capillary tube at each end, the extremities of which tubes rise above the upper end of the cylinder and are bent at right angles. This apparatus is heated in a glass tube with a bulbous extremity 400^{mm} long, and of sufficient size to contain the liquid, whose boiling point is the temperature of measurement. The liquids used in the outer vessel are water, aniline, amyl benzoate, and diphenylamine. For higher temperatures boiling sulphur and penta-sulphide of phosphorus are used, in which case the inner vessel receives a spherical form, and the outer vessel is made of iron.

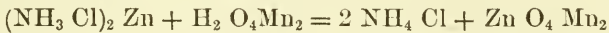
The authors obtained by this process a density of 1.53 for carbonic anhydride, and of 1.26 for hydrochloric acid gas, figures exactly equal to the theoretical values.

The apparatus can also be employed as an air thermometer. Sulphur was found to boil at 426° C. (*Berichte d. chem. Ges.*, XV, p. 137.)

Chemical Reactions in the Leclanché Cell.—Dr. Edward Divers has presented the following reactions: Zinc is slowly acted upon by a solution of ammonium chloride, and crystals of zinco-diammonium-chloride are formed; this is decomposed by water alone into an insoluble and a soluble portion, probably as shown in this equation:

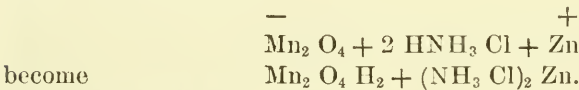


Zinco-diammonium-chloride dissolved in solution of ammonium chloride acts gradually on artificially prepared hydrogen manganite, $\text{H}_2 \text{O}_4 \text{Mn}_2$, causing manganese to go into solution, and the precipitation of zinc on the manganite, probably thus:

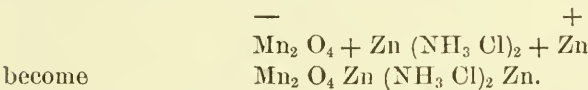


These experimental facts lead the author to the following theory of the action of the cell:

Primary action.—Formation of hydrogen manganite and zinco-diammonium-chloride.

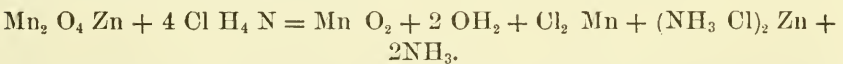


Secondary actions, causing polarization.—The hydrogen manganite acts locally upon the zinco-diammonium chloride solution, and forms zinc manganite and ammonium chloride; this proceeds more rapidly by galvanic action when the cell is at work, thus:



The zinc manganite and the hydrogen manganite by coating over the manganese dioxide, protect it from the primary action of the ammonium chloride and zinc, and thus cause polarization of the cell.

Secondary actions, causing depolarization.—The ammonium chloride dissolves manganous and zinc oxides out of the manganite, the manganous oxide liberating ammonia:



The manganous chloride dissolves in the presence of the free ammonia as a double chloride of manganese and ammonium. By the solution of these oxides the manganese dioxide of the manganite becomes active again. The depolarizing action proceeds slower than the polarizing, and therefore the battery requires to be left uncircuited, in order to recover its full power after use. (*Chem. News*, XLVI, p. 259.)

Atomic Weights of the Elements.

Carbon.—Roscoe has redetermined the atomic weight of carbon by the direct combustion of the diamond. If $\text{O} = 15.96$, he obtained as a

mean of six experiments $C = 11.9757$. Dumas and Stas in 1840 obtained 11.9708. (*Comptes Rendus*, CIV, p. 1180.)

Uranium.—Zimmermann has prepared metallic uranium by Pélignot's method and studied its properties. Its specific gravity is 18.685, and its specific heat between 99° and 0° is .02765; the latter number multiplied by 240 gives a product of 6.64, which agrees with the mean atomic heat indicated by Dulong and Petit's law. This settles the controversy concerning the correct value in favor of 240 and in accordance with Mendelejeff's classification. (*Berichte d. chem. Ges.*, XV, p. 847.)

Glucinum.—Dr. James Blake thinks that the evidence derived from the physiological action of the salts of glucinum may be of use in determining its true position among the elements. He finds that the effects produced by the introduction into the blood of salts of Be are the same as those caused by the salts of alumina and of ferric oxide. He regards glucinum as a member of the aluminium group of metals. (*Chem. News*, XLV, p. 111.)

Aluminium.—The atomic weight of this element has been subjected to a painstaking revision by Prof. J. W. Mallet. The general mean of 30 experiments gives $Al = 27.032$, with a probable error of ± 0.0045 . [Oxygen = 15.961.] (*Chem. News*, XLV, pp. 256 et seq.)

Rubidium.—Charles T. Heycock has redetermined the atomic weight of rubidium with the view of testing its relation to Prout's hypothesis. The figures obtained by titration of the chlorine in pure chloride of rubidium are 85.344; and those by titration of the bromide are 85.387, results which lead the author to the conclusion that at present rubidium cannot be regarded as conforming to Prout's hypothesis. (*Report of British Assoc.*, in *Nature*, XXVI, p. 467.)

Didymium.—Brauner has determined the atomic weight of didymium as 146.18, and that of lanthanum as 138.88. (*J. Chem. Soc.*, XLI, p. 68.)

Yttrium has been prepared by Cleve free from terbium and its atomic weight redetermined. He assigns the value 88.9 to Y''' when $O = 15.9633$. (*Comptes Rendus*, December 11, 1882.)

Thorium.—L. F. Nilson has redetermined the atomic weight of thorium by ignition of the carefully purified sulphate: $Th(SO_4)_2 \cdot 9H_2O$, and obtains as a mean of ten experiments 232.40. (*Berichte d. chem. Ges.*, XV, p. 2519.)

A recalculation of the atomic weights, by Prof. E. W. Clarke.—Brief mention must be made in this connection of the systematic recalculation of the atomic weights carried out by Professor Clarke and published by the Smithsonian Institution as Part V, of the Constants of Nature. Chemists are under great obligations for this invaluable treatise.

Composition of the Atmosphere.

Several chemists have carried on independently more or less elaborate researches on this subject. Reiset has made numerous determinations of the amount of carbonic anhydride in the atmosphere, and finds the

values usually given (4 to 6 volumes in 10,000) much too high. He gives 2,962 vols. in 10,000 as the mean of 220 experiments made near Dieppe. The ratios obtained in Paris are somewhat higher, being 3,168 vols. of carbonic anhydride in 10,000 of air. (*Ann. Chim. et Phys.* (5) XXVI, pp. 245 *et seq.*)

A. Muntz and E. Aubin have also made determinations of the proportions of carbonic anhydride in the atmosphere at Paris and near Vincennes, and the results (which confirm Reiset's figures) show that the variations in the amount of carbonic anhydride are due to local influences, and that in general the heavier gas is quite uniformly distributed throughout the lower strata of the atmosphere. These chemists also examined the air of elevated regions, conducting experiments at the altitude of 2,877 meters (9,422 feet) in the Pyrenees. Although the direction of the wind and state of the atmosphere varied greatly during their experiments, the proportion of carbonic anhydride was found to be constant, being about 2.86 vols. in 10,000 of air. For the sake of comparison the air was examined in two valleys at the foot of the Pyrenees, one near Pierrefitte (507 meters above the sea-level) and the other near Luz (730 meters); at the first station the air was found to contain 2.79 vols. of carbonic anhydride in 10,000, and at the second 2.69 in 10,000, the latter determination being made in the midst of luxurious vegetation. Muntz and Aubin conclude that carbonic anhydride is very uniformly distributed throughout the atmosphere, and regard their results as confirming Reiset's statements and Schloesing's theories concerning the circulation of carbonic anhydride upon the surface of the earth. (*Comptes Rendus*, XCIII, p. 797.)

Dr. Edward W. Morley has devised a method for accurate and rapid analyses of air, and has made a series of daily analyses in duplicate of air collected at Hudson, Ohio, for six months, beginning with January 1, 1880, and one for six months and twenty days, beginning October 1, 1880. For details of the apparatus and process we refer to the original paper. Each pair of analyses occupied about 70 minutes of time, and the mean error of a single analysis for half a month was less than the thousandth part of one per cent. By comparing the results of this long series of daily determinations with the data obtained from the thrice-daily maps of the state of the weather furnished by the United States Signal Service Bureau, Dr. Morley finds that most of the variations in the amount of oxygen are caused by the vertical descent of air from high elevations. This descent of cold air seems to be the effect of sudden and severe depressions of temperature rather than the cause; the descent follows the cold by a day or two, and the decrease in amount of oxygen begins simultaneously with the descent from above. (*Proc. Am. Assoc. Adv. Sci.*, 1881; abstract in *Chem. News*, XL, pp. 245, 284 *et seq.*)

List of New Elements announced since 1877.

The six years ending in 1882 have been unusually prolific in new elements, or at least in announcements of the same, for it must be conceded that most of them will fail to stand the test of more thorough investigation. These alleged discoveries are widely scattered in periodical literature, and the following list may prove useful for reference:

List of elementary substances announced from 1877 to 1882.

Date.	Name.	Source.	Discoverer.
1877	Neptunium	Columbite.....	Hermann.
	Lavcesium	Pyrite.....	Pat.
	Mosandrum	Samarskite.....	J. L. Smith.
1878	Dayum	Platinum ores.....	Seignus Kern.
	"New earths"	Unnamed mineral.....	Gerland.
	"X"	Gadolinite.....	Soret.
	Philippium	Samarskite.....	Delafontaine.
	Decipium	Samarskite.....	Delafontaine.
1870	Ytterbium	Gadolinite.....	Marignac.
	Scandium	Gadolinite.....	Nilson.
	Norwegium	Gersdorffite.....	Dahll.
	Uralium	Platinum.....	Guyard.
	Samarium	Samarskite.....	Lecoq de Boisbaudran.
	Bare-nium	(Misapprehension).....	Wagner's Jahresbericht.
	Thulium	Gadolinite.....	Cleve.
	Holmium	Gadolinite.....	Cleve.
	Columbium	Samarskite.....	J. L. Smith.
	Rogierium	Samarskite.....	J. L. Smith.
	Vesbium	Lava.....	Seacchi.
1880	Comesium		Kaemmerer.
1881	Ya and Yβ	Gadolinite.....	Marignac.
	Actinium	Zinc ores.....	Philpson.
1882	Didymiumβ	Gadolinite.....	Cleve.

New Elementary Substances.—At the meeting of the Russian Chemical Society held October 20, 1881 (and reported in the *Bulletin de la Société Chimique de Paris*, for August, 1882), Mendelejeff, the distinguished author of the periodic law, remarked that only two of the recently announced elements—scandium and ytterbium—had been satisfactorily confirmed. These have been obtained in a pure state by Nilson, and neither of them has absorption spectra. All the other metals seem to be mixtures, as was the case with the old erbium of Bunsen and Bahr, and which proves to contain Se, Yb, Er, Tr, and other elements. Scandium corresponds in its atomic weight and properties to *ekabor*, a hypothetical substance, the existence of which had been foreseen by the speaker.

Mendelejeff expressed himself convinced that his periodic law will find further confirmation in the results to be yet obtained in studying the elements of cerite and of gadolinite. (*Bull. Soc. Chim.*, xxxviii, p. 140.)

A new element accompanying didymium is announced by the Swedish chemist, Prof. P. T. Cleve. He has long studied the rare earths existing in cerite, gadolinite, and similar minerals, and the behavior of the oxide of didymium obtained from the latter has led him to suspect the presence of a new element. In the beginning of the year 1882 he submitted to fractional precipitations about 200 grams of didymium oxide, and separated from the yttria earths with potassium sulphate by repeated precipitations; the atomic weight of the first fraction was 146, that of the

last 142. The examination of the ignition spectrum of the last fraction showed, besides strong rays of didymium and lanthanum, new rays, among which is a very strong one having the wave-length of 4333.5. This ray belongs neither to didymium, lanthanum, yttrium, erbium, terbium, nor to Marignac's Y_a , and is regarded by Cleve as peculiar to a new element which he designates provisionally by $Di\beta$. (*Comptes Rendus*; abstract in *Chem. News*, XLV, p. 273.)

Soon after the publication of the above statement by Professor Cleve, B. Brauner printed a note in the *Chemical News* (46, 16), in which he shows that he anticipated the Swedish chemist in discovering a new element accompanying didymium in cerite. His experiments were made in Professor Roscoe's laboratory, and some of his results were published in the *Anzeiger der kais. Academie der Wissenschaften* (October 6, 1881). Brauner thinks that oxide of didymium, as usually known to chemists, consists of a mixture of at least three elements, true didymium having an atomic weight =145.4, Cleve's element, more basic than didymium, and a third with a higher atomic weight is less basic than didymium. This last may possibly be samarium.

Professor Cleve in a still later communication states that continued researches by himself and Thalèn have convinced him that the ray 4333.5 belongs to the spectrum of lanthanum, and that the existence of a new element is very improbable. (*Chem. News*, XLVI, p. 43.)

The earths contained in samarskite have been studied by Professor H. E. Roscoe, with the object of ascertaining the existence or non-existence of Delafontaine's philippium. Roscoe worked up 1,500 grams of samarskite and obtained about 60 grams of oxides containing terbium, erbium, yttrium, and philippium (?). The oxides were converted into formiates, and these salts carefully examined to obtain pure philippium salt, but the author failed to get an oxide having a constant atomic weight equal to 122 (claimed by Delafontaine). The numbers varied between the atomic weights of terbia and yttria. Roscoe then tried the following conclusive experiment: 3 grams of terbia, having an atomic weight of 147.9, and 3 grams of crude yttria, with an atomic weight of 101.4, were respectively converted into formiates. Of each of these two formiates, two-thirds were brought into solution separately while the other third of the terbium formiate was mixed with the remaining third of yttrium formiate, and the mixture dissolved. Each of the three solutions was then mixed with an equal bulk of alcohol and allowed to stand for the same length of time. The two solutions, containing respectively terbia and yttria, gave crystals presenting the ordinary appearance of formiates of the metals in question, but the third solution containing the mixed formiates deposited rhombic prisms exactly like the crystals which Delafontaine claims are peculiar to the formiate of philippium. The non-existence of philippium is thus undoubtedly established. (*Chem. News*, XLV, p. 184.)

Researches on other Elements, etc.

Thorium.—Two important memoirs have been published by L. F. Nilson on thorite and its chief constituent, thorium. He worked upon two kilograms of the rare mineral and prepared a very pure thorium sulphate, from which he made a determination of the atomic weight of the element. (See paragraph on atomic weights.) He determined the specific gravity of thoria, finding the figures 10.2199. He also prepared the metal by the reduction of potassio-thorium chloride with sodium in the iron apparatus he had previously used for beryllium. The metal obtained formed a gray shining powder showing distinct crystals under the microscope; it is unaltered by exposure to air up to 100–120° C.; when heated higher it burns brilliantly, forming a snow-white oxide. The metal burns in chlorine, bromine, and iodine gases, yielding sublimates; it is slowly attacked by dilute sulphuric acid, and by dilute nitric; concentrated nitric acid has very little effect. Hydrochloric acid dissolves the metal readily. The metal has the specific gravity of about 11, results being not perfectly satisfactory. (*Berichte d. chem. Ges.*, xv, pp. 2519–2547.)

Properties of Pure Metallic Aluminium.—Prof. J. W. Mallet, in the course of his researches on the atomic weight of this metal, required a quantity in a very pure condition, and this gave an opportunity of studying its properties. Crude (commercial) aluminium contains:

Al	96. 89
Fe.	1. 84
Cu.....	trace.
Si.....	1. 27
	<hr/>
	100. 00

This was converted into bromide by treatment with liquid bromine, and the product purified by fractional distillation. It was then reduced by sodium in a crucible lined with a mixture of purified and dried alumina, with sodium aluminate. The metallic globules were again fused and further purified with hydrochloric acid. The metal thus obtained was perceptibly whiter than the commercial article, also softer, more malleable, and had a fracture with some appearance of fibrous silkiness. Its specific gravity at 4° C. is 2.583. Its specific heat is 0.2253 as a mean for the range of temperature 0°–100° C. Attempts were made to roughly estimate the fusibility, and the pure metal seems to be a little less fusible than the commercial article. It also presents greater resistance to the prolonged action of solvents—acids and alkalis—than the impure metal. (*Chem. News*, XLVI, p. 178.)

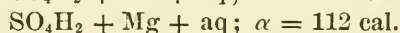
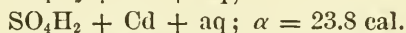
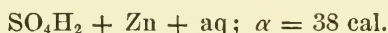
Iridium, according to Mr. John Holland, can be alloyed with phosphorus at a high heat, and the alloy fuses at a comparatively low temperature. The fused metal contains, according to Prof. F. W. Clarke, about 7½ per cent. of phosphorus. The phosphorus is removed by heating

in a Hessian crucible with lime. The iridium melted by this process is compact and crystalline; it is harder than the natural metal, being nearly as hard as the ruby; it has the color of steel and is not attacked by acids. (*Chem. News*, XLV, p. 168.)

Preparation and Properties of Metallic Cæsium.—Owing partly to the extreme scarcity of material Bunsen's attempts to obtain cæsium in metallic form were unsuccessful, but Carl Setterberg, availing himself of the tons of alums obtained in Marquart's establishment as a secondary product in the manufacture of lithium compounds from lepidolite, has isolated this rare metal and studied its properties. Setterberg prepared in 14 days 40 kilograms of rubidium alum and 10 kilograms of cæsium. He obtained metallic rubidium by decomposing the hydrogen-tartrate with calcium carbonate and sugar, in a mercury flask, but attempts to prepare cæsium by a similar process were futile. By the electrolysis of the cyanide of cæsium mixed with barium cyanide in the ratio of 4 molecules to one, Setterberg obtained the metal quite free from impurities. Metallic cæsium resembles closely the other alkali metals; is silver white, malleable, and very soft at ordinary temperatures. Thrown upon water it floats around and decomposes it with evolution of heat and light, in the same manner as potassium and rubidium. It inflames easily when exposed to the air unless protected by a film of oxide or by a layer of petroleum. The metal melts between 26° C. and 27° C.; its specific gravity is 1.88 at 15° C. Examined in the spectroscope it showed only traces of sodium as an impurity.

Setterberg failed to detect new elementary substances in the residues from which he extracted the rubidium and cæsium salts. (*Liebig's Annalen*, CCXI, p. 100.)

Nascent Hydrogen.—D. Tommasi, by numerous experiments on the reducing power of nascent hydrogen, has been led to the conclusion that its peculiar power varies with the reaction by which it is generated. Hence, hydrogen in a nascent state may be regarded as hydrogen + calories; or $H + \alpha$, in which α has different values according to the source of the hydrogen; thus:



The hydrogen increases in activity with the increase in value of α ; for sodium amalgam it is 112 cal. (*Bull. Soc. Chim.*, XXXVIII, p. 150.)

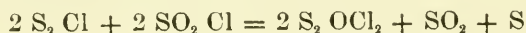
Preparation of pure Nitrogen.—Attempts to remove the last traces of oxygen from atmospheric air by means of phosphorus, potassium pyrogallate, hyposulphites, potassiumsodium alloy, and red-hot copper proving unavailing, Dr. Walter Flight found that it can be effected by passing the gas over a large surface of freshly precipitated ferrous hydrate. The latter reagent he prepares by adding a strong solution of 80 grams

of caustic potash to one of 200 grams of ferrous sulphate. The nitrogen thus treated failed to develop a brown color with potassium pyrogallate. (*Chem. News*, XLV, p. 105.)

Behavior of Nitrogen in the Distillation of Coal.—Text-books usually state that coal contains about 2 per cent. of nitrogen, which comes off as ammonia when the coal is heated in closed vessels. Prof. W. Foster, however, finds that only a small fraction of the total nitrogen comes off as ammonia. In an experiment with coal containing 1.73 per cent. of nitrogen, only 14.5 per cent. of this amount was evolved as ammonia, 1.56 per cent. as cyanogen, 35.26 remained unaltered, and 48.68 of the whole amount remained in the coke. (*Chem. News*, XLV, p. 299.)

Presence of Arsenic in Bismuth Subnitrate.—Of fourteen samples of bismuth subnitrate examined by R. H. Chittenden and S. W. Lambert, only one was found to be perfectly free from arsenic. The average content of poison in the samples was .013 per cent. or 13 mgms. (about two-tenths of a grain) of As_2O_3 in 100 grams of bismuth. The subnitrate of bismuth is extensively used in medicine, and though it may not contain arsenic in sufficient quantity to be in itself injurious, the presence of the poison is greatly to be deplored. Fortunately, as the further experiments of the authors show, the arsenic is not readily absorbed into the system when combined with the bismuth preparation. (*Am. Chem. J.*, III, p. 396.)

A new Oxichloride of Sulphur.—J. Ogier, by heating to 250° C. in sealed tubes a mixture of equal weights of chloride of sulphur and chloride of sulphuryle, obtained the body S_2OCl_2 ; it forms a dark red liquid, boiling at 60° and having a specific gravity at 0° of 1.656. Its formation is explained by the equation :

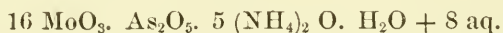


It is decomposed by water, forming a precipitate of sulphur, sulphurous anhydride, sulphuric acid, hydrochloric acid, and thio-acids. (*Bull. Soc. Chim.*, XXXVII, p. 293.)

An abundant source of selenium, according to P. Kienlen, exists in the crude hydrochloric acid condensed in Glover's towers. The selenium is derived from the pyrites, and being volatile at a red heat is carried over by the hydrochloric acid gas during the calcination of the salt cake, and condenses in the first recipients in the form of a reddish mud; this mud, when dried, contains in some cases from 41 to 45 per cent. of selenium. The author extracts the selenium from this deposit by acting upon it with chlorine, which converts it into a tetrachloride, and this, in the presence of water and chlorine, is transformed into selenic acid. The acid liquid obtained is then precipitated with hydrogen sodium sulphite and purified. (*Bull. Soc. Chim.*, XXXVII, p. 441.)

Presence of Tellurium in Copper.—Prof. Th. Egleston has detected tellurium in commercial copper to the extent of about 0.1 per cent. A surprisingly small quantity renders the copper red-short, and consequently worthless for rolling. (*Trans. Am. Inst. Mining Engineers*, Harrisburg Meeting, Oct., 1882.)

Complex inorganic Acids.—Dr. Wolcott Gibbs has published a continuation of his remarkable researches on the complex inorganic acids. He has demonstrated that inorganic compounds possess an unexpected degree of complexity, and has entered a very wide field of research, yielding a rich harvest. After discussing in detail several phospho-molybdates, he describes the preparation of the arsenio-molybdate having the composition:



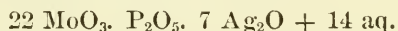
The study of these two series (phospho- and arsenio-molybdates) leads to the following general results:

1. The phospho-molybdates form a series of which the lowest term contains five atoms of molybdic to one of phosphoric oxide, and the highest twenty-four atoms of the former to one of the latter.

2. As in the case of the phospho-tungstates, the greater number of the molybdenum compounds contain an even number of atoms of tungstic acid. The homologizing term is, therefore, 2 MoO_3 for these cases.

3. By far the greater number of phospho-molybdates contain *three* atoms of fixed base (old style), or, in more modern language, may be considered as derived from acids containing *six* atoms of hydroxyl. Anhydrous compounds of this type occur, and are not always simply residues obtained by heating salts which may be considered as acid, as containing, for example, $3 \text{ R}_2\text{O}, 3 \text{ H}_2\text{O}$. It seems, therefore, necessary to admit the existence of acids of the general type $n \text{ MoO}_3, \text{ P}_2\text{O}_5, 3 \text{ H}_2\text{O}$.

4. On the other hand, while no single phospho-molybdate containing more than three atoms of fixed base for one of phosphoric oxide has been obtained in a state of indubitable purity, there is probably at least one salt with *six* or more atoms of fixed base, viz:



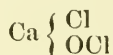
5. Negative evidence concerning the probable non-existence of a series of phospho- or arsenio-molybdates containing more than *three* atoms of fixed base, must not be too highly regarded.

6. As in the case of the phospho-tungstates, there exists a class of phospho-molybdates in which the ratio of the number of atoms of base to that of the number of atoms of phosphoric oxide is as 5 : 2, the number of atoms of molybdic oxide being even.

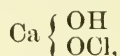
Dr. Gibbs presents a series of structural formulæ which explain all degrees of basicity which appear to be possible under the general conditions of the problem. For these and other details we refer to his original paper. (*Am. Chem. J.*, III, p. 402.)

Constitution of Bleaching Powder.—Chemists have devoted much labor to the determination of the exact constitution of bleaching powder, and have arrived at results expressed in a great variety of formulæ.

Thorpe gives: $\text{Ca}_2\text{H}_6\text{O}_6\text{Cl}_4$ ($= \text{CaCl}_2\text{O}_2 + \text{CaCl}_2 + \text{CaH}_2\text{O}_2 + 2\text{H}_2\text{O}$); Rose gives: $(\text{CaCl}_2, \text{Ca}_2\text{O}_2) \text{CaO}_2\text{Cl}_2 + 4\text{H}_2\text{O}$; Kolb after a very thorough investigation: $(2\text{CaO Cl}_2\text{H}_2\text{O}), \text{CaH}_2\text{O}_2$. Odling proposed the formula

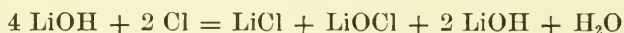


and this view has been quite generally adopted. Stahlschmidt regards bleaching powder as calcium hydroxychloride,



i. e., calcium hydroxide, CaH_2O_2 in which one atom of hydrogen is replaced by chlorine.

The question has been again investigated by Dr. Karl Kraut, who examined the action of chlorine on lithium hydroxide and obtained a compound very similar to the calcium analogue. When chlorine gas was brought in contact with the melted lithium hydroxide, the latter increased only 1 per cent. in weight in $4\frac{1}{2}$ hours, but by the addition of crystallized lithia in such quantities that the mixture contained about 1.4 per cent. H_2O the action of the chlorine was hastened. The reaction is as follows:



This equation was confirmed by analysis of the product. The lithium bleaching powder reacts with carbonic anhydride exactly like the calcium compound, *i. e.*, it is decomposed with liberation of chlorine. It also behaves with chlorine just like the calcium compound. Since, however, lithium is a mono-valent element, one atom of the metal cannot simultaneously bind chlorine and the radical of hypochlorous acid, and Odling's manner of representing the constitution of bleaching powder is inapplicable. Besides, the lithium bleaching powder contains lithium chloride ready formed. The author therefore concludes that bleaching powder is a mixture of calcium hypochlorite, calcium chloride, and calcium hydrate. (Liebig's *Annalen*, CCXIV, p. 354.)

Lead peroxide can be advantageously prepared, according to Fehrmann, by decomposing a concentrated solution of chloride of lead at 50° or 60° C. with a solution of bleaching powder. The latter is added until the filtrate no longer shows a brown color when tested with an additional quantity of the bleaching powder. The lead peroxide is well washed and collected on a filter. It is nearly black, and very pure. The acetate of lead does not yield such good results as the chloride. (*Berichte d. chem. Ges.*, XV, p. 1882.)

Determination of Organic Matter in Potable Water.

Prof. J. W. Mallet, in compliance with the instructions of the National Board of Health, has made a thorough investigation of the chemical methods in use for the determination of organic matter in the potable waters. Assisted by Mr. W. A. Noyes, Dr. Charles Smart, and Dr. J. A. Tanner, he examined the merits and demerits of the "combustion process," the "albuminoid-ammonia process," and the "permanganate process." The special conclusions as to the combustion process may be briefly stated: The combustion itself, carried out according to Frankland's directions, is a process of great delicacy and satisfactory in trained hands; it requires constant practice to secure good results; the defective point is the failure of the evaporation to leave a residue representing the original organic matter of the water, a loss in carbon and a gain in nitrogen being constant errors; the dissociation of ammonia salts during the evaporation occasions a loss of nitrogen; in the presence of nitrates the difficulties of combustion are great and as yet insuperable; finally, the combustion process cannot be considered as "determining" the carbon and nitrogen of the organic matter in water in a sense to justify the claim of "absolute" value for its results which has been denied to those of all other methods.

The special conclusions as to the albuminoid-ammonia process are as follows: In the determination of both "free" and "albuminoid" ammonia there is a loss resulting from imperfect condensation of the ammonia during distillation; when urea is present some ammonia is easily formed by boiling with sodium carbonate, and this vitiates the determination of "free" ammonia; in the distillation with alkaline permanganates the nitrogenous matter sometimes fails to be completely acted upon before the contents of the retort is nearly reduced to dryness, and great uncertainty results; the value of the results by this process depends more upon watching the *progress* and *rate* of evolution of the ammonia than upon determining its total amount.

The special conclusions as to the permanganate process are: The results obtained by the Tidy method, and by Kubel's modification of the same, differ irregularly, the latter usually giving much higher figures; the results obtained by the Tidy process are liable to variations with the atmospheric temperature prevailing at the time the process is applied; the amount of oxygen consumed cannot be taken as a measure either of the organic carbon or of the total organic matter, though a general resemblance may be traced between strongly marked results, high or low, for the consumption of oxygen on the one hand and inorganic carbon (by the combustion process) on the other; the process is capable of giving more valuable information by watching the *rate* and *progress* of the oxidation of organic matter present than by any single determination of the absolute amount of oxygen consumed in a given time. (*Am. Chem. J.*, IV, p. 341.)

Use of Quicklime in Blasting.

An interesting application of the force resulting from the expansion due to hydration is recorded in *Nature*. To obviate the danger attending the use of explosive substances in coal mines, the following process has been successfully employed in Derbyshire; A series of holes six feet apart and about three feet in depth are drilled into the coal at the proper points; these holes are then filled with cylinders of compressed quicklime, each $2\frac{1}{2}$ inches in diameter and $4\frac{1}{2}$ inches long; each hole receives seven of these blocks. A groove in each cylinder admits the insertion of a $\frac{1}{2}$ -inch pipe which extends a few inches beyond the aperture of the drilled hole; through this pipe water is forced by a small hand pump. Each hole is of course firmly tamped with paper and rubbish. Soon after the water is introduced a sound as of escaping steam is heard, here and there the tamping is blown out, and in a few minutes the whole mass of coal is thrown out from the face upon "sprags," short timber props placed to receive it. The time required in the various operations is as follows: drilling 12 minutes, charging 4 minutes, watering 2 minutes, total 17 minutes for each bore-hole. (*Nature*, xxvi, p. 298.)

ORGANIC CHEMISTRY.

Formaldehyde (or oxymethylene) has acquired great importance within a short period, the researches of Baeyer, Wurtz, and others having shown that it forms an intermediate product between carbonic acid and carbo-hydrates in the physiology of plant-life. It may be regarded as the first product of the assimilation of carbonic acid by plants, and by simple polymerization and elimination of water, is probably capable of producing sugar, glucose, starch, and cellulose.

B. Tolleus has described a convenient method for preparing this substance, which is based upon the oxidation of methylalcohol by air and incandescent platinum. For details we refer to the original paper. (*Berichte d. chem. Ges.*, xv, p. 1629.)

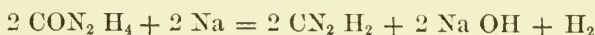
Curcumin and other Substances from Turmeric.—C. Loring Jackson and A. E. Menke give the following: Bengal turmeric root is ground and treated in an extractor with ligroine to remove turmeric oil, and then the curcumin, mixed with a large quantity of resin, is extracted with ether and finally purified by crystallization from alcohol. The average yield of curcumin was 0.3 of one per cent. The mean of five analyses indicates the following composition:

Carbon.....	68.30
Hydrogen.....	5.63

Curcumin crystallizes from alcohol in stout needles often in radiating groups. It has an orange to yellow color with a blue reflex; its ether solution fluoresces green; it melts at 178° C. It is nearly insoluble in water, slightly in benzol, readily soluble in hot alcohol, and more read-

ily soluble in glacial acetic acid; dissolved in strong sulphuric acid it blackens by charring; it is readily soluble in alkalis and alkaline carbonates. It forms two potassium salts $K_2 C_{14} H_{12} O_4$ and $K C_{14} H_{13} O_4$, as well as calcium, zinc and barium salts, the last named being insoluble. By a study of the esters of curcumin the authors definitely establish $C_{14} H_{14} O_4$ as the true formula. The results of incomplete oxidation are most interesting; by treating an aqueous alkaline solution with potassium permanganate, not in excess, a strong smell of vanilla was observed. Further treatment effected the separation of an oil, gradually solidifying in circular groups of radiating needles, and having a strong odor of vanilla. By sublimation and purification of this product, white needles of vanillin, melting at $78^\circ C.$, were obtained. The yield was very small. The authors also show that diethyleurcumin yields by oxidation ethylvanillic acid. (*Am. Chem. Journ.*, IV, p. 77.)

Urea, its Synthesis and its Estimation.—Fenton has succeeded in transforming urea into cyanamide; the dehydration was effected by means of sodium in accordance with the reaction:



Prof. W. G. Mixer has succeeded in forming urea by the reaction of ammonia on carbonic anhydride at a red heat. The urea forms slowly, 2 to 3 decigrams per hour, and collects in fine crystals in the cooler parts of the tube through which the gases are conducted. He regards the formation of urea, as preceded by that of cyanic acid, thus: $\text{CO}_2 + \text{NH}_3 = \text{HCNO} + \text{H}_2 \text{O}$. The cyanic acid probably unites with ammonia in the cooler part of the tube to form urea. (*Am. Chem. J.*, IV, p. 35.)

J. R. Duggan described a modification of Knop's process of estimating urea by the amount of nitrogen evolved on the addition of an alkaline hypobromite. His method consists in mixing the urea and caustic soda solutions first and then adding the bromine. He employs a caustic soda solution made by dissolving 20 grms. of sodium hydrate in 100 c. e. of water; and with each 20 c. e. of this he uses 1 c. e. of bromine. The results are satisfactory. The weight of nitrogen multiplied by 2.143 gives the amount of urea. (*Am. Chem. J.*, IV, p. 47.)

Dr. Theodore G. Wormly has also investigated the above method of determining urea and finds that only under the following conditions is the whole of the nitrogen uniformly set free: 1st. The reagent (hypobromite) should be freshly prepared; 2d. The urea solution should be wholly added to the reagent; 3d. The amount of urea operated upon should not exceed 1 part to about 1,200 parts of the diluted reagent; 4th. When comparatively large amounts of urea are present the surrounding temperature should not be less than about $20^\circ C.$ (68°Fah.). (*Chem. News*, XLV, p. 27.)

Acrolein Urea.—Hugo Schiff has described under the name acryldiureide, a body resulting from the union of two molecules of urea and one of acrolein: Prof. A. R. Leeds has obtained a body having the same

constitution, $\text{CO}(\text{NH})_2\text{C}_3\text{H}_4$. It forms a white amorphous substance, slightly soluble in alcohol, ether, chloroform, and carbon-disulphide. Dr. Leeds points out some irrational conclusions in Schiff's paper, and accounts for them by presuming that Schiff operated upon imperfectly purified material. (*Berichte d. chem. Ges.*, XV, p. 1159.)

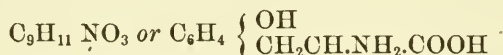
Synthesis of Uric Acid.—This interesting synthesis has been accomplished by Prof. Johann Horbaczewski. Pure, finely powdered glyco-coll (made from hippuric acid) is mixed with ten parts of pure urea (made from ammonium cyanate) and heated in a flask to 200° to 230° C., until the material becomes brownish-yellow and viscous. After cooling the mass is dissolved in diluted potassium hydroxide, saturated with ammonium chloride, and precipitated with a mixture of ammoniacal silver nitrate and magnesia mixture. The precipitate, which contains the uric acid, is well washed with ammonia water and treated with potassium sulphide. The filtrate is then over-neutralized with hydrochloric acid and boiled down to a small bulk. The raw material thus obtained is purified by solution in potassium hydroxide, and after repeating the operation, the yellowish crystalline powder is washed with alcohol, dried with carbon disulphide (to remove the sulphur), and finally with ether. This purified material exhibits all the properties and reactions of uric acid. The author is engaged in a further study of this synthetical reaction. (*Berichte d. chem. Ges.* XV, p. 2678.)

Synthesis of a new Amido-Acid analogous to Hippuric Acid.—By the action of silver glyco-collate on benzoylchloride, Th. Curtius has obtained three acids, ordinary hippuric acid, hippurylglyco-coll, and a third of unknown constitution having the empirical formula $\text{C}_{10}\text{H}_{12}\text{N}_3\text{O}_4$. The hippurylglyco-coll or hippurylamidoacetic acid crystallizes from hot water in rhombic tables or needles which melt without decomposition at $206^\circ.5$ C. The new acid crystallizes in microscopic needles which become brown when heated to 230° , and are decomposed at 240° C. (*Journal prak. Chem. N. F.*, XXVI, p. 145.)

Synthesis of Tyrosine.—Tyrosine forms a crystalline nitrogenous body existing in the animal organism (spleen, liver, urine, &c.), produced by the decomposition of albuminoid substances. It has long been studied by chemists; Liebig obtained it by acting on decomposing caseine with melted potash, Müller found it in putrefying yeast, Hinterberger prepared it by boiling oxhorn with sulphuric acid, and its constitution has been discussed by several authors. In 1869 L. Barth pointed out that tyrosine could be regarded as a parahydroxyphenylamidopropionic acid, but his attempts to prepare it, as well as the proposed reactions of Bèilstein and Kuhlberg, were unsuccessful.

Erlemeyer has been engaged for several years in experimenting in this direction, and with the assistance of Dr. A. Lipp has at length accomplished this interesting synthesis. The process is as follows:

Phenylalanin (phenyl- α -amidopropionic acid) is converted into paranitrophenylalanin by the action of sulphuric and nitric acids, and this product is transformed into paraamidophenylalanin by means of tin and hydrochloric acid. The chloride of this diamido compound is treated in alcoholic solution with nitrous acid and the resulting body heated with water. On evaporating and treating the residue with ether a sirupy liquid is obtained which is probably parahydroxyphenyllactic acid. This product is supersaturated with ammonia and concentrated by evaporation, which gives a crystalline mass showing under the microscope the crystalline characters of tyrosine. By recrystallizing from dilute boiling alcohol the material is purified. Analysis shows it to have the exact constitution of tyrosine:



(*Berichte d. chem. Ges.*, xv, pp. 1006 and 1544.)

Synthesis of Anthracene and Phenanthrene from Orthobrombenzyl-bromide.—C. Loring Jackson and J. Fleming White, with a view to settling the exact constitution of anthracene, have studied the action of sodium on orthobrombenzyl-bromide, and obtained anthracene and phenanthrene. The former was identified by its melting point (212°), by the formation of anthraquinone (melting at 273°), and of alizarine; the latter was identified by the melting point of its quinone, 198° , and by Laubenthaler's test. Dibenzyl also forms in this reaction, and an oil of uncertain composition, possibly benzyltoluol.

By this synthesis it is proved that the two connecting carbon atoms in the benzol rings are attached to each ring in the ortho-position, and the last doubt about the constitution of anthracene is removed. (*Chem. News*, XLVI, p. 44.)

Synthesis of Organic Bodies by the Electrolysis of Water and Solutions with Electrodes of Carbon.—A. Bartoli and G. Papisogli, in researches on galvanic polarities, had observed that coke, charcoal, or graphite, under the action of the current, is disaggregated; the electrolyte is blackened more or less, according to its nature and that of the carbon, and the gas evolved at the positive pole is below the normal volume. The authors undertook the present investigation to ascertain what becomes of the oxygen. They experimented with graphite, coke, and wood charcoal, purified by chlorine at high temperatures. With coke or charcoal as positive electrode and distilled water as electrolyte and a battery of 1,200 Daniell cells, they remarked after two days a brown color in the electrolyte and an acid reaction. The battery was then reduced to 100 Bunsen cells, and ten days later to 20 Bunsen cells; these were in operation for 30 days. The water became black; the electrode, which weighed about 500 grams, was totally disaggregated, and a thick muddy deposit was formed. The electrolyte was found to contain

mellitic acid and some of its derivatives, such as the hydro-mellitic, pyro-mellitic, and hydro-pyro-mellitic acids.

The muddy deposit contained a black substance soluble in hot water and alkalis, but insoluble in most mineral acids and in the majority of organic solvents. The authors named this body mellogen, since, on oxidation, it yields acids of the benzo-carbonic series. It has the composition $C_{14}H_2O_4$. (*Comptes Rendus*, May 15, 1882.)

Acetoxims.—By the action of acetone on hydroxylamin, Alois Janny has obtained the first member of a new series of bodies, for which series he proposes the name of acetoxims. This name is applied to bodies containing the group $=CNOH$ united on two sides to carbon. When only one bond of the carbon group is united to carbon and the other to hydrogen, derivatives of aldehyde are formed for which the name aldoxims is suggested.

The simplest body of the acetoxims is dimethylacetoxim, having the formula $CH_3-C(NHO)-CH_3$. This is obtained by mixing an aqueous solution of hydroxylamine with acetone and extracting ether, which leaves, on evaporation, brilliant white, hard, volatile, prismatic crystals. It is soluble in water, alcohol, ether, &c., and melts at 59° to 60° C., distilling without decomposition at $134^\circ.8$ C. It is a neutral substance, and has a slight odor, resembling chloral.

The author has also prepared and studied ethyl-methylacetoxim, methylpseudobutylacetoxim, and some analogous phenyl derivatives. (*Berichte d. chem. Ges.*, xv, pp. 1324 and 2778.)

Diphenylaminacroleine has been prepared by Prof. Albert R. Leeds by heating an alcoholic solution of diphenylamine with an excess of acroleine. After a few hours' digestion a heavy red precipitate forms, soluble in boiling alcohol, together with a sticky insoluble mass. The latter is treated with alcohol and water until it becomes pulverulent and capable of being powdered in a mortar. This amorphous substance proves to be diphenylaminacroleine $(C_{12}H_{10}N)_2C_3H_4$. It does not fuse nor sublime, but is decomposed, on heating, into a carbonaceous mass. It is insoluble in ether, slightly soluble in alcohol and acetic acid, and soluble in chloroform, yielding a dark red liquid. It could not be obtained in crystals. Bromine converts it into a bromo-compound, also amorphous, and not further examined.

Homoquinine, a new Alkaloid.—Howard and Hodgkin have obtained a new alkaloid from cinchona bark, for which they propose the name *homoquinine*. Its properties are similar to those of quinine, having the same specific rotary power, and nearly the same composition, but it crystallizes from ether more readily, and differs in the solubility of its salts. One part of the sulphate of homoquinine requires more than 100 of water for solution. Alcohol of 90 per cent. dissolves 7.64 parts of the alkaloid, a 5 per cent. solution of which shows a rotation of -158° . (*J. Chem. Soc.*, xli, p. 66.)

Iodide of Bismuth and Potassium as a Reagent for Alkaloids.—F. Mangini prepares this reagent by mixing 3 parts of iodide of potassium with 16 of iodide of bismuth (liquid) and 3 parts of hydrochloric acid. Thus prepared it is not decomposed by water and gives characteristic phenomena with many alkaloids.

Strychnine, a light-yellow precipitate, limpid solution; after standing the precipitate turns dark yellow. One part of strychnine in 500,000 of water can be detected.

Brucine, a golden-yellow silky precipitate becoming lighter in color.

Morphine, a reddish-yellow precipitate disappearing after some days, when the liquid becomes canary-yellow.

Codeine, a yellowish-red precipitate turning brick-red on standing.

Narceine, a light-yellow precipitate remaining a long time suspended in the liquid; it turns reddish-yellow on standing.

A tropine, a silky precipitate, which settles as a reddish-yellow powder; on standing the precipitate turns canary-yellow and slowly dissolves, coloring the liquid golden yellow.

Aconitine, a flaky precipitate, which settles as a chrome-yellow powder; no change on standing.

Nicotine, a red pulverulent precipitate, becoming reddish yellow.

Conicine, a red pulverulent precipitate of a more intense color than the preceding, and becoming dirty white on standing.

Solanine, a golden-yellow precipitate forming slowly, and turning darker.

Veratrine, a light-yellow precipitate, turning lighter.

Quinine sulphate, a brick-red precipitate, turning dirty white.

Cinchonine sulphate, like the preceding, but darker after standing. (*Gazzetta Chimica Italiana*, 1882, p. 155, and abstract in *Bull. Soc. Chim.*, xxxviii, p. 670.)

Application of Electrolysis to Dyeing.—Dr. Frederic Goppelsroeder, of Mühlhausen, has extended the application of electrolysis to the formation of coloring matters and to the art of dyeing. He has employed the galvanic current in producing and simultaneously fixing dyes on various textile fabrics, in preventing the oxidation of colors during the printing, and in preparing solutions of *reduced* dye-stuffs, the so-called blue-vats. To obtain, for example, an aniline black on a fabric or on paper, the stuff is soaked in an aqueous solution of a salt of aniline (the chloride is preferred), and then placed on an unoxidizable metallic plate connected with one pole of a galvanic battery or with a small dynamo machine. A second metallic plate, bearing in relief the design and connected with the other pole, is then placed upon the stuff. By pressing gently and passing the current of electricity a black design is formed. Medals and coins may be copied in a similar manner. By drawing lines on the paper or fabric impregnated with the aniline salt, with a piece of carbon forming one of the poles, or with a non-oxidizable metal, black

lines are obtained whenever the presence of the conducting carbon permits the passage of electricity.

Hydrogen generated at the negative pole may be employed instead of zinc, ferrous sulphate, glucose, hydrosulphite, and the other common agents, to reduce baths of indigo, of aniline black, &c. A feeble continuous current gives the best results. The two electrodes must be separated completely. Dr. Goppelsroeder expresses the hope that his experiments may eventually become of industrial importance. (Reprinted from *L'Electricien*, and communicated by the author.)

Method and Apparatus for Testing Inflammable Oils.—In accordance with the instructions of the New York State Board of Health to its sanitary committee, and in response to an order of said committee, Arthur H. Elliott has made an exhaustive report on the methods and apparatus for testing inflammable oils, with special reference to dangerous kerosene. The investigations were made with the ultimate intention of establishing a standard for testing petroleum in New York State. Mr. Elliott examined thirteen kinds of testers, including three open testers, and some electric testers, and experimented with four different samples of oil on each apparatus. His tests show that it is very important to know which apparatus has been used when an oil is said to have a given flashing point. One of the oils showed a range of temperature from 95° to 130° F. The general conclusions to which Mr. Elliott comes are briefly as follows: Of all the 13 apparatuses not one can be called perfectly satisfactory; open testers are entirely untrustworthy for determining the safety of kerosene oil; of the closed testers the Wisconsin State tester, with a few alterations suggested by the author, gives the most reliable results. The electric testers are troublesome to keep in order. (*Second Annual Report of the State Board of Health of New York, Albany, 1882, p. 449.*)

“Benzol” or “Benzene,” a Question in Nomenclature.—Attention is being directed to the necessity of greater uniformity in nomenclature, especially as regards the important hydrocarbons C_6H_6 and $C_{10}H_8$. German, French, and most American chemists designate C_6H_6 by the name *benzol* (sometimes spelled with a superfluous final *e*), while English chemists use the term *benzene*; in like manner continental chemists name $C_{10}H_8$ *naphthalin*, and Englishmen call it *naphthalene*.

A few years ago the London Chemical Society issued a six-page pamphlet* to its corps of abstractors giving rules of nomenclature and notation, and this has materially aided in securing uniformity. In preparing a paper for the *Berichte der deutschen chemischen Gesellschaft*, on the “Laws of Substitution in the Naphthalene Series,” Prof. Henry E. Armstrong, of the London Institution, employed the customary English terms, and desired the publication committee to refrain from changing them. This led to correspondence which is published in the *Berichte* (vol. XV, p.

* Reprinted in *Chemical News* (1883), vol. XLVII, p. 15.

200). Professor Armstrong objects to the termination *ol* for hydrocarbons not of the paraffin series, and would restrict it to the alcohols—carbinol, phenol, &c. He calls attention to the confusion which results from the terms “ethylene,” “anthracene,” “phenanthrene,” on the one hand, and “benzol,” “toluol,” and “naphthalin” on the other; and he expresses the hope that the German Chemical Society may unite with the London organization in attempting a uniform nomenclature. The publication committee of the *Berichte* approved of an exchange of views on the question.

American chemists are vitally interested, for in this country the occurrence of the petroleum product called benzine complicates the matter. While the English custom has much in its favor, the similarity in pronunciation of “benzine” and “benzene” leads many Americans to follow the continental terminology. Consistency is eminently desirable. It will be interesting to watch the result of the movement.

The *Berichte d. chem. Ges.* for 1882 contains articles on the nomenclature of special groups. We refer to Herrmann on the nomenclature of azo-compounds (p. 813), and to Wallach’s paper on the same subject. Liebig’s *Annalen* also has a paper, by Aug. Bernthsen, on the nomenclature of derivatives of carbonic acid. (Liebig’s *Annalen*, CCXI, p. 85.)

NOTES.

Black phosphorus is formed, according to Maumené, when phosphorus is distilled in hydrogen (made from zinc and sulphuric acid), and not formed when the distillation is conducted in carbonic anhydride. The black color soon disappears.

Lecture experiment.—H. Schwarz finds that zinc dust and sulphur, when intimately mixed, combine with very great energy, and the experiment is more brilliant and interesting than the usual one with iron filings (or copper turnings) and sulphur. The best proportions are two parts by weight of zinc and one of sulphur. The mixture inflames also when struck heavily by a hammer, and when ignited in a confined space (gun-barrel) explodes with about one-fourth the energy of gunpowder.

The rare metal vanadium occurs in large quantity, according to Witz and Osmond, in the residues of the iron furnaces of Creusot, and they describe a process for extracting it on a large scale with a view to its industrial applications.

Solid paraffine has been discovered by Silvestri in basalt. It occurs in cavities about a centimeter in diameter, and is nearly identical with the paraffine occurring in petroleum.

Bernthsen has discussed the unsatisfactory nomenclature of the isomeric sulpho-derivatives of carbonic acid, and proposes to call the radical $=C=S$ *thio-carbonyl*, and to name the acids thio-carbonyl acids. In like manner we may have for $=C=NH$ imido carbonyl and similar derivatives.

Phosphate of chromium, prepared by the action of phosphoric acid and
H. Mis. 26—34

sodium hyposulphite on chromates of the alkalis, forms a fine green pigment, which is proposed by Ad. Carnot as a substitute for the injurious arsenical and cupriferos colors.

Paul Sabatier has published a note claiming priority over A. Colson in the discovery of the *sulphides of silicium*, Si S, and Si SO.

Constantine Fahlberg has patented a process for preparing sulphate of aluminium free of iron for the mineral bauxite. The essential point in the method is the use of lead peroxide for the removal of the iron; the lead compound being afterwards recovered in a very simple manner.

Hautefeuille and Chappuis have studied the formation of pernitric oxide, and assign to it the formula N_2O_6 .

Cailletet has obtained a crystalline hydrate of phosphoretted hydrogen by strongly compressing the gas in the presence of water and then suddenly decreasing the pressure. Hydrates of ammonia and of sulphuretted hydrogen have also been obtained by this method.

Wroblewski, by a somewhat similar method, has obtained a solid crystalline hydrate of carbonic anhydride, $CO_2 \cdot 8H_2O$.

In a letter to Nature, G. F. Rodwell revives the controversy concerning the relative claims of Lavoisier and of Priestley to the discovery of oxygen. Rodwell endeavors to give the greater honor to Lavoisier.

Hydroxylamine is found by G. Berton and C. Raimondi to be an active poison when injected into the blood. Less than 0.2 gram killed a medium-sized dog. It also exerts a poisonous effect when introduced into the stomach or under the skin. The blood assumes a chocolate color and yields on dialysis nitrous acid, an oxidation product of hydroxylamine.

Two new antiseptics, calcium- and sodium-glycero-borates, have been announced by G. Le Bon, and experiments prove their utility. They are odorless and without injurious action on the most delicate tissues.

The discovery of hydrazin, NH_2 , claimed by Maumené, has been denied by several chemists who repeated the process (action of potassium permanganate on ammonium oxalate) and obtained negative results.

Bromo-sulphide of carbon has been discovered by Carl Hell and Fr. Urech. It is obtained by the direct action of bromine on carbon disulphide, and forms small brilliant prismatic crystals having the composition $C_2S_3Br_6$.

Rose's fusible alloy has been prepared by W. Spring by subjecting the constituents (lead, bismuth, and tin) in their proper proportion, to enormous pressure. Wood's alloy, melting at $65^\circ C$. can be obtained in a similar manner. The pressure employed was 7,500 atmospheres.

Metallic uranium, according to Zimmermann, forms a silver-white, somewhat malleable metal, very hard, but scratched by steel. It has a specific gravity of 18.7. It burns with brilliant light and scintillations, forming a bulky oxide. It is slowly attacked by warm nitric acid and by sulphuric acid, and readily dissolves in hydrochloric.

The Royal Society awarded the Davy medal (in duplicate) to D. Men-

delejeff and to Lothar Meyer for their discovery of the periodic relations of the atomic weights. This has drawn out a protest from John A. R. Newlands, of London, who claims priority in the publication of the periodic law, and who produces evidences of his assertion. (*Chem. News*, 46, 278.)

The French Academy of Sciences offer the new Volta prize of 50,000 francs to the author of the discovery which shall enable electricity to be applied economically in one of the following directions: as a source of heat, of light, of chemical action, of mechanical power; as a means of the transmission of intelligence, or of the treatment of disease. Competition is open until June 30, 1887, to scientific men of all nations, and the award will be decided in December, 1887.

The German Chemical Society is in a very flourishing condition. At the close of 1882 it numbered 2,527 members, of whom 16 are honorary and 263 associate members. The *Berichte*, published annually by the society, forms one of the most important of chemical journals; the two volumes issued in 1881 comprise over 3,000 pages, and the volumes for 1882 attain about the same size. The total income of the society for 1882 amounted to 56,247 marks, and the expenses for the same period were 44,697 marks.

Necrology.—During the year 1882 the deaths of many eminent chemists were recorded. Among them may be mentioned: Dr. John W. Draper, of New York; Dr. Henry Draper, of New York; Prof. William B. Rogers, of Boston; Dr. John Stenhouse, of Manchester; Prof. Rudolph Böttger, of Frankfort; Dr. Ludwig Feder, of Munich; Prof. A. Popoff, of Warsaw; Prof. Friedrich Wöhler, of Göttingen.

MINERALOGY.

BY EDWARD S. DANA,

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The following pages contain a summary of the progress of Mineralogy during the years of 1881 and 1882. The attempt has been made to give as complete a statement as possible, in the allotted space, of the recent advances made in the different departments of the science. Especial attention is devoted to the mineralogical discoveries in America. In presenting the subject, the recent contributions to general mineralogical bibliography are first mentioned; then follows a general statement of work done in crystallography and physical mineralogy; following this is given an account of recent investigations on the chemical side of the subject; next comes a somewhat particular statement of discoveries of new localities of minerals; and finally descriptions are given of the new species added to the science.

1. GENERAL WORKS ON MINERALOGY.

The most important of the recent additions to the works on general mineralogy is the eleventh edition of the *Elemente der Mineralogie* of Naumann, edited by Zirkel. Since the publication of the first edition in 1846, Naumann's Mineralogy has been the standard work in Germany; and the later editions have more thoroughly established its position. Since the death of the author in 1873, the work has been continued by Zirkel, and two editions have been published under his editorship; the tenth in 1877, and the eleventh in 1881. The fundamental changes introduced by him in the classification of species and other respects have brought the work more into harmony with modern views. Of the large number of other mineralogical books recently published in the German tongue, the majority are of an elementary character. The *Lehrbuch der Mineralogie*, by Tschermak, however, deserves especial mention, because of the clear and satisfactory manner in which the physical portion of the subject is treated; the descriptive part is, however, rather meager and inadequate. It is stated that an English translation is soon to appear; and if so, it will doubtless meet with a good reception.

An addition to the list of English mineralogical text-books has been made by Bauerman in his *Text Book of Systematic Mineralogy*. The

first volume, the only one thus far published, is devoted to the theoretical portion of the subject, leaving the description of species for another volume. The work has many excellent features, and it is worthy of note that it is the first important contribution to mineralogical treatises published in England since the *Mineralogy of Greg and Lettsom* in 1858. The second edition of Groth's *Tabellarische Uebersicht der Mineralien*, &c., published in 1882, is a work of more importance than might appear at a first glance. It professes to be only a system of tables giving a statement of the crystalline system and chemical composition of each species, designed especially for the use of the student in the lecture-room; but in the discussion of the chemical formulas of the species, many new points are brought out, and in their classification, the relation of the species, especially on the chemical side, has been developed with an unusual clearness. The book is consequently a real contribution to the development of the science.

A third appendix to the fifth edition of Dana's *System of Mineralogy* has been recently published (April, 1882), covering the period from 1875 to 1882. It is comprehensive in its scope, and gives full descriptions of the species announced as new, and also references to all mineralogical memoirs and articles, large and small, which have appeared during the seven years mentioned, with a brief mention of the contents of the more important. Some idea may be formed of the amount of mineralogical work done in recent times from the fact that this appendix covers 134 large octavo pages in small type; and also of the zeal for naming "new species" from the fact that 300 new names are here included.

Among mineralogical works of a more local character is to be mentioned first, the continuation of the *Materialien zur Mineralogie Russlands* by Kokscharof, of which great work the eighth volume is now completed. The monographs of the crystalline form of the species contained in these volumes are models of accurate, careful work. The third edition of the *Mineralogia*, by Domeyko, is also an important work. It was published in 1879, and a first appendix to it appeared in 1881. This work gives a complete account of the present state of the mineralogy of Chili and the neighboring countries of South America. Although far removed from the great centers of science, Professor Domeyko has carried on his work for many years with great zeal, and his labors have done much to make known the remarkable mineral riches of the countries in which he is interested. Another important work is that on the minerals of New South Wales, by A. Liversidge, which covers 140 pages.

Among works of a more special character is to be mentioned the *Sammlung von Mikrophotographien*, &c., by Cohen, which gives on a series of quarto plates excellent photographs of the various points of interest involved in the microscopical study of minerals and rocks; some of these are the inclusions in crystallized minerals, the phenomena of abnormal double refraction, figures produced by etching, the kinds of cleavage and structure, and so on. The execution of these plates leaves

nothing to be desired, and they will be of great assistance to those who are either studying or teaching this branch of mineralogy. Thus far four numbers of this work have appeared.

This seems to be the proper place to mention the *Sketch of the Progress of American Mineralogy* by Prof. G. J. Brush, delivered as the presidential address before the Montreal meeting of the American Association for the Advancement of Science, in August, 1882. This address gives an interesting and valuable account of the development of the science of mineralogy in America, commencing from its earliest beginning with the formation of the "American Mineralogical Society," in 1798. The great ignorance of the science which characterized the early years of this century is shown, and then the successive steps are pointed out which have gradually led up to the advanced position of mineralogy in this country at the present time. As typical of the work done and the workers engaged in it, sketches are given of four leading mineralogists: Dr. Archibald Bruce, who founded the American Mineralogical Journal; Col. George Gibbs, whose collections made abroad afforded a great stimulus to the development of the science at home; Prof. Parker Cleaveland, author of the most valuable work for the time, an *Elementary Treatise on Mineralogy and Geology*; and Prof. Benjamin Silliman, of Yale College, who established the American Journal of Science.

2. CRYSTALLOGRAPHY AND PHYSICAL MINERALOGY.

Among the recent general treatises devoted to crystallography and physical mineralogy, those of Tschermak and Bauerman have already been alluded to. In addition to these the *Geometrische Krystallographie* by Liebisch is to be mentioned. It devotes nearly 500 octavo pages to the development of the subject, and accomplishes this with system and thoroughness. Rammelsberg has published the first volume (615 pp.) of a new edition of his *Handbuch der krystallographisch-physikalischen Chemie*, a work which is a valuable auxiliary to the study of minerals, although discussing the crystalline form of artificial compounds. The *Stereographische Projection* of Reusch will be a help to those studying the system of mineralogy based upon it.

A noteworthy advance in the methods of research in physical mineralogy has been made through the introduction of a solution of mercuric iodide in potassium iodide as a means of determining the specific gravity of minerals, and also of separating different minerals when mixed together in the form of small fragments. The solution, called the Sonstadt solution, because proposed by E. Sonstadt in 1873, has a high specific gravity, attaining at a maximum about 3.2, so that a fragment of fluorite floats in it. This specific gravity can be varied almost indefinitely by the gradual addition of water, so that it may be used to determine the specific gravity of any mineral not heavier than the limit mentioned; all that is necessary being to obtain the weight of a known volume of the liquid in which the mineral in question just floats. The

solution is even more useful for the separation of two or more minerals when mixed together in the form of small fragments, the solution being graded by successive dilution so that in succession one constituent after another of the mixture sinks and is removed while the others float. This method of procedure is much used in connection with the study of the minerals in rocks, and for the development of it science is especially indebted to Thoulet and Goldschmidt. Another solution of similar properties has been proposed by D. Klein; this is best made, as he states, from the boro-tungstate of cadmium, and may be obtained with a specific gravity up to 3.6. Breon has obtained remarkable results from a liquid obtained by fusing lead chloride and zinc chloride together at about 400° C. A liquid with a specific gravity above 7.5 has been obtained, and although the practical use of such a liquid is not very convenient, Breon has been able with it to separate as many as twelve constituent minerals from a sample of sand; he has also used it for minerals as heavy as wolfram.

In optical mineralogy the subject which has attracted most attention during the period under consideration, as indeed for the few years preceding it, is the cause of the so-called "optical anomalies" of crystals. Since the time of Brewster it has been well known that many species exhibit in polarized light optical phenomena not in accordance with their apparent geometrical form; for example, that alum, fluorite, the diamond, and other species show double refraction, while their crystalline form is apparently isometric. Later investigations have largely increased the list of crystallized minerals exhibiting these "optical anomalies," as they have been called, and various explanations have been offered for them. At present there may be said to be two opposed theories, both having strong supporters, and the weight of evidence is hardly sufficient to make it possible to decide finally between them.

In the view of Mallard, first advanced in 1876, the apparent symmetry exhibited by the crystals of the species under discussion, which show optical anomalies, is only *pseudo-symmetry*; the optical properties observed belong inherently to the molecular structure of the individual parts of the crystal; and the external crystalline form observed is really due to the grouping; or twinning, of several simple crystals, each of a lower grade of symmetry than that which the complex whole so formed simulates. For example, according to this view, an apparent isometric cube may in fact be made up of six four-sided pyramids, each optically uniaxial, and united so that their bases form the sides of the cube and their vertices are grouped at the center. Similarly, an apparent regular octahedron may be made up of eight uniaxial triangular pyramids; or, still more generally, a hex-octahedron of garnet may be composed of forty-eight triangular pyramids, each optically biaxial, and four together forming a pseudo-rhombic pyramid. The theory of Mallard has been warmly supported by Bertrand; and the labors of the French mineralogists in general, including Des Cloizeaux, have increased largely the list of so-called pseudo-

isometric, pseudo-tetragonal, pseudo-hexagonal, &c., species. The most common typical species under the systems of high grade of symmetry have thus been thrown over into systems of lower symmetry; the list includes such species as garnet, fluorite, analcite, apophyllite, rutile, zircon, beryl, apatite, and so on.

Opposed to the theory of Mallard is that advanced by Marbach and Reusch, and developed by Klocke, Klein, Ben Saude, and other mineralogists, which explains the "optical anomalies" by reference to the state of molecular tension existing within the crystal and produced during its growth. According to this view, the apparent geometrical form of the crystal represents its true symmetry, and the optical properties observed which are at variance with it do not belong inherently to the substance of the crystal, but have been produced by secondary causes. Klocke has applied this theory to alum, Klein to boracite and garnet, and Ben Saude to analcite and perovskite, but the full explanation would require an amount of detailed description inconsistent with the space allotted for this summary.

As between the two theories, it may be said that while pseudo-symmetry has a real existence—twins of orthorhombic species, aragonite, for example, often imitating hexagonal forms—still the weight of argument seems to be in favor of referring the phenomena observed to secondary causes, so that it is not yet necessary to call garnet a triclinic species. On the other hand, although the extreme view of Mallard may not be accepted, it is beyond question true that the result of the accurate crystallographic and optical investigations of the past few years has been to show that many crystals really belong to systems of a lower grade of symmetry than that to which they have been previously referred. It is impossible at present to say how far this may be carried. The number of minerals to whose crystalline form and optical properties especial attention has been directed in the past two years is so large that they cannot be even enumerated here.

One explanation for the great amount of study that has been devoted to the questions above mentioned, and for the interest which they have excited, is to be found in the fact that recent years have brought great improvements in the instruments for the investigation of both the form and optical properties of crystals. The microscope of Rosenbusch, since 1876 much used in the study of rock-sections, has been improved so as to be suitable for the optical study of minute crystals. A microscope especially adapted for this purpose has been devised by Bertrand in Paris, and in his hands, as also those of Des Cloizeaux, it has given accurate results in very many cases where the earlier instruments would have yielded nothing. Improvements have also been made in the polariscope and other similar instruments. New methods have been introduced for the determination of the indices of refraction of crystallized minerals; the most recent is that employed by Bauer, in which he obtains the desired values by calculation from the measured distances

between the black rings of the axial interference figures seen in monochromatic converging polarized light; he has applied this method to muscovite and more recently to the uniaxial mineral brucite.

3. CHEMICAL MINERALOGY.

In the direction of chemical mineralogy the most important advances that have been made are in the artificial formation of minerals. This is a subject to which the French mineralogists and chemists have especially devoted themselves, and the results they have attained are most remarkable. Some of the more recent achievements in this line are the making of analcite, leucite, gaylussite, opal, wurtzite, scorodite, &c. It would not be appropriate to discuss here the methods employed in these or similar cases, but attention may properly be called to a work on the subject by Fouqué and Lévy entitled *Synthèse des Minéraux et des Roches*. These authors have already themselves performed some of the most important of the synthetic experiments, and they have now published a volume of 420 pages octavo, in which all previous results are brought together. The work is admirably constructed, giving a summary of the methods employed, a discussion of the principles involved, as well as of the value of the synthetic method, and further, a statement of the artificial production of the individual species, with full references to previous experimenters and observers. This valuable work cannot but act as a stimulus to further the development of a most important branch of mineralogy, which has a wide bearing not only upon this science itself, but beyond, upon geology and chemistry.

The analytical method has also, as of old, been followed most industriously in the past two years, and the result has been to settle the composition of some minerals in cases where it has long been doubtful, and to throw light on many obscure points. Among the many cases coming under this head may be mentioned the work of Penfield on amblygonite, in which he shows that the many varieties of the species all conform to the same general formula, although differing in the amount of fluorine and water they contain, the latter increasing as the former diminishes. He explains this variation by assuming that hydroxyl comes in to replace the fluorine to a greater or less extent. The same chemist has also settled the doubtful composition of monazite. Early analyses showed the presence of a considerable amount of thorium, while some later ones have afforded no thorium at all. Penfield has proved that the mineral is a simple phosphate of the metals of the cerium group, the thorium being due to admixed thorite. He analyzed samples of monazite from different American localities, and showed that while all afforded thorium in widely different amounts, the silica present also in each case was sufficient to unite with the thorium; moreover, thin sections showed the existence of a foreign mineral which gelatinized with acids. The doubtful relations of the minerals of the cryolite group have been made clear by the chemical work of Brandl

and the crystallographical work of Groth. The species thomsenolite and pachnolite, which have often been confounded, are shown to be distinct both in form and in composition. Cathrein has examined the minerals called leucoxene and titanomorphite, both of which are alteration minerals of titanite iron or of rutile, and has shown that they are really identical with the common mineral titanite. It will be remembered that Lasaulx attempted to set up titanomorphite as an independent species on the ground that it was simply a new calcium titanate, but the analysis of Bettendorff, on which the conclusion was based, is shown to have been inaccurate.

The gaseous inclusions in smoky quartz, especially that of Branchville, have been studied microscopically by the late Dr. Hawes, and chemically by Prof. A. W. Wright. W. E. Hidden has also described large fluid cavities in the quartz of North Carolina. The Branchville quartz is shown to be exceptionally rich in cavities with liquid carbon dioxide, so much so that a thin fragment broken off by a tap of a hammer separates with explosive force, and a fragment held in the flame of a Bunsen burner flies to pieces with great violence. The analysis of these gases by Wright has proved the presence, besides the carbon dioxide, of nitrogen, sulphureted hydrogen, ammonia, sulphur dioxide, and fluorine.

Bamberger has shown that the picranalcite of Bechi, supposed to be a distinct mineral, is ordinary analcite, containing only a trace of magnesia. H. Sjögren has proved the presence of both chondrodite (monoclinic) and humite (orthorhombic) in Sweden, and he has attempted to establish the chemical composition of these two closely related species, as also of the third species of the group, called clinohumite. It will be remembered that these are equivalents of Scacchi's three types of Vesuvian humite: type I = humite, type II = chondrodite, and type III = clinohumite.

The chemical composition of the zinc silicate, calamine, has been established by Fook. He shows that it remains unchanged at 340° C., and loses its water only at a red heat; the water consequently is not to be regarded as water of crystallization, but the true formula is $H_2 Zn_2 Si O_5$, it being thus a basic silicate with an oxygen ratio of 3 : 2 like andalusite. A similar change had already been made earlier in the method of viewing the composition of the copper silicate diopside.

Dr. Genth has published some new observations bearing upon the subject of the alteration of corundum, a subject to which he devoted an extended and important memoir in 1873. Some of the cases noted by him are: (1) Corundum altered to spinel. At the Carter mine, Madison County, North Carolina, corundum is found in white and pink crystals and in irregular grayish-white or white cleavage masses enveloping a variety of a delicate pink color; this corundum is often more or less completely changed to a massive greenish black spinel of a fine granular structure, but rarely showing octahedral crystals in the compact mass.

The corundum of Shimersville, Pa., is also in part altered to spinel. (2) Corundum altered to zoisite. A new locality is mentioned in Towns County, Georgia. (3) Altered to feldspar and mica (damourite). At Presley mine, Haywood County, North Carolina, feldspar and mica have been observed as alteration products of corundum; the larger crystals of the latter mineral are of a grayish-blue color and contain patches of a white, cleavable feldspar often surrounded by mica. In other cases a small nucleus of the original mineral is surrounded by an aureole of delicate subfibrous mica. One crystal of muscovite contained in the center remnants of a smooth bluish-gray cleavable corundum; another mass resembled a coarse granite, consisting of albite, muscovite, and scattered remnants of grayish-blue corundum. At Belts' Bridge, Iredell County, North Carolina, large crystals of corundum one foot in diameter occur which are more or less completely altered to mica, though they also contain radiating masses of black tourmaline. From the mica-schists near Bradford, Coosa County, Alabama, fine hexagonal crystals have been obtained, consisting of a central part of corundum of a brown or bronze color, inclosing grains of menaccanite, and surrounding this is a perfect ring of subfibrous greenish-white mica; other crystals are almost entirely altered, often being flattened out and so forming nodules in the mica-schist; the mica is sometimes scaly, sometimes very fine-grained and compact. Flattened nodules of mica, inclosing a nucleus of corundum, also occur at the Haskell mine, Macon County, North Carolina. Various new localities are also given of (4) corundum altered to margarite. From Shoup's Ford, Burke County, North Carolina, specimens showing (5) the alteration to fibrolite have been obtained; they consist of brown corundum with a thin shell of fine fibrous radiating white fibrolite. Corundum altered (6) to cyanite has been noted from Statesville, Iredell County, North Carolina; the specimen consisted of a nucleus of pink corundum with pale blue cyanite crystallized about it and presumably having resulted from its alteration; in another specimen from Wilkes County, North Carolina, the cyanite was still further altered to mica.

Notes of work by students in the laboratory of the University of Virginia, recently published as a continuation of a series commenced several years since, contain some points of interest. An analysis is given of the allanite from Bedford County, Virginia, by Page, the results of which are remarkable as showing the presence of over 50 per cent. of the oxides of the cerium metals; analyses are also given of the helvite recently discovered near Amelia Court-House, Virginia (see beyond), of mimetite from Nevada, a sulph-antimonite of copper and zinc, near bournonite, from Park County, Colorado; of fergusonite, samarskite, orthite from North Carolina; of metallic iron found in small flattened scales in the alluvial washings of Brush Creek, Montgomery County, Virginia, of native palladium gold, containing 8.2 per cent. palladium, from Taguaril, near Subara, Minas Geraes, Brazil.

An important memoir, containing the result of numerous chemical analyses on the sodalite-syenite and the associated minerals of the Tunugdliarfik and Kangerdluarsuk fiords of Southern Greenland, has been published by J. Loreuzen, of Copenhagen. The chief constituents of the rock are a greenish-white feldspar, arfvedsonite (and ægirite) and sodalite; there also occur eudialyte, nephelite, lepidolite, ænigmatite, and a new mineral called steenstrupine (see beyond); also at one spot ilvaite with calcite; and finally some zeolites, in particular analcite and natrolite. Analyses are given of most of the minerals mentioned. It is especially interesting to note that the association of minerals is nearly identical with that observed in the syenite of Langesunds fiord of Southern Norway.

4. DISCOVERY OF NEW MINERAL LOCALITIES.

Not the least important advance in general mineralogy is to be found in the discovery of new mineral localities. Great progress has been made in this direction, particularly in the western part of the United States, where the recent development of gold and silver mines has brought to light much that is of very great interest. Of general statements of American mineral regions are to be mentioned the following works: *The minerals and mineral localities of North Carolina*, by F. A. Genth and W. C. Kerr, with notes by W. E. Hidden; *The second report of the State mineralogist of California*, by H. G. Hanks; *Notes on the mineralogy of Missouri*, by Alexander V. Leonhard; *Biennial report of the State geologist of the State of Colorado*, by J. Alden Smith. Similar memoirs in regard to foreign regions are that by Schmidt on the zinc deposits at Wiesloch in Baden, and by Coben on the minerals of the region about Heidelberg.

In the southwestern Territories of New Mexico and Arizona important mineralogical discoveries have been made. For example, in Arizona, Silliman has called attention to the occurrence of the hitherto very rare mineral vanadinite in beautiful crystals, often of a ruby-red color, in Yuma County, at the Hamburg, Princess, and Red Cloud mines; also of fine wulfenite at the last-mentioned mine; further of crocoite and other chromium minerals, with yellow vanadinite, at several mines in the Vulture district; of jarosite from the Vulture mine; of thenardite, in large deposits from the Rio Verde, in Maricopa County. W. P. Blake has described beautiful vanadinite with mimetite, wulfenite, &c., from the Castle Dome mines, Yuma County. Various interesting copper minerals have been obtained from the Copper Queen mine, Pinal County; crystallized silver, argentite, &c., from the Silver King mine; beautiful diopside, almost equal to that from the Kirghese steppes, from near Clifton. The ancient turquoise locality at Mount Chalehuatl, New Mexico, has been recently investigated and good specimens obtained. In Oregon considerable deposits of a hydrous nickel silicate allied to

garnierite have been discovered in Douglas County. The rare mineral wurtzite has been identified at the original Butte mine, Montana.

Onofrite has been discovered at Marysvale, Southern Utah, by Newberry, and described by Brush. Native lead with minium has been described by W. P. Blake as occurring in the midst of masses of galena, at the Jay Gould mine, Alturas County, Idaho; the metallic lead is in small rounded masses or grains from one-eighth to one-quarter of an inch in diameter, also in irregular reniform bunches weighing an ounce or more; the red oxide forms a coating in the native metal. The same author mentions the occurrence of orpiment and realgar in a thin bed in the horizontal sedimentary formations underlying lava in the Coyote district, Iron County, Utah.

The minerals of Colorado have been studied by Cross and Hillebrand, by König, by M. W. Iles, and others. The first-mentioned authors have given a complete description with analyses of the zeolites of Table Mountain, near Golden; they have also described the occurrence of phenacite, of topaz, of zircon, and of several minerals of the cryolite group in the Pike's Peak region. Alaskaitite, beegerite, ilesite, are new minerals from Colorado, descriptions of which are given on a subsequent page. König has described jarosite, from Chaffee County.

In the Southern States W. E. Hidden has continued his investigations near Stony Point, Alexander County, North Carolina, and has brought to light many most interesting and valuable minerals. The beautiful emerald-green variety of spodumene, called hiddenite, has been found in fine prismatic crystals, and of a size and clearness affording gems which are highly valued. The same locality has afforded splendid emeralds in crystals up to 10 inches in length; they are not often clear enough for use in jewelry, but in size and beauty of color they are unique among mineralogical specimens. Splendent rutiles, highly modified and brilliantly polished quartz crystals accompany the emeralds, also fine monazite, allanite, and other species. Monazite has been obtained from the gold washings at Brindletown and elsewhere, also *in situ* from several localities in the same State. Another interesting locality is that near Amelia Court-House, Amelia County, Virginia. This has afforded large crystals of microlite, up to several pounds in weight. It will be remembered that the original crystals of the mineral from Massachusetts were extremely minute, and to them the name given was appropriate, as it is not to those from Virginia. There also occur fine columbite, monazite in large masses, orthite, the rare mineral helvite, and other more common species.

In Maine topaz has been found in fine crystals, sometimes very large, though sparingly, at Stoneham, as first pointed out by G. F. Kunz, with triphylite and columbite. Norway has yielded triphylite (lithiophilite) and chrysoberyl. From Peru, triphylite, columbite, and spodumene have been obtained. It is also worthy of mention that the famous tourmaline

locality, at Paris, has been reopened and has offered some more good specimens.

The many minerals occurring in the diabase dike at Deerfield, Mass., have been exhaustively studied and described by Emerson.

Middletown, Conn., has afforded at Pelton's quarry a few specimens of monazite and samarskite.

De Kalb, N. Y., has yielded interesting crystals of white tourmaline.

In Canada the locality at Eganville, Renfrew County, Ontario, has continued to yield fine specimens; among these are gigantic crystals of apatite and titanite, also large twin crystals of zircon, which are unique for the species. From Hull, Quebec, fine colorless garnets have been obtained. Samarskite has been found in the township of Brassard, Berthier County, Quebec. Lazulite has been analyzed by Hoffmann from Churchill River, Keewatin district.

In regard to new mineral discoveries outside of the United States and Canada, it is unnecessary to speak in detail. Attention may be called to the discovery of vanadates, vanadinite, descloizite, &c., in the Argentine Republic; to the description by Silliman of a mountain of martite, the Cerro de Mercado of Mexico. The ancient mines recently reopened at Laurium, Greece, have afforded, besides the commoner zinc species, also adamite, cabrerite, and several new species mentioned later.

The rare mineral danburite, long known only in imperfect imbedded crystals from Danbury, Conn., afterward (1880) found in large and fine crystals, often transparent, at Russell, N. Y., has now been discovered on the Skopi, Switzerland. The discovery of this borosilicate is worthy of note; the crystals are small, quite clear, and have the same remarkable resemblance to topaz characteristic of the crystals from Russell; the composition is identical with that of the American mineral. The hydrous carbonate of alumina, called dawsonite by Harrington, from specimens found at Montreal, has been identified in Tuscany. A remarkable variety of tourmaline containing chromium has been described from the Urals. Euclase and phenacite have been obtained from the Alps. Beautiful blue opals are now brought from Queensland; their occurrence has been described by Robertson in the Proceedings of the Philosophical Society of Glasgow for 1881-82.

5. NEW MINERALS.

The following pages contain brief descriptions of the minerals announced as new, during the past two years. Only a small portion of these have characters sufficiently distinct to justify their being accepted as true new species. The list is arranged in alphabetical order, and the names of the most clearly defined species are printed in small capitals, the others italics.

ALASKAITE.—A massive mineral with metallic luster and whitish lead-gray color. It contains sulphur, bismuth, lead, silver, and copper;

and the chemical formula is analogous to that of miargyrite with bismuth in the place of antimony. It is described by König as occurring intimately mixed with barite, chalcopyrite and tetrahedrite at the Alaska mine, Poughkeepsie Gulch, Colorado. *Silberwismuthglanz* is a name given by Rammelsberg to a closely related mineral from Morococha, Peru; it contains only sulphur, bismuth, and silver.

ÄNNERÖDITE.—A mineral occurring in prismatic crystals closely resembling columbite in habit and in angles. It has a black color and submetallic luster. In composition it is very near samarskite, and the describer, Brögger, regards it as bearing the same relation to columbite which samarskite bears to tantalite, found in a pegmatite vein at Änneröd, near Moss, Norway.

Arctolite.—A mineral of doubtful character, only interesting because of its source, Hvitholm near Spitzbergen. The name indicates that it comes from the Arctic. It has the prismatic angle of the amphibole, while in composition it appears to be near prehnite. The describer is Professor Blomstrand of Lund, Sweden.

Balvraidite.—A name given by Heddle to a supposed homogeneous substance, having a saccharoidal structure and pale purplish-brown color, which was found in the granular limestone of Balvraid, Inverness-shire, Scotland. An analysis makes it a hydrous silicate containing alumina, iron sesquioxide, lime, magnesia, and alkalies. It has not yet been shown to be a distinct mineral.

BEEGERITE.—Occurs in elongated isometric crystals, also massive, with a brilliant metallic luster and gray color. In composition it is a sulpho-bismuthite of lead. It is described by König as occurring at the Baltic Lode, near Grant P. O., Park County, Colorado, and is named for Mr. Hermann Beeger of Denver.

Bergamaskite.—A variety of amphibole remarkable because containing almost no magnesia. It is described by Lucchetti as occurring in quartzose hornblende-porphry at Monte Altino, province of Bergamo, Italy.

Berlauite.—A name given by Schrauf to a chloritic substance filling cavities between granite and serpentine, found in the serpentine region near Budweis, Southern Bohemia. It is near other members of the vermiculite group, but has not yet been shown to be a distinct mineral.

Brackebuschite.—A hydrous vanadate of lead, containing small amounts of iron, manganese, and copper; related to descloizite. It occurs in small prismatic crystals of a black color, with other vanadium minerals in the State of Cordoba, Argentine Republic. Named by Döring after Dr. Brackebusch of Buenos Ayres.

Bunsenin.—See below under krennerite.

CHALCOMENITE.—Occurs in bright blue monoclinic crystals, and crystalline crusts. In composition it is a hydrous selenite of copper. The describers, Des Cloizeaux and Damour, speak of it as found with

various selenides of silver, copper, and lead from the Cerro de Cacheuta, Mendoza, Argentine Republic; it has resulted from the alteration of these minerals.

Cobaltomenite.—According to Bertrand this is a cobalt selenite from Cacheuta, in the Argentine Republic. It occurs in minute rose-red crystals, resembling erythrite in appearance.

Cossyrite.—A mineral near amphibole in form, but triclinic in form and having a prismatic angle (cleavage) of only 114° . In composition it approaches some very ferruginous amphiboles. Described by Foerster as found imbedded in the liparite lavas of the island of Pantellaria (ancient name Cossyra).

Craigtonite.—A name given by Heddle to a blue-black substance forming dendritic stains on red granite, in the quarry of Craigton, Hill of Fare, Aberdeenshire, Scotland. An analysis gave alumina, iron sesquioxide, manganese protoxide, magnesia, and alkalies. It is not a mineral, and the name deserves no recognition.

Cyprusite.—A supposed new iron sulphate of doubtful character; described by Reinsch. It occurs in larger quantities in an impure condition incrusting the side of a hill in the western part of Cyprus. It is soft, chalk-like in consistency, and of a yellowish color.

Destinezite.—Announced by Forir and Jorissen as a new iron phosphate related to delvauxite, but not yet fully described. It is from the ampelite of Argenteau, Belgium, and occurs in yellowish-white, nodular masses of earthy aspect.

Douglasite.—A hydrous chloride of potassium and iron from the salt mines of Douglass hall, Germany; described by Oehsenius and Precht. It seems to be essentially the same as the Vesuvian mineral called erythrosiderite by Scacchi.

Dumortierite.—A silicate of alumina occurring in prismatic crystals of a light blue color, also in fibrous forms imbedded in blocks of gneiss at Chaponost near Lyons, France. Named for the paleontologist, M. Eugène Dumortier.

Edmonsonite.—A compound of nickel and iron identified by Flight in the meteoric iron of Melbourne, Australia, and regarded as a new and distinct mineral.

Ellonite.—A name attached by Heddle to a pale yellow unctuous powder from the gneiss of Ellon, Aberdeenshire, Scotland. It is an impure hydrous silicate of magnesia, not a distinct mineral.

Enophite.—A name given by Schrauf to a chloritic variety of serpentine, related to the hallite of Cooke. The specimens analyzed were from the serpentine region of Southern Bohemia, near Budweis.

Erilite.—A name given by H. C. Lewis to minute acicular crystals occurring as inclusions in quartz from Herkimer County, New York. Their chemical nature was not determined; there is every probability that they belong to some well-known species.

Erythrozoineite.—A mineral occurring, according to Damour, in thin
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crystalline plates in the lapis lazuli from Siberia. They have a red color, and chemically contain sulphur, zinc, and manganese. Des Cloizeaux, on the basis of an optical examination, regards it as probably a manganese variety of wurtzite.

Gunnisonite.—A name given by Clarke and Perry to a supposed new mineral from near Gunnison, Colo. The substance examined was massive and had a deep purple color. It contains calcium fluoride, silica, lime, alumina, &c., and is probably either an altered or a very impure fluorite. It is not a distinct mineral.

Hieratite.—According to Cossa, a potassium fluo-silicate. It forms with lamellæ of boracic acid stalactitic concretions of a grayish color and generally spongy texture. The concretions contain also selen-sulphur, arsenic sulphide, and the alums of potassium, cesium, rubidium, and, in small quantities, thallium. From the fumaroles of the crater of Vulcano (Greek name Hiera), one of the Lipari Islands.

Hydrobiotite.—A name used by Lewis for a hydrated biotite; also employed, with a slightly different meaning, by Schrauf, in his description of the serpentine minerals of Budweis, Southern Bohemia.

ILESITE.—A hydrous sulphate of manganese chiefly, with also zinc and iron. The mineral occurs in loosely adherent crystalline aggregates, of a white color, and bitter, astringent taste. It is readily soluble in water. Occurs in a siliceous gangue, with sulphides of iron and zinc, in Hall Valley, Park County, Colorado. Named after Dr. M. W. Iles, of Leadville.

Kelyphite.—A gray serpentinous substance coating crystals of pyrope from Kremze, near Budweis, Southern Bohemia. The name is given, but without sufficient reason, by Schrauf.

KENTROLITE.—A silicate of manganese and lead, occurring in dark reddish-brown crystals. The crystals are minute, and often grouped in sheaf-like forms, resembling stilbite (the name is from the Greek *κεντρον*, *spike*). Described by vom Rath and Damour as coming from Southern Chili.

KRENNERITE.—A rare telluride of gold from Nagyag, Transylvania; it contains also a little silver and copper. It occurs in vertically striated prismatic crystals, silver-white to brass-yellow in color, and with brilliant metallic luster. It was first named *Bunsenin* by Krenner, but afterwards more completely described by vom Rath under the name Krennerite, because the former name already belonged to another species.

Lautite.—Described by Frenzel as a new mineral containing sulphur, arsenic, copper, and silver; from Lauta, near Marienberg, Saxony. Since shown by Weisbach to be a mixture of metallic arsenic with a mineral related to tennantite; the name, consequently, is to be discarded.

Lennilite.—A name given by Schrauf to a substance from Budweis, Bohemia, produced by alteration, which is near the vermiculite of

Lenni, Pennsylvania, described by Cooke. Schrauf writes the name *Lernilite*, which, however, is a mistake in orthography for the form above given.

Leucochalcite.—A white mineral, with silky luster, occurring in slender, needle-like crystals. It is essentially a hydrous arsenate of copper, having a composition analogous to that of the phosphate tagilite. Described by Sandberger and Petersen as from the Wilhelmine mine in the Spessart, Germany.

Manganbrucite.—A manganesian variety of brucite, occurring, according to Igelström, in granular form with hausmannite and other manganese minerals at the Jakobsberg, Sweden. It is massive, shows no cleavage, and has a honey-yellow to brownish-red color, though perhaps originally nearly colorless.

MELANOTEKITE.—A silicate of iron sesquioxide and lead, apparently related in composition to the manganese lead silicate called kentrolite (see above). It occurs massive, with two cleavages; it has a metallic to resinous luster, and black or blackish-gray color. It is found with native lead, and intimately mixed with magnetite and yellow garnet at the remarkable mines at Långban, in Wermland, Sweden. The same locality has previously furnished two other lead silicates called hyalotekite and ganomalite. The name melanotekite, given by Lindström, is from μέλας, *black*, and τήκειν, *to melt*.

Molybdomenite.—A lead selenite, named by Bertrand, from μόλυβδος, *lead*, and μήνη, *moon*. It occurs in thin, transparent crystalline lamellæ, white or slightly greenish, with vitreous luster. Obtained with other selenium minerals from Cacheuta, Argentine Republic.

MONETITE.—A mineral from the guano of the islands of Moneta and Mona, West Indies, described by C. U. Shepard, sr. It occurs in minute triclinic crystals, confusedly aggregated, of a white or pale yellowish color. It is intimately mixed with gypsum. An analysis, by C. U. Shepard, jr., shows that it contains lime, phosphoric acid, and water, and making the hydrogen basic, it is an orthophosphate.

MONITE.—Another guano mineral, associated with the above monetite, and named after the other island, Mona. It is intimately associated with monetite, and occurs in an uncrystalline, earthy, slightly coherent form, of a snow-white color. In composition it is a calcium orthophosphate, with one molecule of water.

Nitrobarite.—Groth has described crystals of native barium nitrate from Chili. They are in apparent octahedrons, formed of the plus and minus tetrahedrons; also in twins; the crystals are colorless. The name nitrobarite was suggested by H. C. Lewis.

Nocerine.—According to a preliminary note by Scacchi, a double fluoride of calcium and magnesium, occurring in white acicular crystals in volcanic bombs in the tufa of Nocera.

Parachlorite and *protochlorite*.—General terms used by Schrauf for certain groups of chloritic substances produced by alteration.

Phytocollite.—A black gelatinous hydrocarbon, closely related to dopplerite, first described by T. Cooper, later by H. C. Lewis, who attached the above name (from *φυτον, κολλα*, or *plant-jelly*). It was found in a stratum of muck under a peat-bed at Scranton, Pa. When first obtained it was jelly-like in consistency, but on exposure it became tougher and elastic, like India rubber, and when quite dry it was hard and brittle; in the latter condition it burns with a yellow flame.

Plinthite.—A name given by Heddle to a substance of a deep red color and greasy or dull luster, forming layers in amygdaloid, from Quiraing, in Skye. It is an impure hydrous ferruginous silicate of alumina. There is no excuse for attaching a new name in such a case.

Rezbanyite.—According to Frenzel, a new sulpho-bismuthite of lead from Rezbanya, Hungary. It is a massive mineral, of metallic luster and light lead-gray color. It occurs intimately mixed with chalcopyrite and calcite, also imbedded in quartz.

Rosterite.—A variety of beryl, occurring in short prismatic to tabular, doubly-terminated crystals of a pale rose-red color. It differs somewhat from the ordinary kinds in optical characters and in composition, but is not to be regarded as distinct. From the island of Elba; described by G. Grattarola.

Schneebergite.—A mineral of doubtful relations, occurring in transparent isometric crystals of vitreous to adamantine luster and honey-yellow color. It contains principally lime and antimony, but its exact chemical composition is unknown. Described by A. Brezina; from Schneeberg, Tyrol.

Schuchardtite.—A name given by Schrauf to the so-called chrysoprase, from Gläserndorf, Silesia.

Semseyite.—Briefly described by Krenner as occurring in gray metallic crystals at Felsöbanya, Hungary. It contains sulphur, antimony, and lead, and is said to be related to pligionite.

Serpierite.—Occurs in minute tabular crystals, often grouped into tufted forms. The color is greenish blue. The crystalline form has been described by Des Cloizeaux, but its exact chemical composition is unknown. Damour states it to be a basic sulphate of copper and zinc. It is from the ancient mines, recently re-opened, at Laurium, Greece.

Siderophyllite.—A black mica from near Pike's Peak, Colo., described by H. C. Lewis. It is near biotite, but is remarkable as containing 25½ per cent. of iron protoxide, and almost no magnesia.

Siliciophite.—A heterogeneous substance, high in silica, produced by the continued alteration of serpentine (derived from chrysolite) near Budweis, Bohemia. The name was given by Schrauf. It is not a mineral.

Steenstrupine.—A mineral described by Lorenzen, from the sodalite syenite of Greenland. It occurs massive and indistinctly crystallized, perhaps in rhombohedrons, of a brown color; it is associated with lepidolite and ægirite. Chemically contains chiefly silica, the oxides

of the rare metals cerium, lanthanum, didymium, thorium; also iron, lime, soda, &c.

Talktriplite.—A phosphate of iron and manganese protoxides, of lime and magnesia, perhaps to be regarded as a triplite, peculiar in containing lime and magnesia. It occurs in small transparent grains of a yellow or yellowish-red color, together with lazulite, svanbergite, and other phosphates, at the Horrsjöberg, in Wermland, Sweden. Described by L. I. Igelström.

Tritochorite.—A vanadate of lead, copper, and zinc, related to eusynchite, described by Frenzel as from Mexico or South America. It is a massive mineral, with fibrous-columnar structure, and blackish or yellowish-brown color.

Tyreeite.—A name given by Heddle to the soluble portion (in sulphuric acid) of a small amount of red mud obtained as a residue after dissolving 150 pounds of the carnelian marble of Tyree, Scotland, in hydrochloric acid. The author has given many names to bad minerals, but this is the worst case of all.

Uranopilite.—According to Weisbach a hydrous silicate of lime and uranium, forming a lemon-yellow ochereous substance, at Johanngeorgenstadt, Saxony. The material analyzed was so impure that the existence of a new mineral is yet to be proved.

Uranothallite.—A hydrous carbonate of uranium and lime, occurring in confused aggregates of siskin-green color at Joachimsthal; the form, according to Schrauf, approximates to that of aragonite. The same mineral was earlier analyzed by Lindacker and partially described by Vogl.

Uranothorite.—A variety of thorite remarkable as containing 10 per cent. of uranium oxide. The single specimen found was massive, had a dark-red color, and resinous to subvitreous luster. It is described by P. Collier as from the Champlain iron region of New York, but the exact locality is unknown.

ZINCALUMINITE.—A mineral occurring in thin hexagonal plates of a white or slightly bluish color. It is a hydrous sulphate of zinc and alumina. It is described by Bertrand and Damour from the zinc mines of Laurium, Greece.



BOTANY.

By Prof. WILLIAM G. FARLOW.

The greatest activity has been shown this year in the departments of vegetable physiology and anatomy and publications describing new species of phænogams and fungi, while comparatively few works have appeared relating to algæ and higher cryptogams.

VEGETABLE ANATOMY.

Strasburger has published two important papers on the structure of the cell. In his *Theilungsvorgang der Zellkerne* he describes and figures the minute changes which the cell-nucleus undergoes during division, and finally concludes that the division of the cell does not arise primarily from the division of the nucleus, but rather that the changes which tend to bring about cell-division are the exciting cause of the division of the nucleus itself. In his second paper, *Bau und Wachstum der Zellhäute*, he treats not only of the formation and thickening of the cell-wall, but also of the growth of starch grains, the molecular structure of organized structures, the function of the nucleus, and several other points. Many of the facts which have hitherto been explained by the theory of intussusception Strasburger now believes can be better explained by the apposition theory. He is confirmed in his previous view that the nucleus plays an active part in the formation of protoplasm, since, if we except the sieve-cells, the nucleus is of all the living parts of a cell the most persistent part. Tangl has published a paper on the division of the nucleus and the cell in the formation of the pollen in *Hemerocallis fulva*, and the *Bot. Zeitung* has a paper by Zalewski on the division of the nucleus in the mother cells of the pollen in some *Liliaceæ*. In the last-named journal is also a paper by Zacharias, in which he gives a detailed statement of the opinions of different writers on the chemical nature of the different parts of the nucleus and a critical review of the terminology of the parts of the nucleus. The chemical character of protoplasm has been studied by Loew, Bokorny, and Reinke in papers in the *Bot. Zeitung* and elsewhere, but the complications of the subject can hardly be followed except by persons thoroughly versed in chemistry.

Two important papers have appeared from Schwendener—*die Schutzscheide und ihre Verstärkungen* and *Scheitelwachstum der Phanerogamen*

Wurzeln. In the first-named paper he discusses the formation and thickening of the protective sheath and its adaptation to climate and locality; in the second he states that as a rule there are groups of *scheitel* cells in phænogamic roots, four being a frequent number, although in *Heleocharis palustris* there is a single cell, and he denies that in the root there is a distinct plerom in the sense the word was used by Hanstein. A new structure, which he calls the *coolorhiza*, has been described in the young roots of *Eucalyptus* by Briosi. The development of the *hoftuepfel* in Coniferae has been the subject of a controversy between Sanio and Russow in the *Centralblatt*. Russow's original paper appeared at Dorpat, in 1881, and this paper is the subject of a sharp criticism by Sanio, to which Russow replied. The *Annales des Sciences* contains French translations of the papers of Russow and Janczewski on the structure and development of sieve-cells, which have been mentioned by us in reports for previous years. The *Annales* also contains papers by Trécul on large spiral cells in the parenchyma of the leaves of *Crinum*; by Mangin on the development of spiral cells, and on the origin of adventive roots in Monocotyledons; and a paper by Vesque on the possibility of characterizing species by means of their histological structure, followed by another paper in which he applies this principle to the *Capparidaceæ*, and shows that the species and groups classified on an histological basis correspond closely to those formed in the usual manner from morphological characters. In his *Anatomie der Baumrinden*, Joseph Møller describes the anatomical structure of the bark of 392 different species of plants. In the third part of his *Beiträge zur Morphologie des Blattes*, Goebel treats of the arrangement of the stamens in certain flowers. Under the title of *Beiträge zur allgemeinen Morphologie der Pflanzen*, Fr. Schmitz gives to the botanical world miscellaneous matter left by Hanstein, who at the time of his death contemplated writing an extensive work on general morphology.

On the subject of vegetable embryology should be mentioned Ludwig Koch's *Entwicklung des Samens von Monotropa hypopitys*, in the *Bot. Zeitung*; Guignard's *Recherches sur le sac embryonnaire des Phanérogames angiospermes*; Treub's *Notes sur l'embryo, le sac embryonnaire et l'ovule*, in which the species specially studied were *Peristylus grandis* and *Aricennia officinalis*; and Bower's "Germination and Embryogeny of *Gnetum Gnemon*," in *Quart. Journ. Micros.* There has also appeared a work in Danish by N. Wille, on the *Development of the Embryo in Ruppia rostellata and Zannichellia palustris*.

VEGETABLE PHYSIOLOGY.

The principal general work on physiology which has appeared this year is *Vorlesungen über Pflanzen-Physiologie*, by Sachs. The author states in the beginning that he has given up the intention of publishing a fifth edition of his *Handbuch*, and that the present work is, to a certain extent, a substitute for a new edition of that work. The sub-

ject is presented in the form of twenty-two lectures. The first eleven treat of the physiological organography of the organs of vegetation; the next two lectures treat of the general vital conditions and properties of plants; and the remainder of the book is devoted to the subject of nutrition, which will be continued in the next volume. The second part of Detmer's *System der Pflanzen-Physiologie*, published in Schenk's *Handbuch*, is devoted to the physiology of growth. The continuation of Van Tieghem's work, *Traité de Botanique*, contains a large amount of information on physiological subjects.

The subject of the action of light on plants and the relations of chlorophyl to the plant economy has not occupied the attention of botanists to the same extent that it did during 1881, although several papers have appeared this year on the subject. Dr. Adolph Hansen, in his doctorate thesis at Würzburg, called in question the correctness of the views of Pringsheim on the nature of hypochlorin and its relation to chlorophyl, and his paper was published at Leipsic this year. Pringsheim in consequence addressed a circular to the philosophical faculty of the University of Würzburg in support of his views, and this circular, which is of a personal character, was embodied by him in an article on *Chlorophyllfunction und Lichtwirkung in der Pflanze*, published in Pringsheim's *Jahrbuch*. The paper includes a summary of the views of botanists up to the present day on the subject of assimilation. Arthur Meyer, in the *Bot. Zeitung*, has a paper on the nature of what Pringsheim calls hypochlorin-crystals, and another in the *Centralblatt* on chlorophyl-grains, starch-builders, and chromatophors. A summary of recent works on the nature and function of chlorophyll is given by Bonnier in the *Annales des Sciences*. Pringsheim's *Jahrbuch* contains a lengthy paper on plant respiration by Godlewski. Schimper has a paper on *Gestalten der Stärkebilner und Farbkörper* in the *Centralblatt*.

The accuracy of Darwin's views on the action of the root-tip, advanced in his "Power of Movement in Plants," had been called in question by Wiesner, and this year two pupils of Wiesner, Burgerstein and Tomaschek, have published articles on the sensitiveness of the root-tip, in which they agree with Wiesner in believing that there is no intrinsic power in the tip by means of which it tends to grow away from an object pressing against it. Kirchner, on the other hand, in studying the same subject, thinks that the conclusions of Darwin are correct. A paper by Darwin, was presented in March, before the Linnean Society, on the "Action of carbonate of ammonia on the roots of certain plants." In *Euphorbia pepus* a cloud of fine granules is formed in the root-cells, even when the carbonate is dissolved 1 part to 10,000 of water. In *Cyclamen* the roots are turned green by the carbonate. At the same time Darwin also presented a paper on the "Influence of the carbonate of ammonia on chlorophyl bodies." Dr. Emil Detlefsen, in a paper on what Darwin has called the "brain function" of the root, in the *Proceedings of the Wirtzburg Laboratory*, concludes that the whole of the growing part of

the root, and not merely the tip, in consequence of unequally distributed moisture, bends in the direction of the greater moisture.

Sachs, in his second paper on *Stoff und Form der Pflanzenorgane*, takes occasion to criticise sharply the statements of Vöchting in his *Organbildung im Pflanzenreich*. Detlefsen in the *Wirtzburg Proceedings* offers a mechanical explanation of the excentric thickenings of woody stems and roots, and Kny has also published an elaborate paper on the thickening of woody axes and its dependence on external influences. In the second volume of Schenk's *Handbuch*, Haberlandt has a treatise on the *Physiologischen Leistungen der Pflanzengewebe*, which is an elaboration of the subject of the physiological significance of the different histological systems of plants from the point of view first adopted by Schwendener in his *Mekanische Princip des Monocotyledones Baues*. Cunningham, in the *Quart. Journ. Micros.*, and Gardiner, in the *Proc. Royal Soc.*, state that by means of reagents which contract the protoplasm in contractile organs, especially in the pulvinus of the petioles of the sensitive plant, there is a direct communication of the protoplasm of adjacent cells through pits in the cell walls.

The relations of plants to insects and the contrivances for cross-fertilization in different species have been studied by a number of botanists, including several in this country. Hermann Müller has a third part of his *Weitere Beobachtungen über Befruchtung der Blumen durch Insecten*, in which the arrangements for crossing in a considerable number of species are given in detail, and also a paper on the "Relation of the Honey-bee to Flowers," in which he states that the bee assists not only in the crossing of insectivorous but also of anemophilous flowers. In the *Bot. Zeitung*, Müller describes the biological significance of the arrangements for crossing in *Eremurus spectabilis*. In a paper in the *Proc. Nat. Hist. Soc. of Boston*, by Trelease, on the "Structures which favor cross-fertilization in several plants," he explains the arrangements for fertilization in several obscure cases which have not been hitherto well studied by botanists, more particularly in the *Ericaceæ* and *Proteaceæ*. Trelease also has a paper in *Am. Naturalist*, on the "Heterogony of *Oxalis violacea*," and in the *Bot. Gazette* is a discussion by Trelease and A. F. Færste as to the character of the dichogamy in *Umbellifera*. The *Am. Naturalist* has a paper by J. E. Todd on the flowers of *Solanum rostratum* and *Cassia chamaerista* with reference to cross-fertilization. F. Ludwig, in *Kosmos*, hints that in *Philodendron bipinnatifidum* fertilization may be aided by snails. The subject of *caprification* is treated in an elaborate paper by Solms-Laubach; and in *Kosmos* Fritz Müller, under the title of *Caprificus und Feigenbaum*, gives the results of his observations on the fertility of fig trees in Brazil. "Insectivorous plants" are described by Schimper in the *Bot. Zeitung*, the species observed belonging to the genera *Sarracenia*, *Drosera*, and *Utricularia*.

FERMENTS AND BACTERIA.

Most of the very numerous papers on bacteria have treated the subject from a purely medical point of view. Of those having also a botanical interest the most important are two papers by Robert Koch. The first paper, *Ueber Tuberculose*, published in the *Berlin Medicin. Wochenschrift*, contains a description of a new *Bacillus*, which is shown by means of inoculations to be the cause of tuberculous disease, which Koch shows to be contagious rather than hereditary. The second paper, *Ueber die Milzbrandimpfung*, is a pamphlet published in reply to the address delivered by Pasteur at Geneva, in September, before the international hygienic congress. In his address Pasteur replied to the strictures upon his work made by Koch in the *Mittheil. aus dem Kaiserlich. Gesundheitsamte*, issued in 1881. The reply of Koch is important from a botanical point of view, because, while criticising the inaccuracy of some of Pasteur's investigations, he admits that it is possible by means of cultures to produce a harmless form of *Bacillus* from a pathogenic form; in other words, he admits in the present paper what he denied in his paper in the *Gesundheitsamte*, viz, the possibility of changing the pathogenic character of a fungus like *Bacillus anthracis* by changing its conditions of growth, and thus practically acknowledges the truth of the view upheld by Pasteur, Naegeli, and Buchner. The practical method of producing a harmless *Bacillus* for vaccination from a pathogenic *Bacillus* may hereafter be considered as at least possible, even if the method at present pursued by Pasteur is not altogether satisfactory. In the *Proc. Roy. Soc.*, Dr. W. Roberts states that he collected in glass globes the air expired by patients suffering with phthisic and found constantly bacterial forms.

The *Comptes Rendus* contains several references to pathogenic bacteria. Pasteur presented a report on the results of inoculation for splenic fever in 85,000 cases, showing the reduced percentage of death in consequence of the inoculation. Pasteur, in conjunction with Chamberland, Raux, and Thuillier, reports on the *nouveaux faits pour servir à la connaissance de la rage*, and Strauss and Chamberland report their observations on cobayas, which seem to show that, contrary to the hitherto accepted opinion, the "bactéridie charbonneuse" can be transmitted from the mother to the fœtus. Richard describes an oscillarioid parasite which is found in the blood corpuscles in malaria. A pathogenic *Schizophyte* of the hog is described by Detmers in the *Am. Naturalist*.

In a paper read before the Munich Academy Buchner discusses the experimental production of the splenic fever contagion, and gives an account of the method used by him to transform the infectious into the harmless form, which consists principally in allowing the bacillus to grow in the presence of an abundance of free oxygen. Naegeli, in a paper, *Zur Umwandlung der Spaltpilzformen*, emphasizes the fact that the species of bacteria cannot be distinguished by their form, but can

only be determined by long and careful observations on their action under different physiological and chemical conditions.

Zopf studied the development of several filamentous forms of *Schizomycetes* and *Schizophyta*, and in his work, *Zur Morphologie der Spaltpflanzen*, as well as in a preliminary communication in the *Botanisches Centralblatt*, advances the view that forms commonly regarded as filamentous may have a micrococcus, a bacterium, a leptothrix, a spirillum, and in some cases even a spirochæte condition, and he gives full accounts of the different transformations in *Cladothrix*, *Crenothrix*, and several other genera.

Dr. T. W. Engelmann has studied the relations of bacteria to light and air, and comes to the conclusion that bacteria collect in heaps where there is a development of oxygen, and he also describes in Pflüger's *Archiv* a new species, *Bacterium photometricum*, found in the Rhine, in which he studied the action of light, and found that it did not act momentarily, but produced an after effect, which he terms photokinetic induction. In the *Centralblatt*, Haberkorn has a paper on the "Genesis, Morphology, and Properties of Pathogenic Bacteria," in which he maintains the polymorphic nature of these organisms. The *Bacteria* is the subject of a paper in the Eleventh Report Illinois Industrial University, by Prof. T. J. Burrill. It is a summary of the known species of schizophytes, preceded by an introduction on the nature and effects of bacteria. He gives full descriptions of *Micrococcus amylovorus*, pear blight, *M. toxicatus* found in the poison dogwood, and *M. insectorum* found in the digestive organs of chinch bugs.

Two important papers relating to the action of species of *Saccharomyces* in fermentation have appeared during the year. In the reports of the Carlsberg Laboratory, Hansen gives an account of the organisms found in the air at different seasons near Carlsberg, especially those which can develop in beer wort. He found that *Dematium pullulans* could invert sugar to some extent, and states that *Saccharomyces pastorianus* is a dangerous organism in breweries on account of the rapidity with which it produces alcoholic fermentation and the ease with which it produces its endospores, while it gives a disagreeable, bitter taste to the beer in which it is found. In *Comptes Rendus*, Gayon has a report on the action of some molds in alcoholic fermentation. Some, as several species of *Mucor*, produce a fermentation in glucose, but are not able to invert cane sugar, so that in substances like molasses they can be used as a means of separating cane sugar from other sugars. Edward Kern has discovered a new ferment, which he calls *Diaspora caucasica*, in a fermented liquor known as kephir, formed from milk in the Caucasus. *Ferments et maladies*, by E. Duclaux, is a good general statement of the action of ferments of *Saccharomycetes* and *Schizomycetes*, both from a chemical and pathological standpoint.

THALLOPHYTES.

Fungi.—Papers describing new species of fungi have been excessively numerous, but those relating to their development have not been so numerous as usual. Of developmental works mention should first be made of Woronin's beautifully illustrated *Beiträge zur Kenntniss der Ustilagineen*, which forms the fifth part of De Bary and Woronin's *Beiträge zur Morphologie und Physiologie der Pilze*. The greater part of this paper is devoted to the development of *Tubercinia trientalis*, and at the end is a classification of the genera of *Ustilagineæ*. The *Bot. Zeitung* has a paper by Fisch on the "Development of Ascomycetes," in which the principal genera studied were *Polystigma*, *Xylaria*, and *Claniceps*. In the first-named genus Fisch found spermatia and trichogynes resembling those found by Stahl in *Collema*, but no sexuality could be discovered in the two last-named genera. In *Grevillea* and the *Gardener's Chronicle* Plowright gives an account of his experiments on the *Heteræcism* of *Uredineæ*, in which he confirms the views of continental mycologists as to the connection between several forms, and shows further that the teleutospores of *Puccinia graminis* may be made to grow directly on wheat without the intervention of an æcidium. The act of fertilization in *Achlya* and *Saprolegnia* was treated by Pringsheim in a paper read before the Berlin Academy. He differs with De Bary in regard to the apogamic character of some of the species of the genera named above, and thinks that there is really a fertilization which may be accomplished by means of motile masses of protoplasm, which he calls spermamæbæ-Zopf, in a communication in the *Bot. Centralblatt* states his belief that the spermamæbæ of Pringsheim are really parasites. The parasites of *Saprolegniæ* are described by Alfred Fischer in Pringsheim's *Jahrbuch*.

Relating to the fungi of this country should be mentioned two papers by Peck in the *Torry Bulletin*: "Fungi in Wrong Genera," where it is shown that *Mitruia inoplata* Schw. is a new genus of *Basidiomycetes*; and an "Imperfectly described Phalloid." New species of fungi are described by Peck and Ellis in the *Bulletin*, the *Bot. Gazette*, and *Am. Naturalist*, and a new *Polyporus* is described in the *Bot. Gazette* by A. P. Morgan. *Michelia* contains descriptions by Saccardo of more than a hundred species of American fungi, most of which are new.

The most extensive descriptive work which has appeared during the year is the *Sylloge Fungorum* of Saccardo, the first part of which forms a large volume, including the *Perisporiaceæ* and a part of the *Sphaeriaceæ*. New British fungi have been described by Berkeley and Broome in *Ann. and Mag. Nat. Hist.*, and by Cooke in *Grevillea*. In the last-named journal is a "Monograph of British Hypomyces," by Plowright. Cooke's "Illustrations of British Fungi" has been continued through several parts. The first volume of Rabenhorst's *Kryptogamen Flora* has been continued during the year, completing the *Uredineæ* and including a large part of the *Hymenomycetes*. *Michelia* contains papers on the

Fungi Gallici and *Fungi Veneti* by Saccardo, who has, in addition, issued parts 28 to 32 of his *Fungi Italici Delineati*. In *Hedwigia* are descriptions of new *Ascomycetes* by Rehm, and new *Sordaria* by Oudemans. Bainier, in his *Étude sur les Mucorinées*, describes several new species of that order, and Blytt describes a new species of *Myxomycetes*, *Clastoderma De Baryanum*. The development of the sclerotium of *Peziza sclerotiorum* has been published by Mattiolo in the *Giorn. Bot. Schræter* has notes on the genus *Physoderma* in the *Bericht Schles. Gesellsch.* Fungi from South America have been described by Spegazzini; from Australia by Cooke, and from the Cape of Good Hope by Kalchbrenner, the last two of which appeared in *Grevillea*. The *Revue Mycologique* contains numerous notices of fungi by Roumeguère, including notes on the species included in *Fungi Gallici Exsiccati*, which has reached the "24th century."

Of works relating to the diseases of plants caused by fungi should be mentioned R. Hartig's *Lehrbuch der Baumkrankheiten*. *Michelia* contains an elaborate article by Penzig, *Funghi Agrumicoli*, in which he describes all the species of fungi known by him to be parasitic on different species of *Citrus*. The diseases of grape-vines have been treated by Millardet, Thuemen, and Comes. In his paper on *Pourridié et Phylloxera*, Millardet ascribes the rotting of vines at first attacked by Phylloxera to the growth of *Rhizomorpha fragilis*, whose action on the roots and young stems he describes and figures. Thuemen ascribes the origin of the rotting of the roots to the moisture in the ground. Comes considers what is known in Italy as the Mal Nero to be a gummy degeneration like similar diseases in the *Amygdalea*. Prillieux, in the *Comptes Rendus*, describes the change produced in grapes by mildew. Marshall Ward presented to the Linnæan Society the results of his later observations on the coffee-leaf disease, giving still stronger reasons than before for considering the fungus *Hemileia vastatrix* to belong to the *Uredineæ*. Prillieux regards the rot of grapes as caused primarily by *Peronospora viticola*, and states that *Phoma uvicola* follows, but is not the cause of the disease. He also notes the occurrence of disease of beets in France caused by *Peronospora Schachtii*. Of works relating to disease in animals caused by plants of a higher grade than bacteria, we should mention the *Actinomykosis des Menschen*, in which Ponfick describes and figures a species of *Actinomyces*, which attacks primarily the lower jaw in man, causing a disease similar to one already known to occur in cattle. The diseases produced by the growth of species of *Aspergillus* is the subject of a paper by L. Lichtheim, in the *Berlin Klinische Wochenschrift*.

Algæ.—Among the more important works on the development and general structure of algæ should be mentioned the *Chromatophoren der Algen* by Fr. Schmitz, in which he gives an account of the morphology and development of the colored body in the cells of algæ. These

bodies, which contain nuclei, to which he gives the name of pyrenoids, are always derived from some previously existing chromatophor and are not formed from the protoplasm proper. The *Nuovo Giornale Bot. Ital.* contains an important continuation of Borzi's "Morphology and Biology of the *Phycochromaceæ*," in which many new facts of the growth and reproduction of that group are brought forward. The paper of Zopf on *Spaltpflanzen*, previously mentioned under the head of "Bacteria," also contains an account of the development of certain *Phycochromaceæ*, in which he finds that the filamentous species have also a glæocapsoid condition. Pringsheim's *Jahrbuch* contains a lengthy article by Berthold, *Beiträge zur Morphologie und Physiologie der Meeresalgen*, relating principally to the development of the frond. Rostafinski, in a paper on *Hydrurus und seine Verwandtschaft*, gives an account of the development of that genus and a detailed synonymy of the species *H. penicillatus*.

Relating to the marine species of the United States, we would mention a description of a new genus, *Phæosaccion*, and some new species by Farlow; "Notes on New England Algæ," by F. S. Collins; and "Note on *Arthrocladia villosa*" by A. B. Hervey; all in the *Bulletin of the Torrey Club*. "Fresh Water Algæ of the United States" have also been described in the *Bulletin* by Wolle.

The paper by Agardh, *Til Algernes Systematik*, is an illustrated account of a number of new species and genera, most of which belong to the *Chordariaceæ* and *Dictyotaceæ*. The eighth monograph of the *Flora and Fauna of the bay of Naples* is by Berthold, and includes the *Bangiaceæ*, in which he gives an account of the reproduction by antheridia, and procarys resembling those already known in other *Florideæ*, although of a more simple type. Of the second part of *Rabenhorst's Kryptogamen-Flora*, including the marine algæ by Hauck, the earlier numbers appeared at the end of the year, and include the lower orders of *Florideæ*. Hauck has also described a curious new genus, *Marchisettia*. A species of alga, *Cladophora ophiophila*, growing on a reptile, *Herpetion*, from Bangkok, has been described by Magnus. New Arctic marine algæ have been described by M. Foslie, and algæ from Patagonia and the Argentine Republic have been described by Nordstedt in *Bot. Notiser*. In the *Botanische Zeitung* are articles by Fr. Schmitz and Just on *Phyllosiphon arisari*, a singular parasite on the leaves of *Arisarum* in Italy, whose place among algæ is doubtful, and Schmitz is inclined to place it in fungi. A new work by M. C. Cooke, on *British Fresh-Water Algæ*, has appeared, the three parts already issued this year including the *Palmellaceæ*, *Protococcaceæ* *Volvocineæ*, and *Zygnemaceæ*. The *Pediastra* and *Palmellaceæ* of the region of Stockholm have been described in a paper by Lagerheim. "The Development and Systematic Position of *Vampyrella*" is the subject of an illustrated paper by Klein, in the *Bot. Centralblatt*. Parts 9 and 10 of Wiltrock and Nordstedt's *Algea Scandinavica* appeared during this year, together with an index to the ten parts already published.

A number of descriptive papers on diatoms have appeared. Cleve and Moller described a large number of species from Northern Siberia, collected by the Vega Expedition; Reinhard described the diatoms of the White Sea; Cleve and Jentzsch, species from North Germany, and Juhlin-Dauffelt, species from the Baltic. Of Schmidt's *Atlas der Diatomeenkunde* parts 19 and 20 have appeared, and of Van Heurek's *Diatomées de Belgique*, part 5, including the *Crypto-Raphideæ*. The *Am. Micros. Journ.* contains two articles on the motion of diatoms by H. Mills and C. M. Vorce.

Lichens.—The most important work on lichens which has appeared during the year is Tuckerman's *Synopsis of North American Lichens*, part 1, which gives descriptions of all our species of *Parmeliacei*, *Cladoniæ*, and *Cænogoniæ*, including 411 species and 46 genera. Minks has issued a second part of his *Symbolæ Licheno-Mycologiæ*. G. Krabbe, in the *Bot. Zeitung*, has an article on the apothecia of certain lichens, belonging principally to the genera *Beomyces* and *Cladonia*, and finds that the formation of the apothecia is entirely a vegetative process, as he was unable in the genera studied to find ascogonia and trichogynes, as had been observed in *Collema* by Stahl. Additions to the lichen flora of Europe have been published by Nylander in *Flora*, which journal also contains the continuation of Arnold's *Lichenologische Fragmente*; Jatta has described *Lichens from Southern Italy* in the *Giorn. Bot.*; Müller, *Socotra lichens*, collected by Bayley Balfour, in *Proc. Roy. Edin. Soc.*; and Crombie, species collected in the East Indies by Main-gay, in the *Proc. Linn. Soc.* The *Lichenes Gallici* of Roumeguère have been continued in a fourth part, and Olivier's *Herbier des Lichènes de l'Orne et du Calvados* has been continued through parts 5 and 6. In the *Journ. Linnæan Soc.*, Charles Knight has described a considerable number of new species from New South Wales.

ARCHEGONIATA.

Characeæ.—The manuscript of the late Alexander Braun has been edited by Norstedt, and has been published in the *Abhandl. Akad., Berlin*, under the title *Fragmente einer Monographie der Characeen*. The number of species and subspecies described is 142, including many forms which had not been previously described. In this country Dr. T. F. Allen has published two papers: "Observations on some American Forms of *Chara coronata*" in *Am. Naturalist*; and "Development of the Cortex in *Chara*" in the *Torrey Bulletin*.

Hepaticæ.—But little has appeared on this group of plants. Lindberg's *Monographia præcursoria Peltolepidis, Sauterieæ, et Cleveæ*, besides treating of the three genera just named, has notes on some other *Marchantiaceæ*. Massalongo and Carestia describe some Hepaticæ from the Apennines, in the *Giorn Bot.* A general synopsis of the Hepaticæ of

Germany, Austria, and Switzerland has been published by P. Sydow, under the title *Die Lebermoose Deutschlands*, etc. In the *Bot. Gazette* for February, L. M. Underwood gives a list of North American Hepaticæ, including 49 genera and 219 species.

Musci.—A number of important papers on *Sphagnæ* should be mentioned. In his *Promotionsprogramm*, Lindberg gives an account of "European and North American *Sphagna*," preceded by a short notice on the general organization and development of mosses. In *Flora*, Warnstorf describes some new German *Sphagna*, and in the *Bot. Centralblatt*, the same writer gives an account of the *Sphagna* in the royal botanical museum at Berlin. He has also issued a second part of his *Sphagnotheka Europea*. The *Centralblatt* also has a paper, by Limpricht, *Zur Systematik der Torfmoose*. Husnot has published a paper on the same group, *Sphagnologia Europea*. One of the most important papers on mosses is C. Mueller's *Prodromus Bryologiæ Argentinicæ*, the second part of which appeared this year in *Linnaea*, and contains descriptions of 131 new species, collected principally by Lorentz. The *British Moss-flora* of Braithwaite has been continued through part 6, which includes the *Dieranacæ*. In the *Proc. Roy. Soc. of Victoria* is an "Enumeration of Australian Mosses," by Mitten. Of other papers on mosses we would mention Lindberg's "Observations on Species of *Timmia*" and Venturi's *Barbulæ rurales*, both in the *Revue Bryologique*; Limpricht's "New and Critical Mosses" in *Flora*; Fehlner's *Moss-Flora of Lower Austria*; Gæbel's *Male Inflorescence of Polytrichum*, and Lindberg's *Families and Genera of Swedish and Norwegian Mosses*.

Ferns and higher Cryptogams.—Eaton describes some "New or little known Ferns of the United States" in the *Torrey Bulletin*, and in the same journal are "Fern Notes" Nos. 3 and 4, by G. E. Davenport, besides numerous other short notices of species in new localities from several contributors.

Dr. J. H. Mellichamp records the occurrence of *Psilotum triquetrum* in Bluffton, S. C. In the *Botanical Gazette*, Davenport has some "Notes on Alaska Ferns," and J. G. Lemmon describes a new species, *Woodsia Plummeræ*. The *Trans. Saint Louis Academy* contains an elaborate paper by Dr. Engelmann on the Genus *Isoetes*, with minute descriptions of North American species and a very full account of their distribution. An enlarged second edition of Lucien M. Underwood's, *Our Native Ferns and their Allies*, contains synoptical descriptions of the American *Pteridophyta* north of Mexico.

Of papers on exotic ferns there is very little to be said. In the *Journ. Linn. Soc.* Baker describes some species, collected by Rèv. R. B. Comins, in the Solomon Islands, and in the *Journ. Bot.* the same writer describes some ferns from Southern Brazil. The *Bot. Centralblatt* has a paper by Luerissen, *Pteridologische Mittheilung*, in which he describes some spe-

cies from New Holland and Polynesia. The development of the fruit of *Pilularia globulifera* is discussed by Gœbel in the third part of his *Beiträge zur Entwicklungsgeschichte der Sporangien*.

PHLENOGAMS.

Relating to species of this country, we should mention, in the first place, Gray's *Contributions to North American Botany*, which consists of two parts. The first gives the results of his studies of *Aster* and *Solidago* in the older herbaria; the second, entitled *Novitiæ Arizonicæ*, describes principally *Gamopetalæ* from Arizona and adjacent regions, including several new genera. In a note two new gentians are described by Engelmann. In the *Bot. Gazette*, Professor Gray describes a new species, *Parishella Californica*, and at the meeting of the Am. Ass. Adv. Sci., at Montreal, he delivered an address on the history of the study of botany in this country. In the *Proc. Am. Acad. of Boston*, Watson has published a list of plants from Southwestern Texas and Northern Mexico, consisting principally of *Polypetalæ* collected by Dr. E. Palmer in 1879-80, and a "Description of New Species of Plants," chiefly from the Western Territories. Several important papers by Dr. Engelmann have appeared in different journals. In the *Botanical Gazette* are "Notes on Western Conifers;" "Additions to the North American Flora," including new species of *Stellaria*, *Campanula*, &c.; the "Black-fruited *Cratægi*," with a description of a new species, *C. brachyacantha*; and "Some Notes on *Yucca*." In the *Gardener's Chronicle*, Engelmann has some notes on *Picea Engelmanni* and *Pinus pungens*. New grasses have been described by Vasey, species of *Poa* and *Stipa* from California, in *Bot. Gaz.*; and species from Arizona and California, described in *Torr. Bull.* by F. L. Scribner. Dr. Parry has papers on a new rose, *R. minutifolia*, and on the "Fruits of *Cueurbita*," both in *Torr Bulletin*. M. S. Bebb has "Notes on *Salix Sitchensis* and its Affinities," and "*Salix flavescens* var. *Scouleriana*," both in *Bot. Gazette*. "New Species of Compositæ" and "New Western Plants" by E. L. Greene, and "New California Plants" by M. E. Jones, have appeared in the *Torr. Bulletin*. The *Bulletin* also contains "Notes on Hybrid Oaks" by Professor Meehan and N. L. Britton; "Notes on the Trees of the Southwest" by H. S. Rusby; "Notes on the White Mountain Flora" by W. W. Bailey; and a paper on the "Migration of Weeds" by H. W. Ravenel. The "Native Trees of the Lower Wabash" are described by Robert Ridgway in the *Proc. National Museum*. The *Flora Peoriana*, by Fred. Brendel, is an account of the plants near Peoria, Ill., published in German at Buda-Pesth.

Except as continuations of previous works, no very elaborate books have appeared this year on exotic floras. Vol. v of Boissier's *Flora Orientalis* includes monocotyledons. Hooker's *Flora of India* has been continued, and also the *Icones Plantarum*, which has reached the 4th

volume of the 3d series. Hooker has also described a new genus of rubber-producing plants, *Dyera*, from the Malay Archipelago. J. G. Baker has published *Contributions to the Flora of Central Madagascar*, and he has also described four new *Bromeliaceæ* from British Guiana. G. Maw gives the *Life History of a Crocus* and the classification and geological distribution of the genus. Crepin's monograph of *Roses* has been continued, and his *Manuel de la Flore de Belgique* has reached a fourth edition, while the popular *Flora von Deutschland*, by Garcke, has reached a fourteenth edition. Ferd. Mueller's *Eucalyptographia* and his *Fragmenta Phytographiæ Australicæ* have been continued in parts. Spengazzini, who has been traveling in South America, has made a preliminary report on the flora of Patagonia and Terra del Fuego. New orchids have been described by Reichenbach and four new genera of *Aroideæ* by N. E. We should also notice the appearance of Arcangeli's *Compendio della Flora Italiana*; Regel's description of plants in the *Reise nach Turkestan*; a monograph of the European *Festuceæ* by Edouard Hackel; the *Palmaceæ* of the Flora Brasiliensis by Drude; and Bretschneider's *Botanicon sinicum*. Engler's *Jahrbücher* includes several important papers on different orders discussed from a morphological point of view, amongst which are Hæck's *Morphology and Distribution of Valerianaceæ*; Kœhne's monograph of *Lythraceæ*; and Buchenau's *Beiträge zur Kenntniss der Butomaceen, Alismaceen, und Juncaginaceen*. With relation to the foliar theory, as shown in the fruit of the *abietineæ*, there has been a controversy between Celakovsky and Eichler, and there is a review of the subject by Dr. Engelmann in the *Am. Journ. Science*.

GENERAL.

Under this heading may be mentioned A. P. De Candolle's *Origine des Plantes cultivées*, which is a very important contribution to our knowledge of the origin of useful plants. The second part of Eugler's *Versuch einer Entwicklungsgeschichte der Pflanzenwelt* includes the extra-tropical regions of the southern hemisphere and the tropics. Cohn's *Die Pflanze* is a series of popular essays on various botanical topics, historical, physiological, &c. John Smith has published a *Dictionary of Popular Names of the Plants* which furnish the natural and acquired wants of man.

ZOOLOGY.

By Prof. THEODORE GILL.

INTRODUCTION.

Zoologists continued during the year 1882 the lines of investigation followed in the past, and the methods of modern science have been applied to the investigation of various mooted questions in Morphology and Taxonomy. Some valuable works have been published on systematic Zoology, and of these several are worthy of special mention on account of the completeness with which the classes treated of have been brought up to date. Such are Mr. Saville Kent's "Manual of the Infusoria," Professor Verrill's "Report on the Cephalopods of the north-eastern coast of America," Mr. G. A. Boulenger's catalogues of the Batrachia Salientia, Gradientia, and Apoda in the collection of the British Museum. On account of the general interest attached to the groups thus elaborated, the results of the investigations recorded in these volumes are detailed at some length.

Another subject of popular interest that has received unusual attention the past year is the natural history and especially the natural and artificial propagation of the oysters. Much light has been thrown on the life history of that important mollusk, and it can be foreseen that man may greatly assist nature and thereby benefit himself by due attention to those details which science has shown to be necessary for successful ostreaculture.

The line of zoological stations which may be said to have been inaugurated by the establishment of that at Naples, now so well known, less than ten years ago, seems destined soon to girdle the globe.

A station has been established at Sydney, New South Wales, chiefly through the efforts of Baron Mielucho-Maclay. Among other contributions, the Royal Society of New South Wales has made a grant therefor of £25 for the year, and assistance is expected from the Royal Society of Victoria and the Australian Biological Association. The station will be open to "biologists of the male sex" of all nations on the payment of a small weekly sum, which is to meet the expenses of service, &c.

The past year may also be considered as memorable for the great mortality that occurred among the marine animals along the shallower part of a belt "(in 70 to 150 fathoms) where the southern forms of life and

higher temperatures (48° to 50°) are found." The cause is supposed to have originated in March. (See Verrill in A. J. S., (3,) Nov., 1882.)

Questions of nomenclature have received attention from various naturalists as well as scientific bodies. The Zoological Society of France published a report on Rules applicable to the Nomenclature of Organic Beings (*Règles applicable à la Nomenclature des Êtres Organisés*). The proposed rules are essentially those which for a long time have regulated the usage of zoologists, but there are some which have not found universal acceptance, and some which are of trivial importance. Thus, it is recommended that specific names derived from persons should be nouns in the genitive and with a single *i* (unless actually used and declined otherwise in the Latin language), as in *Lamarcki*, while those referring to places should be adjectives, *e. g.*, *Nova-Batavus* and not *Nova-Hollandia*. Discretion is permitted as to the use of capital or small initials for proper names. Names of similar import, as "*fluviorum*, *fluvialis*, and *fluviatilis*," are negatived for different species of the same genus; and names once used, but fallen into disuse, cannot be repeated or resurrected for other forms. It is laid down, also, that no name once published shall ever be discarded on account of its impropriety. Families should invariably have the patronymic termination "*ida*." (A. J. S., (3,) v. 23, pp. 157-158.)

As in the previous report a partial bibliography of noteworthy memoirs and works relating to different classes 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. But 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*.

The language of the original from which the abstract is compiled is generally followed as closely as the case will permit, as the advantages of such a course must be obvious to all on a little reflection. 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 sys-

tem; 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 largely 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.

SYNOPSIS OF ARRANGEMENT.

I. GENERAL ZOOLOGY.

II. PROTOZOANS.—Sporozoans; Infusorians.

III. PORIFERES.—Sponges.

IV. CŒLENTERATES.—Polyps; Acalephs.

V. ECHINODERMS.—Echinoderms.

VI. WORMS.—Dicyemids; Platyhelminths; Nematelminths; Annelids.

VII. ARTHROPODS.—Merostomes; Crustaceans; Arachnids; Insects.

VIII. MOLLUSCOIDS.—Polyzoans; Brachiopods.

IX. MOLLUSKS.—Conchifers; Gastropods; Cephalopods.

X. PROTOCHORDATES.—Tunicates.

XI. VERTEBRATES.—Fish-like Vertebrates; Leptocardians; Myzonts; Selachians; Fishes; Amphibians; Reptiles; Birds; Mammals.

I. GENERAL ZOOLOGY.

HISTORICAL ZOOLOGY.

Archiv für Naturgeschichte. Gegründet von A. F. A. Wiegmann. Fortgesetzt von W. F. Erichson. In Verbindung mit Prof. Dr. R. Leuckart in Leipzig herausgegeben von Dr. F. H. Troschel, Professor in der Friedrich-Wilhelms-Universität zu Bonn. 48. Jahrgang. Berlin, Nicolaische Verlags-Buchhandlung, 1882. (8vo.)
 Bibliotheca Historico-naturalis, physico-chemica et mathematica, oder systematisch geordnete Uebersicht der in Deutschland und dem Auslande auf dem Gebiete der gesammten Naturwissenschaften, etc., erschienenen Bücher. Herausgegeben von F. Frenkel. XXXI. Jahrg. Göttingen, Vandenhoeck & Ruprecht, 1882. (8vo. M. 1.20.)

Zoological (The) Record for 1881, being Vol. XVIII of the Record of Zoological Literature. Edited by Edw. Caldwell Rye. London, Van Voorst, 1882. (8vo.)

Zoologischer Anzeiger. Herausgegeben von Prof. J. Victor Carus. V. Jahrgang, 1882. Leipzig, W. Engelmann, 1882. (8vo.)

Zoologischer Jahresbericht für 1880. Herausgegeben von der zoologischen Station zu Neapel. Redigirt von J. Victor Carus. I. Abth. Allgemeines bis Vermes. II. Abth. Arthropoda. III. Abth. Tunicata, Mollusca. IV. Abth. Vertebrata. Leipzig, Engelmann, 1882. (8vo.)

DIRECTORY.

International (The) Scientists' Directory. Containing the Names, Addresses, Special Departments of Study, etc., of Amateur and Professional Naturalists, etc., etc., in America, Europe, Asia, Africa, and Oceanica. Compiled by Sam. E. Cassino. Boston, S. E. Cassino & Co, 1882. (8vo. VIII, 391 pp.)

SYSTEMATIC ZOOLOGY.

Bert (Paul). Lectures sur l'histoire naturelle des Animaux, suivies d'un Vocabulaire des mots techniques employés dans l'ouvrage. Paris, Hachette & Co., 1882. (12mo. iv, 399 pp., 75 fig., Fres. 2.)

Brehm's Thierleben. Mit 170 Tafeln in Farbendruck, unter Leitung der Zoologen Dr. Girtanner, Klunzinger, O. Schmidt und Taschenberg nach dem Leben ausgeführt vom Maler Olof Winkler. 4 Bd., 8 Heft, [etc.] Vögel. Leipzig, Bibliogr. Institut., 1881. (8vo. M. 1 each.)

Bronn's Klassen und Ordnungen des Thierreichs. 1. Bd. Protozoa, neu bearbeitet von O. Bütschli. 10-19. Lief. 2. Bd., Porifera, neu bearbeitet von G. C. J. Vosmaer. 1 Lief. 6. Bd., 3. Abth. Reptilien, von C. K. Hoffmann. 30-35. Lief. [etc.] Leipzig und Heidelberg, C. F. Winter'sche Verlagshandlung, 1882. (8vo. M. 1.50 each.)

Claus (C.) Grundzüge der Zoologie. 4. Aufl. 2. Bd. 2. Lief. (Schluss.) Marburg, Elwert, 1882. (8vo. M. 4.)

— Traité de Zoologie. 2. édit. franc trad. sur la 4. édit. allem. Entièrement refondue et considérablement augmentée par G. Moquin-Tandon. Paris, 1882-'83. (8vo. 1. 2. Fasc.)

Edwards (A. Milne). Éléments d'histoire naturelle des Animaux. I. Partie Zoologie méthodique et descriptive. Paris, Masson, 1881. (18mo. 395 pp., 487 fig.)

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II. PROTOZOANS.

GENERAL.

Balbiani (E. G.) Les Organismes Unicellulaires. Les Protozoaires. Leçons faites au Collège de France. *Journ. de Microgr.*, 6. ann.

Bütschli (O.) Protozoa. Neu bearbeitet. 8. Lief. Leipzig, C. F. Winter, 1882. (Bronn's Klassen und Ordnungen Thierreichs.)

Lanessan (J. L. de). Traite de Zoologie. Protozoaires. Paris, Doin, 1882. (8vo, vii, 336 p., 281 fig. Frcs. 10.)

SPECIAL GROUPS.

Infusorians.

Kent (William Saville). A Manual of the Infusoria, including a description of all known Flagellate, Ciliate, and Tentaculiferous Protozoa, British and Foreign, and an account of the organization and affinities of the Sponges. London, 1880-1882. (8vo.)

Sporozoans.

Balbiani (E.) Les Sporozoaires. Seconde partie du Cours d'Embryogenie comparée, professé au Collège de France pendant le second semestre de 1882. *Journ. de Microgr.*, 6. ann., pp. 281-290; pp. 348-356; pp. 448-457.

Schneider (Aime). Seconde Contribution à l'étude des Grégarines. Avec 1 pl. *Arch. Zool. Expérim.*, t. 10, pp. 423-450.

Kent's classification of the Infusorians.

In the report on the progress of the zoology during 1881, a notice was given of "A Manual of the Infusoria," by Mr. W. Saville Kent, condensed from the journal of the Royal Microscopical Society: the notice of the work in that journal not having been entirely comprehensible, the ex-

cerpts were indicated by quotation marks. Some misapprehension was evidently entertained, as the classification really given by Mr. Kent is quite different from what would be supposed from the original notice. The Infusorians of Kent are accepted with nearly the same limits as were accorded to them by Pritchard, and are essentially those Protozoans which for some time have enjoyed the name, including the mouthed forms and certain others evidently related to them, though destitute of the "mouth." The sponges are, however, also included in the group, although the best theoretical naturalists now regard them as the most generalized of metazoic animals, and thus differentiated as representatives of a series contrasting with the Protozoans. Three classes are admitted by Mr. Kent for the Infusorians, and are designated by him Flagellata, Ciliata, and Tentaculifera. These three classes include about 900 species, representing about 300 genera.

Mr. Kent's work, so far as the details are concerned, will prove invaluable to the student of the low forms described. It is not at all likely, however, that his philosophical conclusions will be generally accepted soon, or that they will stand the test of time. Some of the principal types of the animal kingdom are supposed to be genetically derivable from *special types* of Infusorians; for example, the Annelids from the Holotrichous (or Peritrichous) Ciliates, the Echinoderms, Polyzoans, and Mollusks from the Peritrichous Ciliates, the Rotifers and Arthropods from the Hypotrichous Ciliates; and the Cœlenterates from the Tentaculifers. In other words, the complexities of the metazoic organism must have been many times independently attained from unicellular organisms, and the associations or colonies of cells known as metazoic animals must be supposed to repeat, as a whole, unessential features of protozoic animalcules. Doubtless many biologists will object to such conclusions.

Families of Flagellates.

The Flagellata have been extended by Mr. Kent to include not only the Mastigamœbidæ, the Euchitonidæ, and the Noctilucidæ, but also the Sponges, and quite subordinate rank is given to the Noctilucidæ (treated as a simple family of the Eustomata), although many naturalists regard the type as of class value and more differentiated than most of the Flagellates are from each other. The Flagellates thus reconstituted are distributed among seven orders and thirty-nine families, not counting the Sponges, which are omitted from the work. The classification is as follows:

Order 1. Trypanosomata, with 1 family—the Trypanosomatidæ.

Order 2. Rhizoflagellata, with 1 family, Mastigamœbidæ.

Order 3. Radioflagellata, with 2 families: (1.) Actinomonadidæ and (2.) Euchitonidæ.

Order 4. Pantostomata, with 18 families: (1.) Monadidæ; (2.) Pleuromonadidæ; (3.) Cercomonadidæ; (4.) Codonœcidæ; (5.) Dendromonadidæ; (6.) Bikœcidæ; (7.) Amphimonadidæ; (8.) Spongomonadidæ;

(9.) Heteromitidæ; (10.) Trepomonadidæ; (11.) Polytomidæ; (12.) Pseudosporidæ; (13.) Spumellidæ; (14.) Trimastigidæ; (15.) Tetramitidæ; (16.) Hexamitidæ; (17.) Lophomonadidæ; and (18.) Catallactidæ.

Order 5. Choanoflagellata, or Discostomata, with 2 sections:

Section I. Gymnozoida, with 3 families: (1.) Codonosigidæ; (2.) Salpingœcidæ; and (3.) Phalansteriidæ.

Section II. Sarcocrypta (the Sponges not described).

Order 6. Eustomata, with 9 families: (1.) Paramonadidæ; (2.) Astasiadæ; (3.) Euglenidæ; (4.) Noctilucidæ; (5.) Chrysomonadidæ; (6.) Zygoselmidæ; (7.) Chilomonadidæ; (8.) Anisonemidæ; and (9.) Sphenomonadidæ.

Order 7. Cilioflagellata, with 5 families: (1.) Peridiniidæ; (2.) Heteromastigidæ; (3.) Mallomonadidæ; (4.) Stephanomonadidæ; and (5.) Trichonemidæ.

The Families of Ciliates.

Mr. Kent's "class" of "Ciliata" is identical with that called Infusoria (after the exclusion of the Suctoria) by some recent authors, *e. g.* Professor Claus, and his orders bear names that have been current for some time. Perhaps the most noteworthy characteristic is the number of families which is greater than is given in any other text-book. Thirty-four are admitted, viz:

Order 1. Holotricha, with 13 families: (1.) Paramœcidæ; (2.) Prorodontidæ; (3.) Trachelophyllidæ; (4.) Colepidæ; (5.) Enchelyidæ; (6.) Trachelocercidæ; (7.) Tracheliidæ; (8.) Ichthyophthiriidæ; (9.) Ophryoglenidæ; (10.) Pleuronemidæ; (11.) Lembidæ; (12.) Trichonymphidæ; and (13.) Opalinidæ.

Order 2. Heterotricha, with 7 families: (1.) Bursariidæ; (2.) Spirosomidæ; (3.) Stentoridæ; (4.) Tintinnodæ; (5.) Trichodinopsidæ; (6.) Codonellidæ; and (7.) Calceolidæ.

Order 3. Peritricha, with 8 families: (1.) Torquatellidæ; (2.) Dictyocystidæ; (3.) Actinobolidæ; (4.) Halteriidæ; (5.) Gyrocoridæ; (6.) Urceolariidæ; (7.) Ophryoscolecidæ; and (8.) Vorticellidæ.

Order 4. Hypotricha, with 6 families: (1.) Litonotidæ; (2.) Chlamydotodontidæ; (3.) Dysteriidæ; (4.) Peritromidæ; (5.) Oxytrichidæ; and (6.) Euplotidæ.

The families of Tentaculifers.

A special class is admitted for the reception of the suctorial Infusorians—the "Tentaculifera"—and its representatives, included by Claus and other zoologists in one family, are distributed by Mr. Kent into two orders and six families, viz:

Order 1. Suctoria, with 4 families: (1.) Rhynchetidæ; (2.) Acinetidæ; (3.) Dendrocometidæ; and (4.) Dendrosomidæ.

Order 2. Actinaria, with 2 families: (1.) Ephelotidæ; and (2.) Ophryodendridæ.

III. PORIFERS.

- Bowerbank (J. S.) A Monograph of the British Spongiadae. Edited with additions by A. M. Norman. Vol. 4. (Supplementary.) London, Ray Society, 1882. (8vo, xvii, 250 pp., 17 pl.)
- Marshall (W.) Die Ontogenie von *Reniera filigrana* O. Schm. *Zeitschr. f. wiss. Zool.*, 37 Bd., pp. 221-246, pl., 13-14.
- Vosmaer (G. C. J.) Porifera. Neu bearbeitet. 1. Lief. Leipzig, C. P. Winter, 1882. (Bronn's Klassen und Ordnungen Thierreichs, 2. Band. 8vo.)
- Weltner (Wilhelm). Beiträge zur Kenntniss der Spongien. Mit 3 Lichtdrucktaf. Inaug.-Diss. Freiburg. i, Br., 1882. (8vo, 62 pp.)

Relations of the Sponges.

Inasmuch as Mr. Kent has raised again the question as to the affinities of the Sponges, the conclusions reached by Professor Marshall from a study of the development of *Reniera filigrans*, one of the Fibrous Sponges representing a family allied to the commercial species, may be aptly noticed here. After traversing the views of previous investigators, Marshall contends that the Sponges are less differentiated from the Cœlenterates than some of those even who admit the value of its metazoic characteristics—*e. g.* Balfour—have been disposed to concede. The Fibrous Sponges, by their developmental history, are shown to be less specialized than the calcareous types. The objection that the absence of tentacles and nettle-cells is of prime importance is met by the assertion that such are also wanting in *Beroe*, and that, at any rate, it is no more than might be *a priori* looked for, on account of the habits and characteristics of nutrition of the forms. In fine, the Sponges are asserted to be derivatives in common with the typical Cœlenterates from a Protactinian stock, and both are Metazoans with gastric cavities and mesenterial pouches and with centrifugal canals originating from the former, which may open to the exterior by pores and thereby take in nutriment; they are invested by endodermal cells which may become converted into flagellate cells. (J. R. M. S., (2,) v. II, p. 798.)

IV. CŒLENERATES.

GENERAL.

- Hamann (Otto). Studien über Cœlenteraten. Mit 2 Taf. *Jena. Zeitschr. f. Naturwiss.* xv Bd., pp. 545-557.

HYDROIDS.

- Hamann (Otto). Der Organismus der Hydroidpolypen. Mit 6 Taf. *Jena. Zeitschr. f. Naturwiss.*, v. xv, pp. 473-544.
- Haeckel (Ernst). Report on the Deep Sea Medusæ dredged by H. M. S. Challenger. With 32 pl. *Report Scientif. Results, Challenger, Zool.*, v. IV, cv, 154 pp.
- Mereschkowsky (C. de). Structure et developpment des Nematophores Chez les Hydroides. Avec 2 pl. *Arch. Zool. Experim.*, t. x, pp. 583-610.

Primordial Medusæ.

The earliest indications of Medusæ hitherto known have been of triassic age and found in the lithographic slate of Solenhofen. The consistency of these organisms naturally militates against their preserva-

tion or even any indications of their existence, save in exceptional circumstances. But Mr. Nathorst, of Sweden, has lately been pursuing certain investigations which may throw some light on their past history, and at the same time serve to explain the nature of certain problematical bodies discovered in the palæozoic rocks of Scandinavia. While visiting Oeresund numerous Medusæ of the genus *Aurelia* were cast ashore with the mouth downwards. "When he took up one he observed that it had sunk in the soft ground by its own weight, and that its gastrovascular system had made a star-like impression," which reminded him of a Cambrian fossil, described as *Spatangopsis*. "He then followed the matter up further, partly by making impressions of various Medusæ and partly by filling up their gastrovascular system with plaster, and so obtained a cast. The preparations thus made corresponded so exactly in every detail with the problematical bodies from the Cambrian" that no doubt existed as to their analogy. "The stars and pyramids are casts of the gastrovascular systems of the Medusæ, the rays of the stars and the angles of the pyramids correspond with the arms, and the crescent-shaped projections occasionally occurring between the angles are casts of the genital cavities. The impressions on the slabs of rocks are produced by Medusæ thrown on the shore, and which, sinking more or less into the soft ground by their own weight, make a more or less complete impression of the body-cavity. The bodies lying free in the clay were probably produced by Medusæ which lay on their backs, their gastrovascular system becoming filled up with the sand or mud. There are some Medusæ which do not swim, but sink into the mud on their backs, and lie still watching for their prey." The "rays" in the fossils vary from four to five. It is urged, however, that even "in the present day individuals are found with five, six, or nine rays," but it is admitted that "certainly this deviation from the normal number appears more frequently in the Cambrian Medusæ than in the existing species." In further evidence of the medusoid nature of the Cambrian fossils, it is stated, among other things, that "the impression of the disk and traces of the tentacles are distinctly seen round a four-rayed star on a rock from Lagnas." In fine, the testimony seems to Mr. Nathorst to justify the identification of the fossils in question as true Medusæ, and three "species" are considered to be recognizable among those found in the deposits at Lagnas. Inasmuch as the names *Spatangopsis* and *Astylosporgia*, which had been proposed for the Cambrian organisms, were given under a misapprehension as to their relationships and convey misleading ideas, the new *Medusites* has been proposed, and the three species have been designated as *M. radiatus* (ex Linnarson), *M. Lindströmi* (ex Linnarson), and *M. favosus* (n. sp.). If the alleged facts and conclusions are confirmed, the results of the investigation recorded are of unusual interest, as it establishes the contemporaneity of Medusæ with the oldest animals of which we have distinct evidence. (J. R. M. S., (2 II. 326-327), from Handl. K. Svenska Vetensk. Akad., xix.

V. ECHINODERMS.

GENERAL.

Ludwig (H.) Morphologische Studien an Echinodermen. 11 Bd. 2. Hft. Mit.

SPECIAL ORDERS.

Crinoids.

- Bell (F. Jeffrey). An attempt to apply a method of formulation to the species of the Comatulidæ; with the description of a new species. With 1 pl. *Proc. Zool. Soc. London*, 1882. Pp. 530-586. Abstr. in *Journ. R. Microsc. Soc.*, (2,) vol. 11, p. 791.
- Carpenter (Phillip). On the Relations of Hyrocrinus, Bærocrinus, and Hyboecystites. With 1 pl. *Quart. Journ. Geol. Soc., London*, vol. XXXVIII, p. 298-312.
- Wachsmuth (Ch.) and F. Springer. Revision of the Palæocrinoidea. Part III. *Proc. Acad. Nat. Sci., Phila.*, 1882.

Echinoids.

- Köhler (R.) Sur quelques essais d'hybridation entre diverses especes d'Echinoidées. *Compt. rend. Acad. Sci., Paris*, t. 94, pp. 1203-1205.

Ophiuroids.

- Verrill (A. E.) Restoration of the Disk in Ophiurans. *Amer. Journ. Sci.*, (3,) v. XXIII, p. 408: *Ann. & Mag. Nat. Hist.* (5,) v. IX, pp. 476-477.

Asterioids.

- Ludwig (Hub.) Entwicklungsgeschichte der *Asterina gibbosa*. Forb. Mit 8 Taf. *Zeitschr. f. wiss. Zool.*, 37 Bd., pp. 1-98.
- Perrier (Edmond.) Sur une Astérie des grandes profondeurs de l'Atlantique, pourvue d'un pédoncule dorsal [*Caulaster pedunculatus*, n.] *Compt. rend. Acad. Sci. Paris*, T. 95, pp. 1379-1381.

Holothurioids.

- Jourdan (Et.) Sur les organes sexuels males et les organes de Cuvier des Holothuries. *Compt. rend. Acad. Sci. Paris*, t. 95, pp. 252-254.

Hybrization among Echinoids.

Mr. R. Köhler has made "some experiments in hybridization between different species of Echinoidea," and found that cross fecundations "are possible between different species of Echinoidea, and that between very wide limits," as, for example, between a *Spatangus* and a *Psammechinus*, which he thought (without sufficient justification) were at least as different as two mammals of allied orders. "And if the plutei obtained by crossing between regular Echinoids do not appear to differ much from the legitimate plutei of the type functioning as female in the experiments, there are certainly well marked differences between a legitimate pluteus of *Spatangus* and a hybrid pluteus of *Spatangus* and *Psammechinus*." He calls special attention to the fact that "because the ova of a species when fecundated by the spermatozoids of another species arrived at the state of pluteus, it does not follow that the converse is true. Thus, the ovules of *Spatangus* are perfectly fecundated by the spermatozoids of *Psammechinus*, but the ovules of the latter, subjected to the influence of the semen of the *Spatangus*, remain for the most part intact, while the rest scarcely reach the blastula stage."

VI. WORMS.

ORTHONECTIDS.

Julin (Charles). Contribution à l'histoire des Mésozoaires. Recherches sur l'organisation et le développement embryonnaire des Orthonectides. Avec 3 pl. *Arch. de Biolog.*, t. III, pp. 1-54.

DICYEMIDS.

Van Beneden (Edouard). Contribution à l'histoire des Dicyemides. Avec 2 pl. *Arch. de Biolog.*, t. 3, pp. 195-228.

Whitman (C. O.). A contribution to the embryology, life-history, and classification of the Dicyemids. With 5 plates. *Mittheil. Zoolog. Station zu Neapel*, IV bd, pp. 1-89.

Characteristics of the Dicyemids.

The peculiar parasites known as Dicyemids, found in the renal organs of the Dibranchiate Cephalopods, have been the subject of an elaborate monograph by Dr. O. C. Whitman, and much light has been thrown on their true nature.

The Dicyemids are of special interest, inasmuch as Professor Van Beneden regarded them as the constituents of a primary group of animals intermediate between the Protozoans and Metazoans (all animals above Protozoans), distinguished as many-celled animals, developing only two germ-layers, and destitute of a mesoderm. Dr. Whitman's studies, however, have led him to consider that the "Dicyemids may be said to have a transient *triploblastic* stage, represented by an ectodermal layer, an axial endodermic cell, and two intermediate mesodermic cells, derived from the two poles of the endodermic cell."

Prof. Edouard Van Beneden was led to believe that there was an extraordinary parallelism as to mutual relations between the Dicyemids and their hosts, and that they were differentiated in ratio to the cephalopods—genus for genus and species for species; thus, two species of *Dicyema* accompanied two species of *Octopus*, two of *Dicyemella* two of *Eledone*, two of *Dicyemina* two of *Sepia*, and one of *Dicyemopsis* one of *Sepiola*. Dr. Whitman, on the contrary, failed to confirm the generic subdivisions of Van Beneden and discovered that the species of Dicyemids were not limited respectively to single species of cephalopods, or the sole parasites of their kind on their respective hosts. The American naturalist was led to differentiate all the known Dicyemids into two genera; *Dicyema* with one eight-celled "head" or calotte, including seven species, and *Dicyemenea*, with a nine-celled calotte, formed for three other species. In two species of Decaceres of different families were found two species of Dicyemids of the two genera (but different sets of species), and the same species of Dicyemids were found in two or three species of cuttle fishes.

PLATYHELMINTHES.

Francotte (P.). Sur l'appareil excréteur des Turbellairés Rhabdoceles et Dendrocoeles. Avec 1 pl. *Bull. Acad. Sc., Belg.* (3), t. III, pp. 83-98.

Adaptation to environment of Trematods.

Professor Ercolani has published a useful summary of facts in the development of Trematods related to adaptation for environment. (1) The succession of phases of development is not always the same in all Trematods, some leaving the eggs as ciliated embryos requiring water, and others as non-ciliated ones, developing in terrestrial gastropods; (2) the different phases of development are not the same for all encystation, *e. g.*, being sometimes omitted; (3) a special form of scissiparous generation may occur *e. g.*, in the racemose sporocysts where certain living parts (as in Polyzoans and Hydroids) are connected by atrophied stolons; (4) the direct conversion of the tail of a cercaria into a nurse sometimes occurs; (5) encystation may not only be normal, but also accidental or abnormal.

It is far from true that there is a determinate relation between Trematods and Mollusks, and that the latter have only one species each; *Bythinia tentaculata, e. g.*, has as many as twelve different species of cercariæ. (J. R. M. S., (2) v. 3, p. 784, from Arch. Ital. Biol., v. 1, p. 439-453.)

NEMATELMINTHS.

Drascho (Rich. von). Revision der in der Nematoden-Sammlung des k. k. zool. Hof-Cabinetts befindlichen Original Exemplare Diesing's und Molins. Mit. 4 Taf. Verhandl. k. k. zool. bot. Ges. Wien, 1882, pp. 117-138.

Fourment (L.). Sur la vitalité des *Trichines* enkystées dans les viandes salées. Compt. rend. Ac. Sc. Paris, t. 94, p. 1211-1213.

Mégnin (P.). Sur de petits Helminthes agames enkystés qui peuvent être confondus et qui l'ont été avec la *Trichina Spiralis*. Avec 3 pl. Bull. Soc. zool. France, 6. Ann. p. 189-198.

Mégnin (P.). Sur l'organisation de la bouche des *Dochmius* ou *Ankylostomes*, à propos de parasites de ces deux genres trouvés chez le chien. Compt. rend. Acad. Sc. Paris, t. 94, p. 663-666.

Orley (L.). Report on the Nematodes in the possession of the British Museum, with a review of the classification of the order. With 1 pl. Ann. & Mag. of Nat. Hist., (5,) v. 9, p. 301-318.

Orley (L.). Monographie der Anguilluliden. Mit. 7 Taf. Termész Füzetek, v. 4, p. 154-177 (Deutsches Auszug d. ungar. geschriebenen Arbeit., p. 16-150).

Schulthess (Wilhelm). Beiträge zur Anatomie von *Ankylostoma duodenale* (Dubini) = *Dochmius duodenalis* (Leuckart). Mit 2 Taf. Zeitschr. f. wiss. Zool., 37 Bd., p. 163-220.

The Nematoid Worms.

Dr. L. Orley has recently studied the Nematoids in the British Museum and has come to the conclusion that there are three "suborders" although "there are perhaps few orders in which so continuous a series of forms exists as in the Nematodes." His views as to the question of relationship between parasitism and non-parasitism and classification may be gleaned from his diagnosis of the several groups.

1. The Nematentozoa are "thread worms completing their early stage in the free condition, their maturity as parasites in the bodies of
H. Mis. 26—37

the higher or the lower animals; the species being propagated by the production of immense numbers of ova, whose development is more or less complicated." This group includes most of the nematoids and is exemplified by the *Ascarides*, *Filariæ*, etc. The groups proposed by Schneider—*Polymyarii*, *Meromyarii*, and *Holomyarii*—are adopted for its constituent genera.

2. The *Rhabditiformes* are "small, chiefly microscopic thread-worms, which live generally free, but in exceptional cases as parasites, and have without exception the power of developing to the sexually mature state in organic substances in a state of decomposition, or in earth saturated with such substances, such condition being necessary to the process." Only two species were represented in the British Museum.

3. The *Anguillulidæ* are "small microscopic thread-worms leading a free existence in mould or in water throughout all their stages, developing without a complete metamorphosis." The common Vinegar eel is the type.

ANNELIDS.

1. GENERAL.

Kleinenberg (N.). De l'origine du système nerveux central des Annélides. Arch. Ital. Biol., t. 1, p. 63-77.

Verrill (A. E.). New England Annelida. Part I. Historical Sketch, with annotated lists of the species hitherto recorded. Trans. Conn. Acad. Arts. & Sc., v. 4, p. 285-324, 324 a—e., pl. 3-12.

2. SPECIAL ORDERS.

Polychæta.

Giard (Alfred). Sur un type synthétique d'Annélide (*Anoploneireis Hermannii*) commensal des *Balanoglossus*. Compt. rendus Acad. Sc. Paris, t. 95, p. 389-391.

Haswell (Will. A.). On the Structure and Functions of the Elytra of the Aphroditæan Annelids. Ann. & Mag., Nat. Hist., (5) v. 10, p. 238-242.

Kennel (J.). Ueber *Ctenodrilus pardalis* Clap. Ein Beitrag zur Kenntnis der Anatomie und Knospung der Anneliden. Mit 1 Taf. Arb. Zool.-zoot. Instit. Würzburg. Bd. 5, p. 273-429.

Wilson (Edmund B.). Observations on the Early Developmental Stages of some Polychæteous Annelids. With 4 pl. Stud. Biolog. Laborat. Johns Hopkins University., v. 2, p. 271-300.

Powell (Thomas). Remarks on the Structure and Habits of the Coral-reef Annelid *Palolo viridis*. Journ. Linn. Soc. London, Zool., v. 16, p. 393-396.

A periodical worm.

One of those forms whose movements coincide with the phases of the moon once every year at least, appears to be established as the *Palolo* or *Mbalolo* of certain of the coral archipelagoes of the Pacific—Samoa, Viti, and the Gilbert group. The *Palolo* is an annelid related to the *Nereids*, and its binominal designation is *Palolo viridis*. It was first scientifically described by Dr. J. D. Macdonald in 1857 (Trans. Linn. Soc., London, V. 22, pp. 237-239, pl. 41). The Fijian name has ref.

erence to the coincidence of its movements with the moon, and when the worm makes its appearance it does so in such vast numbers that it is collected by the natives as a dainty article of food, and is so much prized that formal presents of it are often sent considerable distances, from certain chiefs, to others whose small dominions do not happen to be visited by the Mbalolo." The worms only make their appearance to spawn, and "the time of their appearance is the day of the last quartering of the moon in October, *unless* that fall at the beginning of the month, in which case there will intervene another lunar month." So says the Rev. T. Powell, and he adds that "the observations of many years, made by many old European inhabitants as well as by the natives, show that, if from the time of spawning in October, we reckon 354 or 355 days, that will bring us to another spawning, unless such reckoning terminate at the end of September or the beginning of October, say from the 1st to the 4th day. In that case the reckoning must extend to 333 or 384 days, when the Palolo will appear. Thus, instead of an interval of only twelve lunar months, one of thirteen will occur. Whether the moon, *directly*, has anything to do with the movements of the Palolo, may be still an open question, but that there is a *coincidence* between the two, seems to be beyond doubt. But although the great host of Palolo makes its appearance as indicated, according to Mr. Powell, "there is a second appearance of Palolo each year, occurring a month after the first, consisting of such worms, probably, as were not sufficiently mature to spawn in October, or, it may be, of an other species."

VII. ARTHROPODS.

MEROSTOMES.

Trilobites.

Edwards (H. Milne). Compte rendu des nouvelles recherches de M. Walcott sur la structure des Trilobites, suivi de quelques considerations sur l'interpretation des faits aussi constatés. Avec 3 pl. Ann. Sc. Nat., (6,) Zool., t. 12, Art. No. 3. (33 p.).

Schmidt (Fr.). Revision der ostbaltischen silurischen Trilobiten nebst geognostischer Uebersicht des ostbaltischen Silurgebiets. Abth. I. Phacopiden, Cheiruriden und Encrinuriden. Mit. 16. Taf. Mem. Acad. St. Petersburg., 7. Ser., No. 1. (237 p.— M. 15.)

Xiphosura.

Moseley (H. N.). The Development of Limulus. Ann. & Mag. of Nat. Hist. (5), v. 9, p. 412.

Moseley (H. N.). Limulus. Nature, v. 25, p. 582.

Packard (A. S., jr.). Is Limulus an Arachnid? Amer. Naturalist, v. 16, p. 287-292; Ann. & Mag. of Nat. Hist. (5), v. 9, p. 369-374.

Is Limulus an Arachnid?

An abstract of Prof. Ray Lankester's contention that "Limulus [is] an Arachnid" has been reviewed by Professor Packard. It is recalled that

Limulus differs from Arachnids "in having tracheæ, no spiracles, and no Malpighian tubes," and "also in having compound eyes, no functional mandibles or maxillæ," &c. Professor Packard especially objects to the comparison of the nervous system of *Limulus* with that of the Scorpion; in reference to Professor Lankester's claim that "between the sixth abdominal segment and the spine there are six segments," he ventures to suggest that four of these segments are purely imaginary; in opposition to Professor Lankester "would continue to regard the anal spine as the telson"; repudiates Professor Lankester's interpretation of the nature of the compound eyes, the respiratory amellæ, the four last pair of biramous respiratory feet, and the "parabranchial stigmata" of *Limulus*, and cites the alleged discovery of a naupliiform larva of the Japanese *Limulus* by Willemoes-Suhm.

Professor Mosely, in answer to Professor Packard, renews expression of faith in the views of Professor Lankester as to the relationship of *Limulus* to the Arachnids, and shows that Willemoes-Suhm was mistaken in referring this naupliiform larva to *Limulus*.

CRUSTACEANS.

FAUNAS.

North America.

Smith (Sidney I.). Occasional occurrences of tropical and subtropical species of Decapod Crustacea on the coast of New England. Trans. Conn. Acad. Arts and Sci., v. 4, p. 254-267.

— Reports on the results of dredging by the United States Coast Survey steamer Blake. Report on the Crustacea. Part I. Decapoda. Bull. Mus. Comp. Zool., v. 10, p. 1-103, 16 pl.

Europe.

Joliet (Lucien). Observations sur quelques Crustacés de la Méditerranée. Archiv. Zool. Expériment., t. 10, p. 101-120 (viz: 1. Sur une troisième espèce du g. *Lamippe*, L. Duthiersii, parasite du *Paralcyonium elegans* M. Edw.; 2. Sur l'usage des pieds dorsaux chez les Crustacés Notopodes; 3. Un exemple de Mimétisme, *Pontonia diazona* n. sp.)

Sars (G. O.). Oversigt of Norges Crustaceer med forelbige Bemaerkninger over de nye eller mindre bekjendte Arter. I. (Podophthalmata, Cumacea, Isopoda, Amphipoda.) Med. 6 autograph Pl. (Christian. Vidensk. Selsk-Forhandl. 1882, No. 18.) (124 p.) Note.—576 sp. are enumerated for the Fauna, of which 107 are new.

Australia.

Haswell (Will. A.). Catalogue of the Australian stalk and sessile-eyed Crustacea. Printed by order of the trustees [of the Australian Museum Sydney]. Sydney, 1882. (8v, xxiv, 324 p., Addenda, Explan. of pl., 4 pl.)

SPECIAL GROUPS.

Branchipods.

Herrick (C. L.). A new genus and species of the Crustacean family Lynceodaphnidae. Amer. Naturalist, v. 16, p. 1006-1007, pl. 16.

Pycnogonids.

- Hoek (P. P. C.). Nouvelles études sur les Pycnogonides. Avec. 8 pl. Arch. Zool. Expériment. t. 9, p. 445-542.
- . Pycnogonides du Challenger. Traduction du Resume general de l'auteur. Arch. Zool. Experiment. t. 9, note, p. xlix-lii.

Copepods.

- Biesbrecht (W.). Beitrage zur Kenntnis einiger Notodelphiden. Mit. 3 Taf. Mittheil. Zool. Station Neapel, 3 Bd., p. 293-372.

Edriophthalma.

- Kossmann (R.). The *Etoniscidae*. With 1 pl. Ann. and Mag. Nat. Hist. (5), v. 10, p. 81-99.
- Mocquard (C.). Sur les ampoules pyloïques des Crustacés isopodes. Compt. rend. Ac. Sc. Paris, t. 94, p. 1203-1211.
- Schiodte (J.), et Fr. Meinert. Symbolae ad Monographiam *Cymothoarum*, Crustaceorum Isopodum Familiae. II. Aniloceridae. Cum 10 tab. Naturhistor. Tidsskr. (3.) 13. Bd. p. 1-166.
- Wals (Rud.). Ueber die Familie der Bopyriden mit besonderer Berücksichtigung der Fauna der Adria. Mit. Taf. Wien., Alfr. Holder, 1882. (Arbeit. Zool. Inst. Wien., t. 4, Hft. 2, (p. 125-200.)

Decapods.

- Vitzou (Alexandre N.). Recherches sur la structure et la formation des teguments chez les Crustacés Décapodes. Avec 6 pl. Archiv. Zool. Expériment., t. 10, p. 451-576.
- Guppy (H. B.). Note on the cocoon-eating habit of the *Birgus* in the Solomon Group.—Proc. Linn. Soc. N. S. Wales, v. 7, p. 661-665.

Tropical Crustaceans in New England waters.

Crustaceans of various kinds are apt to be carried far from their customary habitats, especially in their embryonic stages, by currents or other causes, and Prof. Sidney I. Smith has recorded a number of such visitants to the coast of New England. Ten species of Decapods have been thus signalized, the most noteworthy of which are the common West Indian and Southern *Ocypode quadrata* or *arenaria*, *Grapsus pictus*, *Pachygrapsus transversus*, and *Calappa marmorata*. The *Grapsus* (1 specimen) and *Pachygrapsus* (4 specimens) were obtained in the adult condition from the bottoms of whalers in Provincetown Harbor, while the *Ocypode* and *Calappa* were found in considerable numbers, in the emryonic stage, at Wood's Holl, Massachusetts.

A parasitic Cirriped.

To the numerous and remarkable parasites of the animal kingdom a strange one has recently been added by Professor Tozzetti, of Florence. A small pedunculated cirriped or barnacle (*Ornitholepas australis*) has been discovered living upon the ends of the abdominal feathers of a puffin—the *Priofinus cinereus*. The anomaly arises from the fact that the cirripeds are branchiferous, and especially fitted for submarine life, while the puffin, although a waterfowl, is "one of the most aerial of

birds." Nevertheless, all of the puffins taken in the South Atlantic and Indian Oceans—nearly a hundred—were found to be infested with the cirripeds.

Cocoanut-eating Crabs.

It has long been known that a large terrestrial relative of the hermit-crabs, known as *Birgus latro*, inhabiting the Philippine Islands, feeds on cocoanuts, and Darwin, in his *Voyage of a Naturalist* (ed. 1860, p. 468), has recorded the observations on its attack on the husk of the nut made by an English resident of Keeling Island. Mr. Guppy has lately found on an uninhabited islet of the Solomon Group a species supposed to be the *Birgus latro*, and recorded his observations. He found an individual about 15 inches long, which had apparently "not only husked the shell, but also broken the hole at the eye-hole end of the nut" itself: in confinement it did not actually accomplish such a feat. "On one occasion the *Birgus* was surprised with the nut between its large claws; but notwithstanding that no other food was offered to it for a day and a half, it did not attempt to strip off the bark; so the operation was done for it, and a small hole was knocked in the top of the shell." The *Birgus* was kept alive by Mr. Guppy for three weeks, and "its appetite for cocoanuts continued unimpaired to the last day of its life." It consumed about two nuts in three days, or at the rate of about 250 a year. "Other foods, such as bananas, were offered to it, but were left untouched."

It may be here noted that the stomachal armature of *Birgus* has been recently described by Mr. Mocquard in the *Annales des Sciences Naturelles*.

ARACHNIDS.

General.

Bertkau (Ph.) Ueber das Cribellum und Calamistrum. Ein Beitrag zur Histologie, Biologie und Systematik der Spinnen. Mit Abild. *Arch. f. Naturgesch.*, 48. Jahrg., pp. 316-362.

MacLeod (Jul.) Recherches sur la structure et la signification de l'appareil respiratoire des Arachnides. Avec fig. *Bull. Acad. Sc. de Belgique*, (3,) t. 3; pp. 779-792.

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Europe.

Cambridge (O. P.). Notes on British Spiders, with descriptions of three new species and characters of a new genus. *Ann. Mag. Nat. Hist.*, (5), v. 9, pp. 1-13, pl. 1, 1882.

Australia.

Koch (L.). Die Arachniden Australiens noch der Natur beschrieben und abgebildet. Fortgesetzt von Graf E. Keyserling. 30 Lief. Nürnberg, Bauer & Raspe, 1882. (4^o. M. 9.).

SPECIAL GROUPS.

Acarians.

Kramer (P.) Ueber Gamasiden. Mit 2 Taf. *Archiv f. Naturgesch.*, 48. Jahrg, pp. 374-434.

Araneians.

- Emerton (J. H.). New England Spiders of the family Theridiidæ. Trans. Conn. Acad. Arts & Sc., v. 6, pp. (86) with 24 pl.
- Campbell (F. Maule). On a probable case of Parthenogenesis in the House-Spider (*Tegenaria Guyonii*). Journ. Linn. Soc. London, Zool., v. 16, pp. 536-539.

Spiders of Great Britain.

The Rev. O. P. Cambridge completed, in 1881, the publication of a monograph on the "Spiders of Dorset" (in the Proceedings of the Dorset Natural History and Antiquarian Field Club), and in a subsequent article has added several other species, and given the statistics of the Arachnid fauna of Great Britain. It appears therefrom that "the number of spiders recorded in Great Britain and Ireland is 520; but there is little doubt that this number might be considerably increased by diligent search in many as yet untried localities, especially when we consider that a small area of Dorsetshire alone has produced nearly 400 species."

New England Theridiid Spiders.

An illustrated monograph of the spiders of the family of Theridiids inhabiting New England has been published by Mr. J. H. Emerton, almost the only student of the spiders in the United States. As might, therefore, be expected from a field so little cultivated, a very large proportion of the species was previously undescribed. One hundred and thirty-four species of the family have been described and illustrated by Mr. Emerton, and of these no less than 85 were "new."—(Verrill in A. Jr. S., (1,) v. 24, p. 477.)

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GENERAL.

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- Austin (E. P.). A Manual of Entomology. Directions for collecting, preparing, and mounting insects of all orders. Boston. (12mo.)
- Brehm (A. E.). Merveilles de la Nature. Les Insectes. Édit. franç. par J. Kunckel d'Hercules. 2-6. sér. Livr. 11 à 60. Paris, J. B. Baillière et fils, 1882.
- Camerano (Lor.) Anatomia degli Insetti. Con. 57, figure . . . e nove tav. dopp. in fotolit. Torino, Loescher, 1882. (8vo. viii, 251 pp.)
- Hoejo y Rosillo (J.) Manual de Entomologia. Tom. 1. Madrid, 1882. (8vo., 248 pp.)
- Karsch (A.). Die Insektenwelt. Ein Taschenbuch zu entomologischen Excursionen für Lehrer und Lernende. 2. Aufl. Leipzig, O. Lenz, 1882. (8vo.)

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- Mittheilungen der Schweizerischen Entomologischen Gesellschaft. Bulletin de la Société Entomologique Suisse. v. 7. Schaffhausen, 1882. (8vo.)
- Papilio. Organ of the New York Entomological Club. v. 2. New York, 1882. (8vo.)
- Psyche. Organ of the Cambridge Entomological Club. v. 4. Cambridge, Mass., 1882. (8vo.)

- Société Entomologique de Belgique. Comptes-rendus des séances. 3. sér. Bruxelles 1882. (8vo.)
- Stettiner Entomologische Zeitung. 43. Jahrg. Stettin, Gröbmann, 1882. (8vo.)
- Zeitschrift für Entomologie. Herausgegeben vom Verein für schlesische Insectenkunde zu Breslau. Neue Folge. Breslau, Maruschke & Berendt in Comm., 1882. (8vo.)

Physiology.

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- Bennett (Alfred). On the Constancy of Insects in their visits to Flowers. Report 51. Meet. Brit. Assoc. Adv. Sc., p. 667-668.
- Graber (Vitus). Die chordotonalen Sinnesorgane u. das Gehör der Insecten. II. Physiologischer Theil. Mit 4 Holzschn. Arch. f. mikroskop. Anat., 21. Bd., p. 65-145.
- Hagen (H. A.). On the Color and Pattern of Insects. Proc. Amer. Acad. Arts and Sc. v. 17, p. 234-267.
- Müller (Fritz). On some difficult cases of mimicry. Nature, v. 26, p. 436.
- Müller (Hermann). Weitere Beobachtungen über Befruchtung der Blumen durch Insecten. III. Mit 2 Taf. Verhandl. naturhist. Ver. preuss. Rheinl. u. Westf. Bonn.
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- Hagen (H. A.). Experiments with yeast in destroying Insects. Canad. Entomologist, 1882. pp. 38-39.
- Packard (A. S.), jr., Insects injurious to Forest and Shade Trees. U. S. Entomol. Commiss. Bull. No. 7. Washington, 1881. (8vo., 275 pp., 100 fig.)

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- Erichson (W. F.), H. Schaum, etc. Naturgeschichte der Insecten Deutschlands. 1. Abtheil. Coleoptera. 3. Bd. 3 Abtheil., 1. Lief. Bearbeitet von Edm. Reitter. Berlin, Nicolai, 1882. (8vo, vi, 298 pp. M. 4. 50.)
- Fairmaire (Léon). Histoire naturelle de la France. 8. Partie; Coléoptères. Avec 27 pl. et. fig. Paris, Deyrolle, 1882. (8vo., 381 pp.)
- Wood (J. G.). Common British Insects, selected from the Typical Beetles, Moths, and Butterflies of Great Britain. With 120 fig. by E. A. Smith, engraved by G. Pearson. London, Longmans, 1882. (8vo., 292 pp. 3s. 6d.)

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- Deichmüller (J. V.). Fossile Insecten aus dem Diatomeenschiefer von Kutschlin bei Bilin, Böhmen. Mit 1 Taf. Halle, Leipzig, W. Engelmann in Comm. 1881. (1882. 4°. aus: Nova Acta Acad. Leop. Carol., vol. 42, No. 6, 293-331 pp. M. 3.)

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Myriapods.

(*Protosyngnaths.*)

- Scudder (Samuel H.). The affinities of *Palæocampa* Meek and Worthen as evidence of the wide diversity of type in the earliest known Myriapods. Amer. Journ. Sc., (3,) v. 24, pp. 151-170; Ann. and Mag. Nat. Hist., (5,) v. 10, pp. 286-295.

(Archipolypods.)

Scudder (Samuel H.). Archipolypoda, a subordinal type of spined Myriapods from the Carboniferous Formation. With 4 pl. Mem. Boston Soc. Nat. Hist., v. 3, pp. 143-182.

(Chilopods.)

Voges (Ernst). Das Respirationssystem der Scutiggeriden. Zool. Anz., 5. Jhg., pp. 67-69.

*Hexapods.**Apters.*

Taschenburg (Otto). Die Mallophagen, mit besonderer Berücksichtigung der von Dr. Meyer gesammelten Arten systematisch bearbeitet. Mit 7 Taf. Nova Acta Acad. Cæs. Leop. Carol., v. 44, No. 1.

Orthopters.

Berlese (Ant.). Osservazioni sulla anatomia descrittiva del *Gryllus campestris*. Con 4 tav. Atti Soc. Ven.-Trent. Padova, v. 7, pp. 200-299.*

Brogniart (Charles). Observations sur la manière dont les *Mantes* construisent leurs oothèques; sur la structure des oothèques; sur l'éclosion et la première mue des larves. Ann. Soc. Entomol. France (6), t. 1, pp. 449-452.

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Phylloxera.

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Girard (Maurice). Le phylloxera. 3. Edit. Avec gravures et carte. Paris, Hachette et Co., 1882. (8vo., 120 pp.)

Marion (A. F.). Application du sulfure de carbone au traitement des vignes phylloxérées. Rapport sur les travaux des années 1880 et 1881 et sur les résultats obtenus en grande culture. Paris, 1882. (4to., 141 pp., 4 pl.)

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Hagen (H. A.). The tarsal and antennal characters of *Psocidæ*. Entomolog. Monthly Mag., vol. 19, June, pp. 12-13.

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Vayssière (Alb.). Recherches sur l'organisation des larves des éphémériens. Avec 11 pl. Ann. Sci. Nat., Zool. (6), t. 13, Art. 1 (137 pp.)

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Pascoe (Francis P.). Note on the classification of the Homoptera. Ann. & Mag. of Nat. Hist. (5), v. 9, pp. 424-425.

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Allard (Ern.). Essai de classification des *Blapsides* de l'ancien monde. 3. P. Ann. Soc. Entomolog. France (6). t. 1, pp. 493-526.

Burgess (Edward). Structure of the mouth in the larva of *Dytiscus*. Proc. Boston Soc. Nat. Hist., v. 21, pp. 223-228.

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- Bridgman (John B.) and Edw. A. Fitch. Introductory Papers on Ichneumonidæ. No. II. Ichneumonidæ (contin.). Entomologist, v. 15, pp. 78-85.
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A new order of Myriapods.

In 1865 Messrs. Meek and Worthen described a peculiar genus of articulates based on a specimen found in the carboniferous formation of Illinois and named it Palæocampa. They referred the new type, with some hesitation, to the class of worms. Other specimens have been lately examined by Mr. S. H. Scudder, and that naturalist came to the conclusion that the old type was neither a worm nor caterpillar, but really belonged to the group of Myriapods, and represented in that group a previously undifferentiated order, which has been named *Protosyngnatha*. Mr. Scudder was led by the study of this type to the conclusions, (1) that in this ancient Myriapod, as old as any with which we are acquainted, *we find dermal appendages of an extraordinary high organization*, more complicated than anything of the sort found in living arthropods; and, (2) that at the early period when it lived *the divergence of structure among Myriapods* was as great as it is to-day. The bearings of these facts are discussed at length by Mr. Scudder.

Mimicry by plume-moths.

The plume-moths have wings cleft into feathery plumes, and when flying remind one of drifting thistle-down. Mr. J. E. Taylor recalls that of about twenty species of *Pterophorus* whose larval habits are known, one-half feed on composite plants having plumed seeds, and it is therefore suggested that the wings of the moths, mimicking the down, must be protective to females when depositing their eggs, as well as when they are flying.

VIII. MOLLUSCOIDS.

POLYZOANS.

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M'Intosh (W. Carmichael.) Preliminary notice of *Céphalodiscus*, a new type allied to Prof. Allman's *Rhabdopleura*, dredged by H. M. S. "Challenger." Ann. and Mag. Nat. Hist., (5) v. 10, p. 337-343.

A new Rhabdopleuran.

A new genus of *Rhabdopleuræ*, an order of Polyzoans hitherto only known through one genus—*Rhabdopleura*—has been made known by Professor McIntosh. It has been named *Cephalodiscus*. It is especially distinguished by remarkable branchial or tentacular plumes and by the perfectly free condition of the polypides. It may be added that Professor Lankester visited Norway in August expressly to study *Rhabdopleura*, and was successful in finding it in considerable numbers and under favorable conditions.

Variations of the avicularium in Polyzoans.

As the Rev. Thomas Hineks well remarks, "The homology between the curious avicularian [or bird-head-like] appendage which is present on so many of the cheilostomata and the zoœcium with its contained zooid has been amply demonstrated and is now generally admitted. Indeed the rudimentary or primary forms of the organ exhibit so slight an amount of divergence from the ordinary cells that we have no difficulty in recognizing the morphological relationship between the two; and from this starting point a series of transitional forms conducts us to the most highly specialized term, in which the zoœcial type is effectually marked." Further, "the *avicularium* with more or less elongated mandible is a step towards the second of the appendicular organs with which the Cheilostomatous Polyzoa are furnished, the

vibraaculum." Transitions between these two types have even been found in one species of Polyzoan, the ubiquitous *Microporella ciliata*. In specimens from the Queen Charlotte Islands the following modifications were found: (1) "ordinary avicularium with pointed beak"; (2) "avicularium with the mandible elongated into a spine"; (3) "avicularium with the spinous mandible supporting a membranous flapper"; and (4) "vibraeuloid structure with tall, well-developed seta and partially-modified beak."

BRACHIOPODS.

General.

Bemmelen (J. F. van). Over den Bouw der Schelpen van Brachiopoden en Chitonen. Med 1 pl. Acad. Proefschr. Leiden, Brill, 1882. (8vo. 103 pp.)

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Relations of the Brachiopods.

For the benefit of such as may desire to become acquainted with the literature of Brachiopodology, it is fit to state here that Van Bemmelen's article on the anatomical and histological structure of the Brachiopods is directed in part to the attempt to prove an intimate relationship between that class and the worms. It is claimed that instead of being allied to the Mollusca, the Brachiopods "appear to present the closest resemblance to the Chætognatha. Not only do the ectoderm, enteric canal, and the body-cavity present just the same developmental history, but in both we observe a feeble development of connective tissue; the only differentiation in this layer is the formation of supporting fibres." It is concluded that "the important differences are the possession by the Brachiopod of a shell and of a stalk; but the former has been shown to be merely a thickening of the cuticle, and the secondary value of the latter is shown by the differences between the Testi- and Ecardines." (J. R. M. S., (2), v. 3, p. 338-360.)

Dr. Van Bemmelen's facts, so far as given by the abstract, appear on the whole to be well enough, but his use and collocation of them scarcely seem justifiable on principles of sound logic and the facts contravening his postulate have scarcely been sufficiently considered.

IX. MOLLUSKS.

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Crosse (Henri). Faune malacologique du lac Tanganyika. Avec 1 pl. Journ. de Conchyliol., t. 30.

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CONCHIFERS.

Morphology.

Mitsukuri (K.). On the structure and significance of some aberrant forms of Lamelibranchiate gills. With 1 pl. Stud. Biolog. Laborat., Johns Hopkins University, v. 2, p. 257-270. (Reprinted from Quart. Journ. Micr. Sc.)

The Oysters.

Bouchon-Brandely. De la sexualité chez l'huître ordinaire (*O. edulis*) et chez l'huître portugaise (*O. angulata*). Fécondation artificielle de l'huître portugaise. Note de M. Bouchon-Brandely, présentée par M. Berthelot. Comptes rendus, Acad. Sci. Paris, t. 95, pp. 256-259, July 31, 1882.

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———. Rapport relatif à la génération et à la fécondation artificielle des huîtres, adressé au ministre de la marine et des colonies, par M. Bouchon-Brandely, secrétaire du Collège de France. Journal officiel de la République Française. Dec. 16 and 17, 1882; pp. 6762-6764 and 6778-6782.

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Horst (R.) Bijdrage tot de Kennis van de Ontwikkelingsgeschiedenis van de Oester (*Ostrea edulis* L.). Tijdschr. d. Ned. Dierk. Vereen., dl. 6, 1882.

———. On the development of the European oyster (*Ostrea edulis* L.). Quar. Journ. Mic. Sci., n. s. v. xxii, pp. 341-346, pl. 27.

———. A contribution to our knowledge of the development of the oyster (*Ostrea edulis* L.). (Translated from the original Dutch by J. A. Ryder.) Bull. U. S. Fish Commission, v. ii., pp. 159-167.

Oysters and their propagation.

Much alarm has been felt in some quarters lest nature unaided should be unable to answer the demands of an oyster-loving population, increasing in an extraordinary ratio, and covering a continent. The U. S. Commissioner of Fisheries therefore delegated Mr. John A. Ryder, an accomplished embryologist, to investigate the feasibility of the artificial propagation of the esteemed mollusk. Meanwhile European govern-

ments and naturalists were on their side seeking what could be done for the old world, and Messrs. Hoek and Horst in the Netherlands, and Bouchon-Brandely in France, especially took up the investigation of the question. These several naturalists have materially added to the information previously gleaned by Davaine and Brooks, and the results of recent investigations have been ably digested by Mr. Ryder in "a summary of recent progress in our knowledge of the culture, growth, and anatomy of the oyster." From that summary we derive the following data, using in most cases Mr. Ryder's own words:

The oysters of greatest economical importance are three in number; (1) the common species of Northern Europe, *Ostrea edulis*; (2) a more southern species, formerly not occurring northward of the Lusitanian peninsula, *Ostrea angulata*, and (3) the ordinary Virginia oyster, *Ostrea virginica*.

According to M. Bouchon-Brandely, "twenty or twenty-five years ago the Portuguese oysters, indigenous to the Tagus, did not exist on the coasts of France. A damaged vessel discharged its cargo into the Gironde, upon the old Banc de Richard. Here they have since so multiplied that they cover an extent of from twenty-five to thirty kilometers, a vast bed which will soon be limited only by the banks of the river.

Ostrea edulis is undoubtedly hermaphrodite - - - "The Portuguese oyster is, on the other hand, incontestably unisexual. Like the American oyster, as shown by Brooks, its ova and milt are expelled from the shell. Neither ova nor embryos are ever found in its mantle. The young of the common oyster cannot live outside of the shell. According to M. Berthelot's investigations the fluids in the mantle cavity of *O. edulis* contain albumen in a notable proportion, upon which the young are supposed to be nourished. M. Bouchon-Brandely found that the young of *O. edulis*, whether in the form of white or gray spat, could not be developed in sea water external to the parent; the white embryos died in three days, the gray after twelve or fifteen days after their removal from the parent, although within reach of collectors. These facts he thinks, preclude the possibility of the crossing of the species. With respect to this point, however, our author made direct experiments, or attempts to hybridize the two species, which gave only negative results. Mixtures of the eggs of *O. edulis* with the milt of *O. angulata* and *vice versa*, never resulted in fertilization, although the experiments were repeated at different times for the last two years.

M. Bouchon-Brandely succeeded in artificially fertilizing eggs of *O. angulata*. The vital properties of both elements were retained for two to three hours. The embryos began to swim at Verdon in seven hours. The shell was formed on the sixth to the seventh day. The temperature of the water was 22 deg. C. (equal to about 71 deg. Fahr.). The artificial fecundation presented no difficulties. Four times out of five, if good

spawn is used, mobile embryos will be produced. The spawning takes place in *O. angulata* for several weeks and gradually.

"An inclosure about thirty-five feet square was prepared at Verdon, into which the animated products of successive fecundations were poured. The sea water was permitted to enter this space through a bed of fine sand, and to pass out in the same way. This enabled the experimenter to retain the artificially spawned embryos within the inclosure. After a month of reiterated experiments our endeavors were crowned with success. We had the satisfaction of finding some brood fixed on each of the tiles placed in our experimental 'clear.' This is so much the more remarkable as until last week [this appears to have been in July] no spat had yet attached itself to the numerous collectors immersed on the oyster beds of the Gironde; that is to say, in the very center of the clear."

Mr. Ryder, commenting on these experiments, justly claims that they are of the highest interest and may be of great practical value, especially the means resorted to in order to prevent the escape and loss of the embryos from the clear or pond. The Virginian oyster is related physiologically as well as morphologically to the Portuguese species, and what could be done for the one could doubtless be accomplished for the other.

Mr. Ryder turned his special attention to the American form. During the past season he found, after opening the animal carefully, that it is easy to remove the ova and milt from the female and male by stroking the generative ducts towards their outlet, when the products can be picked up with a pipette or "medicine dropper" and transferred to water free from extraneous matters of every kind. He also found that when the milky mass is dropped into water the character of the cloud of particles produced in the water at once diagnoses the sex of the individual from which the spawn has been obtained. If the animal be a male the cloud produced upon stirring breaks up into wisps and streaks, which resemble the cirrus clouds or mare's tails of meteorologists. If the specimen be a female the spawn when dropped into the water immediately breaks up into a distinctly granular cloud. These differences are so marked that any person may be taught to recognize them in a few minutes. The new method of removing the spawn and milt from the reproductive organs insures greater success in impregnation. Ninety per cent. of the eggs may be fertilized by the new method, a result scarcely possible with the usual plan of chopping up the reproductive organs. This method, together with the mode of discriminating the sexes without the use of a microscope, puts us in a fair way to realize some part of a scheme of artificial propagation.

Mr. Ryder also ascertained the nature of the collapse and shrinking of the oyster body about the end of the breeding season. It is due to a total atrophy or wasting away of the reproductive organs at the completion of the spawning season. The whole of the connective tissue sub-

jaacent to the mantle, and between the latter and the liver, disappears, together with all traces of the reproductive organs, ducts and all. "At the first bend of the intestine there is still some of the connective tissue remaining, but even here and in the mantle it has changed its character entirely, and become very spongy and areolar, instead of solid, and composed of large vesicular cells, such as are met with when the animal is in a better condition of flesh. In fact, it appears as if this mesenchymal or connective tissue substance had been used up and converted into reproductive bodies—generative products—in the case of the spawn-spent and extremely emaciated individuals. In sections from individuals in various conditions, from that in which the rudimentary network of generative tubules has just appeared in the connective tissue, on up to those in which the reproductive tissues are enormously developed in bulk and proportion to the mass of the remaining structures, there is a perfect gradation from their complete absence to their full development. This would appear to be very strong evidence in support of the theory that the reproductive follicles or tubules are developed anew each season directly from the specialization of certain strings or strands of connective tissue cells."

Mr. Ryder adds that many animals manifest a periodic development of the glandular portions of the reproductive organs, but he knew of no form in which there is any such presumptive evidence that these organs are annually regenerated and finally altogether aborted as seems to be the case with the oyster. "Together with the changes here described, the most remarkable changes in the solidity and consistence of the animal take place. The shrinkage of a spawn-spent oyster in alcohol or a chromic acid solution is excessive, and will, when complete, reduce the animal to one-tenth of its bulk while alive. This shrinkage is due to abstraction of the water with which the loose, spongy tissue of the exhausted animal is distended. A so-called 'fat' oyster, on the other hand, will suffer no such excessive diminution in bulk when placed in alcohol or other hardening fluid. In consequence of this variable development of the reproductive organs as well as that of the connective tissue of the body mass, the amount of solid protoplasmic material contained in the same animal at different times must vary between wide limits. And inasmuch as the nutritive and reproductive functions of animals are notoriously interdependent, it follows in consequence of the enormous fertility of the oyster that a vast amount of stored material in the shape of connective tissue must be annually converted into germs and annually replaced by nutritive processes. Plenitude or dearth of food are also to be considered, but it now becomes a little easier to understand the physiological interdependence of the reproductive function and the so-called fattening process.

"The widespread belief in 'fat' and 'poor' oysters is simply a widespread delusion, if it be maintained that fleshy oysters owe their rotundity to a deposit of oleaginous or fatty matter. Far from deny-

ing that there is absolutely no fatty matter in these mollusks, I do most emphatically deny that the winter plumpness of the animal is due to such a cause, but rather to large accumulations of protoplasmic matter of a soft, slimy consistency, identical with the more substantial parts of the higher animals. This popular error in regard to the true cause of the plumpness or leanness of the oyster, as the case may be, is only another illustration," adds Mr. Ryder, "of the very many erroneous ideas of the intensely practical multitude who decry scientific methods, which are after all only very rigorously exact common sense methods under another name."

The much-mooted question as to the cause of the green color of some oysters was also inquired into by Mr. Ryder.

His investigations of green oysters confirmed a former conclusion reached by him—that the color was due to a tincture of the blood cells either derived from green vegetable food or possibly by an effect of certain food upon the secretions of liver which have changed in color. The greened blood cells accumulate in some cases in the interstices of the muscular trabeculæ of the ventricle, and are sometimes even packed down behind the auriculo-ventricular valves so as to impede their action. They apparently lose their amoeboid disposition to a great extent. "This amoebal character of the blood-cell of the oyster is very striking, and may continue to exhibit itself in the living blood-corpuseles for four hours after their removal from the animal. The cysts filled with green cells are simply points in the pallial vessels which have been distended by these abnormal accumulations. The greenish cells and blood corpuseles are of about the same size, or about 1-3,000th of an inch in diameter. They are evidently not parasitic; none were ever seen to present anything like an appearance of commencing fission."

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Rhodope a Nudibranchiate.

Many years ago a small worm-like animal was described by Kölliker under the name *Rhodope Veranii*, and approximated by him to the Nudibranchiate Mollusks, and it has been there retained by several malacologists. Some doubt has been entertained as to its relationships, however, and the same type was redescribed as *Sidonia elegans*, and referred by Schultze to the Turbellarian worms. Recently the species has been re-examined by Professor Graff, and according to that naturalist it differs from the Turbellarians by its central ganglia, its sensory apparatus, its generative organs, and the anus, and in these respects most resembles the Nudibranchiate Gastropods. Nevertheless it is devoid of a buccal mass and odontophore, as well as gills. Although retained in the order of Nudibranchiates, it is therefore regarded as the lowest term of that series. It is considered to be a derivative from a generalized Rhabdocœlid stock named "Alloiocœla"—a conclusion which some may doubt until its embryology is known, and that may be required even to prove its pertinence to the Nudibranchiates.

A new family of American Gastropods.

Ten years ago, in the Canadian Naturalist, certain small shells found in Postpliocene deposits of Canada were described by Dr. P. P. Carpenter as representatives of a new generic type, *Choristes elegans*. This form has been found living by attachés of the U. S. Fish Commission in deep water (225 fathoms) off Martha's Vineyard, and an examination of its structure has caused Professor Verrill to differentiate it as a peculiar family type—the Choristidæ. These are Tectibranchiates with a thick short head; large retractile pharynx; well-developed jaws; an

odontophore, with three rows of rhaelidian teeth, and on each side a broad bilobed inner lateral, and two rows of small, hook-shaped outer lateral teeth ($1.1 + 1.2 \times 2$); with frontal tentacles, united by a fold and small posterior tentacles, and with a heliceiform shell provided with a paucispiral operculum.

Although the living shells have been referred to the same species as the fossilized, they have been distinguished as a variety (named *tenera*), inasmuch as they have a "much thinner and more fragile texture," but this difference, it is suggested, "may be due to mere local conditions."

It should be added that the gills of the *Choristiids* are "large, attached to the inner surface of the mantle on the left side of the neck, and extending over to the right side, consisting of numerous lamellæ. (*Proc. U. S. Nat Mus.*, v. 5, p. 337.)

A new deep-sea family of Docoglossates.

The family Cocculinidæ has been proposed for two limpet-like mollusks, of deep water, exhibiting a peculiar combination of characters. The two are congeneric, representing a new genus called *Cocculina*, and belong to the order of Rhipidoglossa. The dentition is typical—50–150 ($1 + 3$) I ($3 + 1$) 150–50—and resembles that of the Fissurellidæ and Helicinidæ; but there is only a single asymmetrical gill, no appendages to the side of the foot or on the mantle are developed, and the shell is patelliform, unfissured, uniserrated, and entirely external. The species have been found at the depth of over 100 fathoms east of the New England coast, and in deeper water in the Caribbean Sea.

A new deep-sea family of Fissurelloid Rhipidoglossates.

The family Addisoniidæ has been constituted for the reception of a remarkable limpet-like Gastropod found about 75 miles south and west from Martha's Vineyard, at a depth of from 96 to 130 fathoms. The mollusk belongs to the order of Rhipidoglossa, but has a very peculiar dentition, viz, $1 (1 + 2 + 2)$ I ($2 + 2 + 1$) 1—the single uncini being flat and scale-like. The parts are very asymmetrical, and there is an enormously developed lateral series of separately inserted gill-laminæ, like those of the Patellidæ, but no filamentary appendage of any kind. The shell is asymmetrical and porcellanous. The type is interesting as being a generalized—or what would have been called by Agassiz a "synthetic"—form. The species has been named *Addisonia paradoxa*.

The Pseudomarginella.

In the annual report of the Smithsonian Institution for the year 1880, a notice of a preliminary article by Dr. Justus Carrière on *Marginella glabella* and *Pseudomarginella* was given. Dr. Carrière claimed to have found in shells having the aspect of "*Marginella glabella*" animals exhibiting three very different types of dentition. It was then supposed by the reporter that the statement that the shells associated with the

several animals would be regarded by a conchologist as *Marginella glabella* was to some extent figurative and intended to convey an idea of a similarity which strongly contrasted with the dissimilarity of the animals. During the past year a full monograph of the several forms has been published by Dr. Carrière. It now appears that the shells are actually undistinguishable *specifically* from each other, and unless special attention was called to them, a conchologist would unhesitatingly consider them to be of the same species. Let it be remembered that the shell of "*Marginella glabella*" is very characteristic in form as well as color, and the difficulty of believing that such a species of shell may be developed by animals of three different families of mollusks may be understood. It will be much more credible that Dr. Carrière has been imposed upon, and that the animals of other shells have been skillfully transferred into emptied shells of *Marginella glabella* than to believe that such an anomaly as has been alleged should occur in nature. Dr. Carrière's good faith cannot be impugned, but there is too much reason to fear that he has been made the victim of a hoax or perhaps a deliberate fraud. Dr. Carrière has well summarized the alleged facts in a tabular form, which is herewith literally translated. The data purport to be the result of examination of eleven specimens, six of which had a marginelloid animal and the others operculigerous ones.

Animal.	Shell.	Foot.	Operculum.	Tentacles.
<i>Marginella glabella</i>	<i>Marginella glabella</i> .	Broad and flat, narrowed backwards, red.	Wanting	Long, attenuated.
<i>Pseudomarginella leptopus</i> .	<i>Marginella glabella</i> .	Narrow and high, uniformly wide, colorless, on the side black spots.	Unguiculate, like that of <i>Fusus</i> .	Short, broad.
<i>Pseudomarginella platypus</i> .	<i>Marginella glabella</i> .	Broad and flat, uniformly wide, colorless.	Lamellar, like that of <i>Purpura</i> .	Short, cylindrical

(Table—continued.)

Animal.	Radula.	Foot gland.	Family.
<i>Marginella glabella</i>	A single median, broad, and multidentate tooth.	Large in comparison with the foot.	Marginellacea.
<i>Pseudomarginella leptopus</i> ..	Lateral teeth, broader than the rachidian.	Very small	Buccinacea (probably).
<i>Pseudomarginella platypus</i> ..	Lateral teeth unguiculate, much narrower than the rachidian.	Very small	Purpuracea (probably).

It thus appears that (1) the same *species* of shell (using the word "species" in a literal sense) is repeated in the several types, and that (2) the several animals, exclusive of the shells, are strictly related to the numerous representatives of three widely differentiated families, and would be unhesitatingly referred to such families were it not for the shells. We are then called upon to decide which of two alternatives is

the more probable, (1) that the same species of shell is developed by *three* family types which otherwise have the hard and soft parts duly co-ordinated, or (2) that the animals have been dissociated from their own shells, and in some way or other been thrust into shells of *Marginella glabella*. If the alleged facts of Dr. Carrière were established, no certainty could be enjoyed in either morphology or palæontology. It is noteworthy, finally, that there is no co-ordination between the opercula or animals of the pseudomarginellæ and the shells.

CEPHALOPODS.

General.

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Digestion.

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Ink-bag.

- Girod (P.) Recherches sur la poche du noir des céphalopodes des côtes de France Avec 5 pl. Archiv. Zool. Expériment., t. 10, pp. 1-100; Abstr. in Journ. R. Microsc. Soc. London (2), v. 2, pp. 487-489.

The major groups of Cephalopods.

The Cephalopods are of peculiar interest on account of the intense morphological specialization of the members, their range in time and space, and the geological history of the group. Within a short period much has been contributed to a better understanding of the class by Messrs. A. Hyatt, Munier-Chalmas, Broch, Paul Fischer, and especially A. E. Verrill. The taxonomic rank of the Cephalopods as a class may be considered to be established and undisputed, and equally certain is it that all the living forms are perfectly segregable into two primary sections of the value of orders at least. These groups were first correctly defined and named Tetrabranchiata and Dibbranchiata by Professor Owen in 1838, but were earlier recognized and denominated Tentaculifères and Acétabulifères by Ferussac and d'Orbigny in 1834. But there are numerous extinct Cephalopods as to whose affinities there are still some doubts. For a long time they were supposed to be closely related to the Nautilids, and consequently to be Tetrabranchiates; such are the Ammonites and kindred forms. But Professor Agassiz nearly twenty

years ago urged that they were ordinarily distinct from both the Tetrabranchiates and Dibbranchiates, and distinguished them as the order of Ammonoids, and was followed therein by Professor Hyatt, and M. Munier-Chalmas, in 1874, even considered them to be nearer the Dibbranchiates than to the Tetrabranchiates. Recently M. Fischer has acceded to the view that they represent an order ("Ammonea"). As to the further subdivision of the class, the Dibbranchiates are with one accord divided into two groups (generally called suborders) distinguished by the development or want of two unusually elongated tentacular arms inside the circle of eight sessile arms common to all the order. Those forms with tentacular arms (Decaceres or Decapods) have an elongated body, with lateral fins, and an internal "shell" or "gladius"; those without the corresponding arms have a roundish sacciform body and are destitute of an internal shell, and are known as Octopods.

The families of Ammonoids.

The "order Ammonea" or Ammonoids is primarily subdivided by Fischer into (1) the Retrosiphonata, in which the partitions are infundibulate backwards around the siphon, and (2) the Prosiphonata, whereof the perisiphonal infundibulation is advanced forwards. The Prosiphonata are by far the most numerous, and were mostly formerly confounded under the generic name Ammonites; they represent, however, a number of families which have been segregated into two major groups, (a) the Aptychidea, which have an "aptychus" composed of two calcareous pieces free or consolidated, and (b) the Anaptychidea, which are destitute of an aptychus, or at least of a calcareous one. The families admitted are the following:

A. Retrosiphonata (*Goniatitidae*).

B. Prosiphonata a. Anaptychidea. Section 1. Latisellata.—(*Arcestidae*, *Tropitidae*, *Ceratitidae*, *Olydonitidae*). Section 2. Angustisellata.—(*Pinacoceratidae*, *Amaltheidae*, *Ammonitidae*, *Lytoceratidae*). b. Aptychidea (*Harpoceratidae*, *Stephanoceratidae*).

Some American palæontologists, especially Professor Hyatt and the late Professor Agassiz, have admitted still more numerous families, and for other reasons.

Families of Tetrabranchiates.

M. Fischer has admitted only three families of Tetrabranchiates in his recent classification of the Cephalopods—the prosiphonate Nothoceratids and the retrosiphonate Nautilids and Ascoceratids. The Nautilids include all these forms with the partitions perpendicular to the axis of the shell, and the Ascoceratids, those whose partitions are very oblique and become even subparallel to the axis. In fine, his arrangement is presented in the following manner:

A. Prosiphonata (*Nothoceratidae*).

B. Retrosiphonata (*Nautilidae*, *Ascoceratidae*).

It will be thus seen that the growth of the shell, whether in a spiral or other curve or even straight, is not only subordinated to other characters (and undoubtedly with propriety), but is ignored as a family character.

The families of Decacerous Dibranchiates.

The suborder of Decacerous or Decapod Cephalopods has been generally differentiated into two primary groups—(1) the “Oigopsidæ,” reputed to have the “eyes naked in front, furnished with free lids, with or without an anterior sinus; pupils circular,” and (2) the “Myopsidæ,” contradistinguished by “eyes covered by transparent skin, sometimes with a thickened fold, forming a lower lid, pupils crescent-shaped.” It has been doubted, however, whether undue value has not been attached to such distinctions, although their importance, to a greater or less extent, has been admitted. During the past year several modifications have been proposed.

Mr. Tryon divided the Decaceres into (a) Decapoda chondrophora and (b) Decapoda calcifera.

Professor Steēnstrup adopts the groups Oigopsidæ and Myopsidæ, and attaches importance next to the particular arm of the male which is hectocotylized. He recognizes two series of Myopsids, which he calls “families,” viz, (1) the “family of Rossia-Sepiola=Sepiolini,” of which an arm of the *first* part is hectocotylized, and (2) the “family of Sepio-Loligini,” whereof the arm of the *fourth* pair is hectocotylized; the latter is subdivided into the groups (a) Loliginei, (b) Eusepii, (c) Sepiadarii, and (d) Idiosepii.

Dr. Fischer attaches primary importance to the nature of the internal dorsal support or skeleton dividing the suborder into (1) Chondrophora, (2) Sepiophora, and (3) Phragmophora. The Chondrophora are subdivided into the “sections” Oigopsidæ and Myopsidæ.

Professor Verrill admits the groups of d’Orbigny, but adds that they are, “perhaps, more convenient than natural,” and he subdivides the (1) Oigopsidæ into two superfamilies, the Teuthidea and Taonidea, and the (2) Myopsidæ into two also, the Sepidea and the Sepiollidea, but suggests that the Spirulidæ (provisionally referred to the Sepidea) “might, perhaps, be best placed with several fossil forms in a division of which it is the sole surviving genus.”

The extent to which the several characters referred to coincide or traverse each other may be appreciated from the diagnoses of the several families, which have been chiefly condensed from Professor Verrill’s catalogue, etc.

A. TEUTHIDOIDEA.—Decaceres with eyes naked in front, with free lids, and not protuberant; with a subterminal valve to siphon, and with the mantle attached to the siphon by free *connective cartilages*.

1. *Onychoteuthids*.—Teuthidoid Decaceres with free arms, with lachrymal sinuses; siphon valviferous, well developed nuchal crests, and ten-

tacular arms clavigerous and armed with horny claws or hooks, and with "a cluster of small, smooth-rimmed suckers" about the tips.

2. *Ommastrephids*.—Teuthidoid Decaceres with free arms, with lachrymal sinuses, valviferous siphon, nuchal crests, and clavigerous clawless tentacular arms "having four rows of suckers" about the middle of the "club."

3. *Mastigoteuthids*.—Teuthidoid Decaceres with free arms, without lachrymal sinuses, with a valviferous siphon, without auditory crests, and with tapering tentacular arms "covered with a multitude of minute suckers, in many rows," towards the ends.

4. *Chiroteuthids*.—Teuthidoid Decaceres with free arms, with lachrymal sinuses, with a small siphon destitute of valve or dorsal bridle, without nuchal or auditory crests, with very elongated clavigerous arms, tipped "with a spoon-shaped organ, opening backward" and "with rows of singular small suckers, having a swollen bulb on the long pedicel" on the "club," buccal membrane seven-angled, and with six buccal aquiferous openings.

5. *Histioteuthids*.—Teuthidoid Decaceres with the six upper arms connected by a very extensive web, without lachrymal sinuses, a siphon without valve or dorsal bridle, without nuchal crests, long clavigerous tentacular arms "bearing large central, and small marginal suckers and tubercles," buccal membrane "with six smooth lobes," and with four buccal aquiferous openings.

B. TAONOIDEA.—Decaceres with eyes naked and free-lidded, and very prominent, without a true subterminal valve to siphon, and with the mantle united to the base of the siphon as well as the back of neck by three *muscular commissures*.

6. *Desmoteuthids*.—Taonoid Decaceres with the body much elongated, the siphon "with three peculiar special thickenings, or raised processes, in its basal portion."

Several other families of Myopsid Decaceres are found outside the limits of Professor Verrill's field of investigation, but their place in the system has not been determined as exactly as is desirable. Those which have received names are the Lorigopsidæ, Cranchiidæ, and Thysanoteuthidæ.

C. SEPIOIDEA.—Decaceres with eyes covered by transparent skin and lidless, arms of the fourth pair hectocotylized, and with an internal flattened calcareous gladius (sepiostaire or cuttle-fish bone).

7. *Sepiids*.—The only known sepoid decaceres, and which furnish the "cuttle-fish bone" of commerce.

D. LOLIGINOIDEA.—Decaceres with eyes covered by transparent extension of the cephalic integument and lidless, arms of the fourth pair hectocotylized, and with an internal corneous gladius.

8. *Loliginids*.—The only known American family.

E. SPIRULOIDEA OR PHRAGMOPHORA.—Decaceres with eyes covered

by transparent skin and lidless, arms of the fourth pair hectocotylized, and with an internal chambered shell or phragmacone.

This superfamily includes only one living family, but the extinct Belemnitids, Belopterids, and Belosepiids have been associated with it as constituents of a natural superfamily group.

9. *Spirulids*.—Spiruloid Decaceres with the internal shell or phragmacone, an elongated chambered cone, wound in a loose coil of several whorls.

This family is only represented, so far as known in the existing fauna, by the genus *Spirula*, whose shell is so well known to all collectors, but Professor Steenstrup has associated in the same family with it a genus named *Idiosepius*. *Idiosepius* is destitute of a shell, but has a tendinous support which is regarded as the homologue of the shell, as well as the gladius of *Loligo*.

F. SEPIOLOIDEA.—Decaceres with eyes covered by a transparent skin, but with false eyelids more or less free, arms of the first pair hectocotylized, and with the gladius corneous and rudimentary, or absent.

10. *Sepioids*.—The only known sepioloid decaceres.

The families of Octopod Dibranchiates.

The octopods in late years have been generally segregated into two principal groups, (1) the pelagic, including the Argonautids and Philonexids, and (2) the littoral, embracing the Octopodids and Cirrhotentidids. But M. Fischer has proposed to differentiate them into two groups, distinguished by the development of one or more rows of suckers, the "Cirrhotenthidæ" and "Eledonidæ" having one row ("monocotylea"), and the Octopodidæ, Tremoctopodidæ (Philonexids), and Argonautidæ having two or three ("polycotylea"). Professor Verrill has made known a "new" family (Alloposidæ), and admits the following:

Argonautids.—Octopods with an ovoid finless body, the two uppermost arms (in female) expanded terminally into broad flattish velamenta which secrete a papery spiral single-chambered involute nautiliform shell.

The family is specialized by the development of a shell, which serves as an ovicapsule in the female. The male is very much smaller.

Philonexids or *Tremoctopodids*.—Octopods with ovoid finless body, tapering arms moderately connected by membrane, and "edge of mantle united to the base of the siphon laterally by a button-like cartilage fitting in a corresponding pit on the inner surface of the mantle."

Alloposids.—Octopods with ovoid finless body, tapering arms connected by a moderate web, and mantle "united directly to the head, not only by a large dorsal commissure, but also by a median ventral and two lateral longitudinal commissures, which run from its inner surface to the basal parts of the siphon."

This family has been constituted by Professor Verrill for a single species (*Alloposus mollis*) discovered by Lieutenant Tanner, under the

auspices of the United States Fish Commission, in deep water (225 to 715 fathoms), in several places near the eastern coast.

Octopodids.—Octopods with an oval finless body, tapering arms little connected by membrane, and “mantle united to the head by a broad dorsal commissure,” and without complex connection with the siphon.

The family is again subdivided by M. Fischer into two, (1) the Octopodidæ with two or more rows of suckers, and (2) the Eledonidæ with a single row of suckers. The common littoral cuttle-fishes are representative of the family.

Cirrhoteuthids.—Octopods with a rather long body, provided with short lateral fins (one on each side), supported by internal cartilages, and “arms united nearly to the tips by a broad, umbrella-shaped membrane or web.”

The umbrella-shaped anterior end is the most obvious characteristic.

It is always an arm of the third pair—generally the right, but sometimes the left—that becomes hectocotylized in the male, the hectocotylization varying in extent from the entire arm to the tip only.

Gigantic Cuttle-fishes.

In the last account of progress in zoology reference is made to Professor Verrill's studies of the gigantic cuttle-fishes, and it was stated that two specimens of *Architeuthis*, the genus including the giants of the class, had been found 52 feet long. But huge representatives of the class have been found elsewhere than the North Atlantic Ocean, and have been found to differ materially from the type of the genus *Architeuthis*, although apparently not as much as has been supposed.

Professor Verrill has reviewed the conclusions formulated by Professor Owen, in his “Descriptions of some new and rare Cephalopods.” The *Enoploteuthis Cookii* of Owen is the *Sepia unguiculata* of Molina (1810), and *Enoploteuthis molina* of D'Orbigny (1845-'48), and “it is not improbable” that it is also specifically identical with the *Enoploteuthis Hartingii* of Verrill (1880). The *Plectoteuthis grandis* of Owen is unquestionably an *Architeuthis*, and the *Ommastrephes ensifer* is a *Sthenoteuthis*, and probably the same as the *S. pteropus* of Bermuda. (A. J. S. (3), v. 23, pp. 72-75.)

The host of giant cephalopods has also been added to from New Zealand. Mr. T. W. Kirk has described two from that region under the names *Architeuthis Verrilli* and *Steenstrupia Stockii*. No generic differences have been signalized between the two, and Professor Verrill would refer the so-called *Steenstrupia* to *Architeuthis* “without much hesitation, though the tentacular clubs, if known, might show some differences.” The species, however, “bear more resemblance to the small squids, *Ommastrephes* and *Loligo*, than do the other large species hitherto discovered.” The *A. Verrilli* had a length for head and body of 9 feet 1 inch, and the tentacular arms were 25 feet long. The *A. Stockii*

was correspondingly 11 feet 1 inch long, but the arms were shorter than in the *A. Verrilli*. (Trans. New Zealand Inst., v. 14; A. J. S. (3), v. 24, p. 477.)

X. PROTOCHORDATES.

TUNICATES.

General.

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- McMurrich (J. Playfair). On the origin of the so-called "Test-cells" in the Ascidian ovum. With 1 pl. Studies from the Biolog. Laborat. Johns Hopkins Univers., v. 2, pp. 147-156.
- Seeliger (Osw.). Zur Entwicklungsgeschichte der Ascidien. Eibildung und Knospung von *Clavelina lepadiformis*. Mit 3 Taf. Sitzgsber. kais. Acad. Wien, math-nat. Cl., 1. Abth., 85. Bd., pp. 361-413.

Larvalia.

- Lankester (E. Ray). The Vertebration of the Tail of *Appendicularia*. Quart. Journ. Microsc. Se., v. 22, pp. 387-390.

Taniobrauchiates.

- Brooks (W. K.). On the development of the ova in *Salpa*. With 1 pl. Stud. Biolog. Laborat. Johns Hopkins Univers., v. 2, pp. 301-313.
- Grobben (Carl). Doliolum und sein Generationswechsel, nebst Bemerkungen über den Generationswechsel der Acalephen, Cestoden und Trematoden. Mit 5 Taf. Arbeit. Zoolog. Instit. Wien., 4. Bd., pp. 201-298.

Saccobranchiates.

- Transtedt (M. P. A.). Vestindiske Ascidiæ simplices. 1. Afd. (*Phallusidæ*) tilligemed indledende Bemærkninger om Skjærheden hos Ascidiæ simplices i Almendelighed. (Med 2 tavl.) Vid. Meddel. Nat. Foren. Kjöbenh., 1881, pp. 257-288.

The tail of Synascidian larva.

A new Synascidian generic type—*Disdapia*—has been made known by A. Della Valle, and the larva described. Inasmuch as one of the most cogent arguments in favor of the relation of the Ascidians to the Protovertebrates is based on the development of a vertebrated tail in the early stage, what Della Valle has to say with reference to that of *Disdapia* is of general interest. The tail presents "an envelope of cellulose, with amœboid nuclei, a membrane continuous with the ectoderm, which is formed of large, flattened epithelial cells, a contractile layer of fusiform cells which are transversely striated, and the axis of the tail, which is more transparent than the rest, and is occupied by the hyaline cylinder, which is, according to some, a solid cartilaginous notochord. The author, however, like some other writers, finds that this axial structure is a hollow tube, the wall of which is continuous with that of the peritoneal sac." (J. R. M. S., (2), v. 2, p. 768, from Arch. Ital. de Biol., 1882, t. 1, pp. 193-203.)

Cycles of Tunicates.

The cycles of development of various types of Tunicates has been presented in a convenient tabular synopsis by Dr. Carl Grobben, in

which "A" represents a sexual generation, "B" an asexual one, "M" the median, and "L" the lateral buds:

Synascidite.	Pyrosoma.	Salpa.	Doliolum.
<pre> AB / \ B AB / \ / \ AB B AB AB </pre>	<pre> AB / \ B AB / \ / \ AB B AB AB </pre>	<pre> A B A </pre>	<pre> A B / \ [A] L M A </pre>

XI. VERTEBRATES.

General.

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Mela (A. J.). Vertebrata Fennica, sive Fauna animalium vertebratorum regionis Fennicæ naturalis. Suomen Luurankoiset, eli Luonnontietoellisen Suomen Luurankois-Eläinistö. Helsingissä (Helsingfors), Holm, 1882. (8vo, xi, 386 pp. 10 pl.)

Teeth.

Baume (Rob.). Odontologische Forschungen. 1. Th. Versuch einer Entwicklungsgeschichte des Gebisses. Mit 97 Holzschn. 1882 (8vo, vii, 307 pp., M. 13.); 2. Th. Die Defecte der harten Zahnsubstanzen. Mit 55 Holzschn. Leipzig, A. Felix, 1882. (8vo. M. 8.)

Nervous system.

Stilling (J.). Untersuchungen über den Bau der optischen Centralorgane. 1. Theil. Chiasma und Tractus opticus. Mit 10 lith. Taf. Kassel und Berlin, Th. Fischer, 1882. (4to., vii, 87 pp., 10 Bl. Tafelerkl. M. 24.)

FISH-LIKE VERTEBRATES.

Nervous system.

Cattie (J. Th.). Recherches sur la glande pinéale (Epiphysis cerebri) des Plagiostomes, des Ganoïdes et des Téléostéens. Avec 3 pl. Archiv. de Biolog., t. 3, pp. 101-194.

Electric organs.

Du Bois Reymond (Emil). Vorläufiger Bericht über die von Prof Gustav Fritsch in Aegypten angestellten neuen Untersuchungen an electrischen Fischen. Monatsber. k. Akad. Wiss., Berlin, 1881, pp. 1149-1164, 1882.

Eye.

Berger (E.). Beiträge zur Anatomie des Sehorgans der Fische. Mit 2 Taf. Morphol. Jahrb., 8. Bd., pp. 97-168.

*Faunas.**(North America.)*

- Bean (Tarleton H.). Notes on Fishes collected by Capt. Chas. Beudire, in Washington Territory and Oregon, May to October, 1881. Proc. U. S. Nat. Mus., v. 5, pp. 89-93.
- Jordan (David S.) and Charles H. Gilbert. Catalogue of the Fishes collected by Mr. John Xantus, at Cape San Lucas, which are in the U. S. National Museum, with descriptions of eight new species. Proc. U. S. Nat. Mus., v. 5, pp. 353-371.

(Asia.)

- Károli (János). Prodrömus Piscium Asiae orientalis a domino Joa. Xantus annis 1868-70 collectorum. Termész Füzetek, v. 5, pp. 147-187.
- Note.*—A nominal list of 625 species.

(Europe.)

- Day (Francis). The Fishes of Great Britain and Ireland. Part 4-5. London, Williams & Norgate, 1882. 8vo. v. 1, pp. 241-240, pl. 69-93; v. 2, pp. 1-96, pl. 94-106.
- Fatio (V.). Faune des Vertébrés de la Suisse. Vol. iv. Histoire Naturelle des Poissons. I. partie. Genève et Bâle, 1882. (8vo. 786 pp., 5 pl.)

(Africa.)

- Guimarães (Antonio Rob. Pereira). Lista dos Peixes da Maderia, Acores e dos possessões portuguezas d'África, que existem no museu de Lisboa. Supplemento. Journ. Sc. Math., Phys. e Nat. Acad. Sc. Lisb., v. viii, pp. 30-39.
- Rochebrune (A. T. de). Faune de Sénégambie. Poissons. Act. Soc. Linn. Bordeaux, t. vi. pp. 37-180, pl. 1-6.

(Australia.)

- Macleay (William). Descriptive catalogue of the Fishes of Australia. Proc. Linn. Soc. N. S. Wales (Sydney). Part 3, v. 6, pp. 1-138, pl. 1-2 (Sp. 544-801); Part 4, pp. 202-387 (Sp. 802-1133).
- — —. Contribution to a knowledge of the Fishes of New Guinea. Proc. Linn. Soc. N. S. Wales, v. 7, pp. 224-250 (Sp. 1-120); pp. 351-366 (Sp. 121-196); pp. 585-598 (Sp. 197-274).

Fossil fishes.

- Kramberger-Gorjanovic (Drag.). Die jungtertiäre Fischfauna Croatiens. 1. Theil. Beitr. z. Paläontol. Österr.-Ungarns von Mojsisovics und Neumayr, 2. Bd., 3. Hft., pp. 86-88; 2. Theil. *Ibid.*, 4. Hft., pp. 89-135.

Australian fishes.

A signal service has been done for ichthyologists by Mr. William Macleay, in his catalogue of Australian fishes. It appears therefrom that 1,133 nominal species (exclusive of many doubtless overlooked by him) are found in the waters that surround Australia and the neighboring islands, or which traverse its interior. This compares not unfavorably with the fish-faunas of other regions, and is not much inferior to those of the United States and the higher north, wherein about 1,500 species have been discovered. The proportions between the fresh-water and marine forms are very different, however, for the two hemispheres. The North American streams and lakes swarm with species,

and contribute well nigh 40 per cent. of the total, while Australia is exceptionally poor, and has a very small percentage of fresh-water fishes. Even the few fluviatile forms are ill understood, but it is not at all likely that any have intimate relations with types of the northern hemisphere, although several genera have been associated in a very heterogeneous group ("Grystina"), of which the Black Bass of America has been taken as a type. Another element that must be considered in a comparison of the respective faunas is the number of ill-defined and doubtful species that have been introduced into the southern fauna, and which Mr. Macleay has evidently been unable to examine and refer to their proper categories. But, making all such allowances, the marine fish-faunas of Australia are very rich, and the number of species surpass those of the North American marine regions. It is lamentable that many genera will have to carry, as long as the present rules of nomenclature prevail, names commencing with "Neo," an anachronism that neophytes in science and nomenclature might be expected to be guilty of, but which good naturalists have also shared, so misleading is a bad example.

The fresh-water types of Australia are more numerous than have been supposed. As recently as 1880, Dr. Günther only admitted 36 species, including therein two "brackish-water" forms, and only three peculiar generic types—*Ceratodus*, *Nannoperca*, and *Macquaria*. Mr. Macleay greatly increases the list. They are named and arranged by him as follows:

Percidæ.—*Lates* (5 of 8 sp.), *Breviperea* (1 sp.), *Bostoekia* (1 sp.), *Edeilia* (2 sp.), *Acanthoperca* (1 sp.), *Nannoperca* (2 sp.), *Gulliveria* (2 sp.), *Oligorus* (2 sp.), *Ctenolates* (properly *Plectroplites*, 3 sp.), *Murrayia* (4 sp.), *Riverina* (1 sp.), *Dules* (i. e., *Kuhlia* or *Moronopsis*, 1 sp.), *Macquaria* (1 sp.), *Therapon* (10 of 16 sp.).

Trachinidæ.—*Aphritis* (1 sp.).

Gobiidæ.—*Gobius* (several sp.), *Eleotris* (several sp.), *Aristicus* (4 sp.).

Blenniidæ.—*Blennius* (several sp.), *Cristiceps* (1 of 16 sp.).

Atherinidæ.—*Atherinichthys* (2 of 7 sp.), *Nematocentris* (i. e., *Melanotenia*, 1 sp.), *Neotherina* (1 sp.).

Mugilidæ.—*Mugil* (several sp.), *Agonostoma* (1 of 2 sp.).

Ophiocephalidæ.—*Ophiocephalus* (1 sp. ??).

Gadopsidæ.—*Gadopsis* (1 sp.).

Pleuronectidæ.—*Arnoglossus* (1 sp.), *Rhombosolea* (1 of 2 sp.), *Synaptura* (1 sp.).

Siluridæ.—*Plotosus* (3 sp.), *Copidoglanis* (1 of 4 sp.), *Neosilurus* (1 sp.), *Cainosilurus* (1 sp.), *Eumeda* (1 sp.), *Arius* (1 of 6 sp.).

Haplochitonidæ.—*Prototroctes* (1 sp.).

Salmonidæ.—*Retropinna* (1 sp.).

Galaxidæ.—*Galaxias* (17 sp.).

Cyprinidæ.—*Leuciscus* (?? 1 sp.).

Osteoglossidæ.—*Osteoglossum* (1 sp.).

Clupeida.—*Chatoessus* (2 sp.), *Clupea* (several sp.), *Brisbania* (1 sp.), *Megalops* (1 sp.).

Muraenida.—*Anguilla* (2 sp.).

—————.—*Ceratodus* (2 sp.).

—————.—*Ompax* (1 sp.).

Petromyzontida.—*Geotria* (3 sp.); *Yarra* (1 sp.).

The most noteworthy facts shown by this list are (1) the paucity of specialized fresh-water types, and (2) the affinity of the majority of the forms to marine types. The only known special fresh-water families are five—the Gadopsids, the Haplochiitonids, the Galaxiids, the Osteoglossids, and the Ceratodontids—and each of these is represented by only one or two species, except the Galaxiids, of which 17 have been found. One Galaxiid, at least, occurs in the high mountainous streams. The affinities of most of the peculiar genera are quite uncertain. It is, however, almost certain that none of the species belong to the same families as the Northern Perches (Percids) and Black Bass (*Grystina* or Centrarchids). Although some of the forms enumerated may be regarded as anadromous or simply excursionists from the sea, many, although very closely related to sea-fishes, have evidently become true fresh-water forms. For example, in a collection later obtained by Mr. Macleay from “the head-waters of Palmer River, cut off by numerous falls from the lower part of the river,” were species of *Therapon*, *Eleotris*, *Aristæus*, *Synaptura*, *Neosilurus*, and *Chatoessus*. These are therefore claimed to be “fresh-water fishes in the strictest sense of the term.” (Proc. Linn. Soc. N. S. Wales, v. 7, p. 69; see also v. 3, pp. 15, 41, 140.)

Lest it may be deemed that there is an incongruity between the statement that there are only five fresh-water family types of Australian fishes and the family types indicated, it will be pertinent to add that the so-called Cyprinidæ are evidently not members of that family, and “*Ompax*” is only known from a figure drawn from memory by a person without any knowledge of ichthyology.

CLASS OF LEPTOCARDIANS.

Rohon (Jos. Viet.). Untersuchungen über *Amphioxus lanceolatus*. Ein Beitrag zur vergleichenden Anatomie der Wirbelthiere. Denkschr. d. math.-nat. Cl. Akad. Wien, 45. Bd. (64 pp.)

CLASS OF MYZONTS.

Dohrn (Anton). Studien zur Urgeschichte des Wirbelthierkörpers. III. Die Entstehung der Hypophysis bei *Petromyzon Planeri*. Mittheil. Zool. Station zu Neapel, 4. Bd., pp. 172-189, pl. 18.

———. Die Entstehung der Hypophysis bei *Petromyzon Planeri*. Zool. Anz., 5. Jahrg., pp. 587-588. (Nature, v. 27, p. 91.)

Rohon (Jos. Viet.). Ueber den Ursprung des Nervus acusticus bei *Petromyzonten*. Mit. 2 Taf. Sitzgsber. Wien. Akad., Math.-nat Cl., 1. Abth. 85. Bd., pp. 245-267.

Development of the pituitary body of the Lampreys.

The pituitary body or hypophysis, it has been claimed by Dr. W. B. Scott, originates in a very peculiar manner in the Lamprey; but H. Mis. 26—39

so anomalous would be the origin alleged, the statement has been regarded with skepticism. Prof. Anton Dohrn has recently studied the subject, and he thinks "the question is solved" by him, but in a way different from what either Balfour or Scott supposed. "The hypophysis arises rather as an independent depression of the ectoderm between the depressions for the nose and the mouth. Its connection with the nasal depression is only secondary, and is caused by the strong and early development of the upper lip. It has no connection with the mouth depression, because the upper lip develops between the mouth depression and the hypophysis." (*Nature*, Nov. 23, 1882.)

CLASS OF SELACHIANS.

General.

- Hasse (C.). Das natürliche System der Elasmobranchier auf Grundlage des Baues und der Entwicklung ihrer Wirbelsäule. Unter Mitwirkung der Herren G. Born, H. Strasser und Ph. Stöhr. Besonderer Theil. 2.-3. Lief. Mit 28 Taf. Jena, G. Fischer, 1882 (4to).
- Koster (W.) and C. K. Hoffman. Rapport over eene Verhandeling van den Heer Dr. J. W. Van Wijhe, getiteld: "Ueber die Mesodermsegmente und die Entwicklung der Nerven des Selachierkopfes." Versl. en Mededeel. K. Akad. Amsterdam, 18. D. pp. 71-85.

Raiæ.

- DuBois Reymond (E.). On a new principle affecting the systematic distribution of the family of the *Torpedinidæ*. *Nature*, v. 26, p. 492.
- Weyl (Th.). Die Säulenzahl im elektrischen Organ von *Torpedo oculata*. *Centralbl. f. d. med. Wiss.*, 1882, No. 16.

Electric organ of the Torpedos.

The number of columns in the battery of the Torpedo fishes is of specific value, according to Prof. Du Bois Reymond. The eastern American species (*Torpedo occidentalis*) has a very large number, and by this character has been claimed as a British fish. Professor Babuchin, of Moscow, has demonstrated that the electric organs are developed by the metamorphosis of striated muscle, and that the columns do not increase in number with age, but by the growth of the individual columns.

CLASS OF FISHES PROPER.

Osseous system.

- Grassi (B.). Beiträge zur näheren Kenntniss der Entwicklung der Wirbelsäule der Teleostier. (Auszug.) *Morphol. Jahrb.*, 8. Bd., pp. 457-473.
- Kostler (M.). Ueber Knochenverdickungen am Skelette von Knochenfischen. Mit 1 Taf. *Zeitschr. f. wiss. Zool.*, 37. Bd., pp. 429-456.
- Rautenfeld (E. von). Morphologische Untersuchungen über das Skelet der hinteren Gliedmassen von Ganoiden und Teleostiern. Mit 2 Taf., u. 13 in den Text gedruckten Figuren. Inaug. Diss. Dorpat, 1882. (8vo., 47 pp., M. 150.)
- Stöhr (Phil.) Zur Entwicklungsgeschichte der Kopfskelets der Teleostier. Mit 1 Taf. *Festschr. z. Feier d. 300. jähr. Bestehens d. Jul. Max. Universität Würzburg*, 1882.

Visceral skeleton.

Wijhe (J. W. von). Ueber das Visceralskelet und die Nerven des Kopfes der Ganoiden und von *Ceratodus*. Mit 2 Taf. Niederländ. Arch. f. Zool., 5. Bd., pp. 207-320.

Nervous system.

Rabl-Rueckhard (C.). Zur Deutung und Entwicklung des Gehirns der Knochenfische. Mit 2 Taf. Arch. f. Anat. und Entwicklsgesch., 1882, pp. 111-137.

Eye.

Zelinka (Carl). Die Nerven der Cornea der Knochenfische und ihre Endignng im Epithel. Mit 2 Taf. Arch. f. mikroskop. Anat., 21. Bd., pp. 202-239.

Vascular system.

Kasem-Beck und J. Dogiel. Beitrag zur Kenntniss der Struktur und der Funktion des Herzens der Knochenfische. Zeitschr. f. wiss. Zool., 37. Bd., pp. 247-262, pl. 15, 16.

Kidneys.

Emery (Carlo). Études sur le développement et la morphologie du rein des poissons osseux. Avec 1 pl. Arch. ital. biol., t. 2, pp. 135-145.

Balfour (F. M.). On the nature of the organ in adult Teleosteans and Ganoids, which is usually regarded as the Head, Kidney, or Pronephros. Quart. Journ. Mic. Sc., n. s, v. 22, pp. 12-16, Jan., 1882.

Embryology.

Agassiz (Alexander). On the young stages of Osseous Fishes. Part III. With 20 pl. Proc. Amer. Acad. Arts and Sc., v. 17, pp. 271-303.

Gensch (Hugo). Das secundäre Entoderm und die Blutbildung beim Ei der Knochenfische. Mit 2 Holzschn.-Taf. Inaug.-Diss. Königsberg, Beyer in Comm., 1882 (8vo., 29 pp. M. 1).

Hoffmann (C. K.). Zur Ontogenie der Knochenfische. Fortsetzung. Mit 4 Taf. Naturkund. Verhandl. Akad. Amsterdam, D. 23. (60 pp.)

Hybridity.

Leuckart (Rudolf). Ueber Bastardfische. Berlin, Nicolaische Verlags-Buchhd., 1882. (8vo., 9 pp. M. 50.)

Fish poisons.

Thomson (Carl). Untersuchungen eines aus West-Africa stammenden Fischgiftes. Inaug. Diss. Dorpat (Karow), 1882. (8vo., 39 pp. M. 1.)

*Special orders.**Dipnoi.*

Beauregard (H.). Encéphale et nerfs crâniens du *Ceratodus*. Avec 1 pl. Journ. de l'Anat. et de la Physiol. par Robin et Pouchet, 17. Ann., pp. 230-242.

Haswell (William A.). On the structure of the Paired Fins of *Ceratodus*, with remarks on the general theory of the vertebrate limb. With 1 pl. Proc. Linn. Soc. N. S. Wales, v. 7, pp. 2-12.

(Rhomboganoidei.)

Balfour (F. M.) and W. N. Parker. On the Structure and Development of *Lepidosteus*. Proc. R. Soc. London, v. 33, pp. 112-119.

Parker (W. K.). On the development of the skull in *Lepidosteus* osseous. Proc. R. Soc. London, v. 33, pp. 107-112.

(Apodes.)

- Goode (G. Brown). Notes on the life-history of the Eel, chiefly derived from a study of recent European authorities. Bull. U. S. Fish Comm., v. 4, pp. 71-124.
- Hermes (O.). On the mature sexual organs of the Conger-eel (*Conger vulgaris*), with some observations on the male of the common eel (*Anguilla vulgaris* Flem.). Bull. U. S. Fish Comm., v. 4, pp. 126-130.
- Pauly (Aug.). Beitrag zur Anatomie der Schwimmblase des Aals (*Anguilla fluviatilis* Fl.). Dissert. (pro venia leg.). München, 1882. (8^c, 22 pp.).
- Weyenbergh (H.). Morphologische Aanteekeningen over de Proest-alen of Symbranchida. Met 1 pl. Periodico Zoolog., t. 3, pp. 278-308.

(Eventognathi.)

- Noll (F. C.). Ein achtunddreissigjähriger Karpfen. Zool. Garten, 23. Jahrg., pp. 225-234.

(Haplomi.)

- Hermann (Otto). *Umbra canina*. Mit 1 Taf. Termész. Füzetek, 5. Bd., p. 275.
- Károli (J.). *Umbra canina* Mars. Termész. Füzeték, 5. Bd., pp. 274-275.
- Walther (Johann). Die Entwicklung der Deckknochen am Kopfskelet des Hechtes (*Esox lucius*). Mit 2 Taf. Jena. Zeitschr. f. Naturwiss., 16. Bd., pp. 59-87.

(Hemibranchii.)

- Ryder (J. A.). Notes on the development, spinning habits, and structure of the four-spined Stickleback, *Apeltes quadracus*. Bull. U. S. Fish Comm., v. 4, pp. 24-29.

(Jugulares.)

- Emery (Carlo). Contribuzioni all' Ittiologia. [III. Aggiunte alla sinonimia e alla storia naturale dei Fierasfer; IV. Sulle cordizioni di vita di giovani individui del Tetragonurus Cuvieri.] Mittheil. zool. Station Neapel, 3. Bd., pp. 281-283.
- Parker (T. Jeffery). Connection of the air-bladder with the auditory organs in the Red Cod (*Lotella bacchus*). New Zeal. Journ. of Sc., v. 1, pp. 185-186.

The kidney of fishes.

The Ganoid and Teleost—that is, all true fishes—have in their larval stage “two very distinct excretory organs, viz, a pronephros or head-kidney, and a mesonephros or Wolffian body, which are usually separated from each other by a more or less considerable interval.” It has been contended that the pronephros is especially, and sometimes, even, as in *Lophius*, exclusively developed as the kidney in fishes; but prior to the discovery of the development of the pronephros, as well as mesonephros, “it was a matter of no very great importance to know whether the anterior part of the so-called kidney was a true excretory organ. In the present state of our knowledge the question is, however, one of considerable interest.” Professor Balfour, consequently, investigated the morphology of the organ in several types of fishes—the Sturgeon, Bony Gar, Smelt, Pike, Eel, and Angler. He was led to the conclusion that the pronephros becomes atrophied, and probably never persists in either the Ganoids or Teleosts, but “is always a purely larval organ, which never constitutes an active part of the excretory

system in the adult state." This conclusion, it is held, adds "probability to the view of Gegenbaur that the pronephros is the primitive excretory gland of the Chordata (*i. e.*, the Vertebrates and Tunicates); and that the mesonephros or Wolffian body, by which it is replaced in existing Ichthyopsida, is phylogenetically a more recent organ."

Echiodon and Tetragonurus commensal fishes.

Professor Emery, as new "Contributions to Ichthyology," has recorded the fact that the *Echiodon dentatus* (or *Fierasfer dentatus*) forces itself upon Holothurians as a guest, like the typical *Fierasfer*. A small specimen of the species was found in a *Holothuria nebulosa* at Naples in the summer of 1881.

Professor Emery also found three young specimens of *Tetragonurus curvieri* in the respiratory cavity of a large *Salpa* caught in the Gulf of Naples in the spring of 1880. It has been stated that young *Tetragonuri* also associate with Medusæ. (See Günther's Introduction to the Study of Fishes, p. 501.)

The electrical organ of the Electric Eel.

The electrical organ of the South American Electric Eel—*Electrophorus* (or *Gymnotus electricus*)—has been studied by Dr. G. Fritsch, and his results are described in the great work of Sachs and DuBois Reymond on that fish. That the electric organ is developed from striated muscle is evident, *inter alia*, from the fact that a common fascia surrounds the organ and inferior lateral muscles; the electric organ, in fact, is the modified superior muscle. It is also noteworthy that there is a remarkable variation in the number of electrical columns, a range between 50 and 100 occurring. The Electric Eel thus contrasts markedly with the Torpedo, in which the number of columns is constant for the species. (J. R. M. S. (2), v. 2, p. 602.)

Determining cause of the coastward movement of the Herring.

The movements of the Herring coastward, concerning which there has been so much speculation, is believed by O. J. Broch to result from the assemblage of the small animals on which it feeds in the summer and autumn. These animalcules live in immense numbers at or near the surface, and their distribution is supposed to be regulated chiefly by the predominant winds and currents. The course of the Herring toward the coast in the spawning season will therefore depend on the locality of the last feeding grounds.

Mortality among the Tile-fish.

The remarkable history of the Tile-fish closes, for the present, with an extraordinary climax. This fish, the *Lopholatilus chamaeleonticeps*, a species sometimes attaining a weight of 50 pounds, or even more,

remained unknown till obtained through the intervention of the United States Fish Commission in 1879. It was then found in great numbers at a depth of about 75 to 150 fathoms, and as it was so large and also savory, promised to become a species of considerable economical importance. But in 1882 a great mortality among fishes occurred in March, in the North Atlantic, chiefly on the borders of the Gulf Stream and southwest of St. George's Bank, extending at least from latitude 37° to 40° , and longitude 71° to $73^{\circ} 10'$. Numerous accounts of the phenomenon have appeared in the newspapers; but there is a deficiency of exact recorded data. It has been stated that a number of different kinds of fishes were affected, but from the imperfect indications it is at least probable that the Tile-fish was the principal sufferer. The fishes were seen floating upon the surface of the water, and various vessels sailed through miles and miles of them—in some places “fully fifty dead fish” occurring in an area equal to the cabin space of a vessel. Of course many hypotheses have been broached to account for the fatality, but they all lack foundation or require verification. The United States Commissioner of Fish and Fisheries has suggested that “it is possible, their appearance being almost concurrent with, or but slightly subsequent to, the great storm off George's Bank,” that this may have been in some way the cause of the mortality. In order to ascertain the effect of this mortality in the haunts of the Tile-fish, special search was made where it was formerly so abundant, but not a single specimen was obtained.

AMPHIBIANS.

General.

Peters (W.). Amphibien von Mossambique. Naturwissenschaftliche Reise nach Mossambique, 1842-48, etc. Zoologie. III. Berlin, 1882. (fol. Mit 28 color. und 5 schwarz. Taf. M. 80.)

Gradientia or Urodela.

Boulenger (George Albert). Catalogue of the Batrachia Gradientia s. Caudata and Batrachia Apoda in the collection of the British Museum. 2d ed. London, 1882. (8vo, viii, 127 pp., 9 pl.)

Gasco (F.). Les amours des Axolotls. Bull. Soc. Zool. France, 6. ann., pp. 151-162.

Parker (W. K.). On the Structure and Development of the Skull in the Urodeles. With 6 pl. Trans. Zool. Soc. London, v. xi, pp. 171-214.

Salientia or Anura.

Boulenger (George Albert). Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum. 2d ed. London. 1882, (8vo, xvi, 503 pp., 30 pl.—£1 10s.)

Peters (W.). Ueber Batrachier, insbesondere über die so eben veröffentlichte zweite Auflage des Catalogs der Batrachia salientia s. ecaudata des British Museum von Herrn G. A. Boulenger. Sitzgsber. Ges. nat. Fr. Berlin, 1882, pp. 60-62.

Yung (Émile). De l'influence des milieux physico-chimiques sur les êtres vivants: influence des différentes espèces d'aliments sur le développement de la grenouille (*Rana esculenta*). Arch. sc. phys. et nat., Genève (3), t. 7, pp. 225-261.

Number of Amphibians.

The last enumeration of the Amphibians by Mr. Boulenger shows that nearly a thousand species are known. Nine hundred and thirty-three species "are described" in the catalogues of the *Batrachia salientia*, *gradientia*, and *apoda* of the British Museum. The progress of our acquaintance since the commencement of the century with the Amphibians, so far as numbers at least are concerned, may be seen from the following tabular synopsis:

Amphibians.	Daudin. 1802-'3.	D. & B. 1842-'54.	B. M. 1850-'58.	Boul. 1882.
Gymnophidia.....	4	8*	9†	32
Gradientia.....	16	58‡	63‡	101
Salientia.....	75	164‡	283‡	800
	95	230	355	933

* Duméril & Bibron, 1842. † Duméril & Bibron, t. 9, 1854. ‡ Gray, 1850. § Günther, 1858.

The Apodal Amphibians.

The known apodal Amphibians do not exhibit sufficient differences among themselves to necessitate subdivisions of more than generic importance, and all have been retained in one family—the Cœciliids. Some, however, have "cycloid imbricated scales imbedded in the skin," and others are naked; some again have "eyes distinct or concealed under the skin," and in others the eyes are "below the cranial bones." Tentacles are developed between the nostrils and eyes, or below them, and their modifications of structure have afforded the means of defining a number of genera. Mr. Boulenger has admitted 11 genera, and recognizes 32 species; South America has 21 species, Africa 5, and India 5.

Families of Urodele Amphibians.

The families of Gradient or Urodele Amphibians admitted by Mr. Boulenger are much more comprehensive than those generally adopted by naturalists in the United States, who have accepted those established by Professor Cope. Only four are admitted, Salamandridæ (with four subfamilies), Amphiumidæ, Proteidæ, and Sirenidæ, and the characters employed to differentiate two of them at least appear to contrast strangely with those which are subordinated to them; thus, the Salamandrids and Amphiumids are only differentiated because the former have "eyelids developed" and the latter "no eyelids." The relations the Boulengerian families bear to the Copean may be seen from the following exhibit:

I. CADUCIBRANCHIATA Cope, = (Salamandridæ + Amphiumidæ B.) Gradients with "no gills in the perfect state, maxillaries present, both jaws toothed". (B.)

1 a. *Salamandrids* = Salamandridæ Salamandrinæ pt. B. Caduci;

branchiates with "palatine teeth in two longitudinal series diverging behind, inserted on the inner margin of two palatine processes, which are much prolonged posteriorly; parasphenoid toothless; vertebræ opisthocælian" (B), and with "no postfronto-squamosal arch or ligament". (C.)

1 a. *Pleurodelidids* = Salamandridæ Salamandrinæ pt. B. Caduceibranchiates with "palatine teeth in two longitudinal series diverging behind, inserted on the inner margin of two palatine processes, which are much prolonged posteriorly; parasphenoid toothless" (B.), and "with a postfrontal arch, sometimes ligamentous". (C.)

1 b. *Amblystomids* = Salamandridæ Amblystomatinae pt. B. Caduceibranchiates with "series of palatine teeth transverse or posteriorly converging, inserted on the hinder margin or posterior portion of the vomers; parasphenoid toothless; vertebræ amphicælian" (B.), and with "palatines not prolonged over parasphenoid, bearing teeth on the posterior portion". (C.)

1 b. *Hynobiids* = Salamandridæ Amblystomatinae pt. B. Caduceibranchiates with "series of palatine teeth transverse or posteriorly converging, inserted on the hinder margin or posterior portion of the vomers; parasphenoid toothless; vertebræ amphicælian" (B.), and with "palatines in contact prolonged over parasphenoid, bearing teeth on posterior external margin". (C.)

1 c. *Plethodontids* = Salamandridæ Plethodontinae B. Caduceibranchiates, with "series of palatine teeth transverse on posterior portion of vomers; dentigerous plates on parasphenoid; vertebræ amphicælian." (B.)

1 d. *Desmognathids* = Salamandridæ Desmognathinae pt. B. Caduceibranchiates with "series of palatine teeth transverse, on posterior portion of vomers; dentigerous plates on parasphenoid; vertebræ opisthocælian" (B.); with the parasphenoid teeth in two elongate patches, and with the tongue free laterally and behind.

1 d. *Thoriids* = Salamandridæ Desmognathinae pt. B. Caduceibranchiates, with "series of palatine teeth transverse, on posterior portion of vomers; dentigerous plates on parasphenoid; vertebræ opisthocælian" (B.); with the parasphenoid teeth in a single patch and with the tongue free all around and attached only by a central pedicel.

2. *Protonopsids* = Amphiumidæ pt. B. Caduceibranchiates without eyelids, with teeth on anterior margin of palatine bones; no dentigerous plates on parasphenoid; vertebræ amphicælian; "no anterior axial cranial bone;" parietals and prefrontals prolonged, meeting and embracing frontals; wall of vestibule membranous internally; premaxillaries separated; occipital condyles sessile; and with well-developed limbs.

2. *Amphiumids* = Amphiumidæ pt. B. Caduceibranchiates without eyelids, with teeth on the outer anterior margin of palatines, no dentigerous plates on parasphenoid; vertebræ amphicælian; "an axial cranial bone (? vomer) in front of orbitosphenoids, and one forming palatal sur-

face in front of palatines;" parietal prolonged laterally, not reaching prefrontals; vestibule wall osseous internally; premaxillaries consolidated; occipital condyles on cylindrical pedestal, and with rudimentary limbs.

II. PROTEIDA Müller, Cope. Gradients with "external gills persistent throughout life, maxillaries absent, intermaxillaries and mandible toothed;" palatine and pterygoid bones developed, and orbito-sphenoid elongate and not entering into palate (C).

3. *Proteids*. The only existing family with two genera—*Proteus* and *Necturus*.

III. TRACHYSTOMATA Müller, Cope. Gradients with "external gills persistent throughout life; maxillaries absent; intermaxillaries and mandible toothless;" palatines and pterygoids undeveloped, and orbito-sphenoids large, anterior and forming part of palate (C).

4. *Sirenids*. The only family with two American genera—*Siren* and *Pseudobranchus*.

The transformation of the Mexican Axolotl.

It has long been recognized that the Mexican Axolotl represented exactly the larval condition of the North American Amblystomæ, but as the Amblystoma form had not been obtained in Mexico, it has been suggested that the Axolotl of that country might never attain the complete condition, and that in fact, in its native state, it might exemplify a condition of arrested development perpetuated by its power to propagate in an immature stage. A Mexican naturalist has, however, discovered that the Amblystoma form is found and well known around the lakes in which the Axolotl occurs, and that it is even known to the people by a name of Aztec origin meaning land Axolotl. The fully developed form has been found about the lakes Santa Isabel, Xochimilco, Chalco, and Zumpango, the last of which is about sixteen leagues north of the city of Mexico. Mr. Velasco has recorded his observations in the Mexican periodical called "La Naturaleza," and an abstract is given in the American Naturalist (v. 16, xvi, p. 913).

Families of Anurans.

The arrangement of this order was in inextricable confusion till the key was found by Professor Cope, in 1865, in sternal characters. To the principal of these characters—the manner of connection at the middle—Mr. Boulenger attaches even greater importance than Professor Cope. The order has been primarily divided into two suborders, the Phaneroglossa and the Aglossa, and the former are differentiated into "sections," the Firmisternia and the Arcifera, the former including the "suborders" Raniformia, Firmisternia, and Gastrechmia of Cope, and the latter his suborders Bufoniformia and Arcifera. Mr. Boulenger's arrangement, so far, appears to be very natural; but he has paid no further attention to sternal or other anatomical characters to distinguish

the *families*, although he uses them for minor groups. As Professor Cope's views have been generally accepted in the United States, the following summary of Mr. Boulenger's views, compared with Professor Cope's, may be of interest, Mr. Boulenger's families being indicated by Roman figures, and those adopted in conformity with Professor Cope's views being distinguished by the numbers in parentheses, and the descriptive portions also in parentheses:

Suborder I. PHANEROGLOSSA.—Salients with the eustachian tubes separated, and with a tongue.

Section A. FIRMISTERNIA.—Phaneroglossates with "coracoids firmly united by a simple epicoracoid cartilage; precoracoids, if present, resting with their distal extremity upon the coracoids, or connected with the latter by the epicoracoid cartilage."

I (1). *Ranids*.—Firmisternalians with premaxillary and maxillary teeth, with subcylindrical sacral diapophyses, with precoracoids, and with an "omosternum."

This is by far the most extensive of the Anurans, comprising, according to Mr. Boulenger, and including the doubtful ones, 286 species. It is represented in North America, Eurasia, India, Africa, South America, and Australia.

(2). *Colostethids*.—Firmisternalians with premaxillary and maxillary teeth, with subcylindrical diapophyses, and with precoracoids, but without an "omosternum."

Only one species has been referred to this family—the *Colostethus latinasus* of Colombia.

II. *Dendrobatids*.—Firmisternalians without teeth, with subcylindrical sacral diapophyses, and with precoracoids.

Seven species of *Dendrobates* from South America, 3 of *Mantella* from Madagascar, and (doubtfully) 1 of *Stumpffia*, also from Madagascar, have been placed in this family.

III (1). *Phryniscids* (Engystomatidæ, § I, Boulenger).—Firmisternalians without teeth in upper jaw, with dilated sacral diapophyses, with precoracoids, and the coracoids nearly parallel with the precoracoids.

Twenty-five species of this section have been recognized by Mr. Boulenger, some of which are Oriental, but most are South American.

(2). *Engystomids* (Engystomatidæ, § II, Boulenger).—Firmisternalians without teeth in upper jaw, with dilated sacral diapophyses, and without precoracoids.

Twenty-three species are attributed to the genera constituting this family by Mr. Boulenger; the typical are South America, but most inhabit the oriental region.

(3). *Brevicipitids* (Engystomatidæ, § III, Boulenger).—Firmisternalians without upper jaw teeth, with dilated sacral diapophyses, with precoracoids; the coracoids directed moderately backwards and much dilated forwards on the epicoracoid cartilage.

Four African species of the type are known.

(4). *Hemisids* (Eugystomatidæ, § IV, Boulenger).—Firmisternials without teeth in upper jaw, with dilated sacral diapophyses, with pre-coracoids, with the coracoids directed very obliquely backwards and little dilated toward the epicoracoid cartilage, and with the "suprascapula" connected by ligament with the "prootic."

Only one species of this group, inhabiting South Africa, is known.

IV (1). *Dyscophids*.—Firmisternials with teeth in upper jaw, with dilated sacral diapophyses (with pre-coracoids "resting upon coracoids," and with a cartilaginous omosternum and "a very large anchor-shaped cartilaginous sternum").

Two Madagascarene species answer to this definition, but three others have been associated with them, which, if Professor Cope's views are accepted, will require to be differentiated as peculiar family types.

(2). *Calluellsids*.—Firmisternials with teeth in upper jaw, with dilated sacral diapophyses (with pre-coracoids "resting upon coracoids," without an omosternum and with a small cartilaginous sternum).

One species is known—the *Calluella guttulata* of India.

(3). *Cophylids*.—Firmisternials with teeth in upper jaw, with dilated sacral diapophyses (and without pre-coracoids).

The Cophylæ of Madagascar (two species) are the only known representatives.

Section B. ARCIFERA.—Phaneroglossates with "coracoids and pre-coracoids connected by an arched cartilage (the epicoracoid), that of the one side overlapping that of the other."

V (1). *Cystignathids*.—Arcifers with toothed upper jaw, and subcylindric (or little dilated) sacral diapophyses.

This is a large family, including "arboreal, aquatic, terrestrial, and burrowing types," and numerous represented in South America and Australia; 173 species are enumerated by Mr. Boulenger, although some are doubtful.

VI (1). *Dendrophryniscids*.—Arcifers without maxillary teeth, with subcylindric sacral diapophyses.

Three South American species are alone known. The family has been named Batrachophrynidæ by Professor Cope.

VII (1). *Bufoinids*.—Arcifers without maxillary teeth, with dilated sacral vertebræ (and a broad flat tongue, free behind).

This family is only equalled in its distribution by the Ranids, and 103 species (including a dozen doubtful ones) have been referred to the family by Mr. Boulenger.

(2). *Rhinophrynids*.—Arcifers without maxillary teeth, with dilated sacral vertebræ (and with an elongate subtriangular tongue, free in front).

This family has been proposed for a Mexican Anuran (*Rhinophrynus dorsalis*), and was contrasted with all the other Anurans on account of its

anteriorly free tongue by Dr. Günther, all the other Phaneroglossates being "opisthoglossate" or with the "tongue adherent in front, more or less free behind."

VIII (1). *Hylids*.—Arcifers with maxillary teeth, dilated sacral diapophyses, and claw-shaped terminal phalanges.

This family is one of the largest and most widely distributed of the Anurans and includes, according to Boulenger, about 180 more or less well known species; these are grouped by that author under ten genera, but many others have been proposed by various authors.

IX (1). *Pelobatids* (or *Scaphiopodids*).—Arcifers with maxillary teeth, dilated sacral diapophyses (the coccyx connate with the sacrum, and with proœlian vertebræ).

Seven species of *Scaphiopus* and two of *Pelobates* represent this family, the former in North America and the latter in Europe.

(2). *Pelodytids*.—Arcifers with maxillary teeth, dilated sacral diapophyses (the coccyx articulating with one or two condyles of sacral vertebræ, and with proœlian vertebræ.)

Two species—*Pelodytes punctatus* of Southern Europe and *Batrachopsis melanopyga* of New Guinea—have two sacral condyles, and two others, of the oriental genus *Leptobrachium*, have only one. *Xenophrys* having proœlian vertebræ, according to Boulenger, would also belong here, although it was associated by Cope with *Asterophrydids*.

(3). *Asterophrydids*.—Arcifers with maxillary teeth, dilated sacral diapophyses (the coccyx connected with one or two condyles or sacral vertebræ, and with opisthocœlian vertebræ).

Four genera are referred to this family by Professor Cope, but, according to Mr. Boulenger, only two of them—the Eastern *Megalophrys* and Papuan *Asterophrys*—have its essential characters, *i. e.*, the opisthocœlian vertebræ. *Cryptotis* is associated with *Cystignathids* and *Xenophrys* with *Pelodytids*.

X (1). *Discoglossids*.—Arcifers with maxillary teeth, dilated sacral diapophyses, precoracoids and coracoid slightly divergent and generally tapering, and with the "sternum" emitting two divergent processes.

This well-marked family has four European species and a fifth peculiar form (*Liopelma Hochstetteri*) in New Zealand—a remarkable distribution.

XI (1). *Amphignathodontids*.—Arcifers with maxillary as well as similar mandibular teeth, dilated sacral diapophyses, and without an omosternum. The *Amphignathodon Guentheri*, recently described by Mr. Boulenger, from Ecuador, is the sole known species of this family.

XII (1). *Hemiphractids*.—Arcifers with maxillary as well as peculiar mandibular teeth, subcylindrical sacral diapophyses, coracoids and precoracoids parallel, an omosternum, and (in *Hemiphractus* at least) opisthocœlian vertebræ, and the coccyx attached to two condyles.

Three tropical American genera, with eight species, have been re-

ferred to this family, but one (*Amphodus Wurcheri*) may require to be differentiated from it.

The Discoglossids differ so much from the other Arcifers that the exigencies of economy in diagnosis, as well as scientific taxonomy, appear to demand its isolation in a peculiar superfamily, contrasting with another containing all the other representatives of the arciferous section, viz:

Bufonoidea.—Arciferous Phaneroglossates without ribs, and with their tadpoles provided with a spiraculum situated on the left side.

Discoglossoida.—Arciferous Phaneroglossates with short ribs and their tadpoles distinguished by a "spiraculum situated mesially on the thoracic region."

Suborder II. AGLOSSA.—Salients with the Eustachian tubes united into a single ostium pharyngium and without a tongue.

XIII (=1). *Dactylethrids*.—Aglossates with maxillary teeth (with dilated sacral diapophyses, and with "coracoids and precoracoids subequal, strongly divergent, connected by a double, not overlapping, cartilage").

This family (which should by rights be called *Xenopodids*) is composed by three species of *Xenopus*, found in Tropical Africa.

XIV (=1). *Pipids*.—Aglossates without teeth (with dilated sacral diapophyses, and with "coracoids and precoracoids strongly divergent, former much dilated, connected by a broad, double, not overlapping, cartilage").

The Surinam Toad, *Pipa americana*, is the only known species of this family.

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Reptiles of the American Eocene.

The Cretaceous was pre-eminently the age of Reptiles, and with that period died out many strange types of the class. In the Tertiary age the reptiles were developed under the same grand orders as those of the present, but under some peculiar families and many peculiar genera. Those of the Eocene of North America have been reviewed by Professor Cope, and no less than 91 species are recognized, and are segregated under four orders—the Crocodilians with 18 species, the Tortoises with 42, the Lacertilians with 25, and the Ophidians with 6. The ratios between the several types will thus be seen to be very different from those exhibited by any existing fauna, but the discrepancy is, doubtless, to some extent due to our imperfect knowledge; nevertheless, the real ratios were probably not very different from those already furnished by palæontology.

Professor Cope well remarks that “the Eocene reptiles were not a new creation nor a new evolution, but a remnant of the types that had co-existed with the monarchs of life during previous ages. We must except from this statement the serpents, which first appear in numbers at this time, only one Cretaceous species having been found by Dr. Sauvage in France. The crocodiles, tortoises, and lacertilians represent orders already abundant in the Mesozoic faunæ. Their decadence in Central North America did not commence until the Miocene period, when the crocodiles and nearly all the tortoises disappeared.”

The Crocodilians, according to Cope, were represented by only 2 genera, both of the family Crocodylidae, *Crocodylus*, with 16 species, and *Plerodon*, with 2. “The Eocene species of true crocodiles differ much in size and characters, ranging from the *C. heterodon*, which is not larger than an Iguana, to the *C. antiquus* and *C. clavis*, which rival the existing species of the East Indies.”

The tortoises of the Eocene are of unusual interest. Eight families

of the order are represented—the Sphargidids; the Cheloniids, or true sea-turtles; the extinct Propleurids, turtles to some extent intermediate between the sea and snapping turtles; the Chelydrids, or snappers; the Trionychids, or soft turtles; the extinct Baënid; the Emydids, now so abundant in species; and the Testitudinids, or land tortoises.

The Dinosaurians.

Most interesting are the extinct reptiles named Dinosaurians, for various reasons. Many of them were of gigantic size, in certain respects they exhibited a considerable degree of specialization, they were also manifested under a variety of modifications, and they either represented the general stock from which the birds originated or were but little removed from that stock. In other words, could we trace the line of the birds backward to their primitive ancestors the naturalist would recognize in the ancestral form a member of the class of reptiles, and in that class he would refer it either to the group of Dinosaurians, or, as is more likely, to a peculiar earlier one, from which may have originated both types. The richness of the Dinosaurian group in species, in genera, and in families, as well as still more comprehensive groups, had been gradually revealed by different palæontologists, and at length in accelerated ratio, till now Professor Marsh has brought into prominence the variety in structure manifested in a new arrangement of the group. He even considers that the Dinosaurians constitute a division of reptiles of superordinal importance, and calls it a “subclass”; the group is divided into five primary sections, and those are denominated “orders.” The characters given to the several subdivisions, “orders,” and “families” are herein condensed from Professor Marsh’s diagnoses and contrasted with each other. Whether the groups are of the value claimed by Professor Marsh may be an open question, and the herpetologist must judge for himself what value he would assign to the modifications employed in the diagnoses.

I. SAUROPODA. Dinosaurians with plantigrade (ungulate) feet, front and hind pentadactyle; fore and hind limbs nearly equal, and without a postpubis; *Atlantosauridæ* and *Morosauridæ*.

II. STEGOSAURIA. Dinosaurians with plantigrade (ungulate) feet, fore and hind pentadactyle; fore limbs very small and locomotion mainly effected by hind ones; and with a postpubis; *Stegosauridæ*, *Scelidosauridæ*.

III. ORNITHOPODA. Dinosaurians with digitigrade feet, the fore pentadactyle, the hind tridactyle, fore limbs small, “limb bones hollow,” and with a postpubis; *Comptonotidæ*, *Iguanodontidæ*, and *Hadrosauridæ*.

IV. THEROPODA. Dinosaurians with digitigrade (unguiculate) feet, the fore pentadactyle, the hind variable (pentadactyle, tetradactyle, or tridactyle), the “fore limbs very small, limb-bones hollow,” and postpubis (?). *Megalosauridæ*, *Zanclodontidæ*, *Amphisauridæ*, *Labrosauridæ*.

V. CÆLURIA. (Not characterized.) *Cæluridæ*.

VI. COMPSOGNATHA. (Not characterized.) *Compsognathida*.

VII. HALLOPODA. Dinosaurians with digitigrade (unguiculate) feet, the fore (not described), the hind tridactyle, the "fore limbs very small," and with the metatarsals greatly elongated, the calcareum much produced backwards, the vertebræ biconcave, and the vertebræ as well as limb-bones hollow. *Hallopodida*.

Five orders and fourteen families, it will be hence seen, are admitted by Professor Marsh.

The fourteen families admitted are distinguishable as follows:

I (1). *Atlantosaurids*. Sauropods with ischia directed downwards and meeting at median line at their extremities.

(2). *Morosaurids*. Sauropods with ischia directed backwards and meeting along median line by their sides.

II (1). *Stegosaurids*. Stegosaurians with astragalus co-ossified with tibia, and very short metatarsals.

(2). *Scelidosaurids*. Stegosaurians with astragalus distinct from tibia and elongated metatarsals (with four *functional* digits in pes).

III (1). *Comptonotids*. Ornithopods without clavicles, and with a complete postpubis.

(2). *Iguanodontids*. Ornithopods with clavicles, and with an incomplete postpubis.

(3). *Hadrosaurids*. Ornithopods with "teeth in several rows, forming, with use, a tessellated grinding surface." (Clavicles and post-pubis not described.)

IV (1). *Megalosaurids*. Theropods with biconcave vertebræ, pubes slender and united distally, and tetradactyle pes.

(2). *Zanclodontids*. Theropods with biconcave vertebræ, pubes broad, elongate plates, with anterior margins united, and pentadactyle pes.

(3). *Amphisaurids*. Theropods with biconcave vertebræ, pubes rod-like, and tridactyle pes.

(4). *Labrosaurids*. Theropods with strongly opisthocælian and cavernous anterior vertebræ.

V. *Cælorids*. Dinosaurians with anterior (of cervical) vertebræ opisthocælian and rest biconcave; very long and slender metatarsals, and "bones of skeleton pneumatic or hollow."

VI. *Compsognathids*. Dinosaurians with anterior vertebræ opisthocælian, and others not described, and tridactyle fore as well as hind feet, and ischia with long symphysis on median line.

VII. *Hallopodids*.

The Wings of Pterodactyles.

Prof. O. C. Marsh has given a large plate and woodcuts illustrating a Pterodactyle, named by him *Rhamphorhynchus phyllurus*, found in 1873 "near Eichstädt, Bavaria, in the same lithographic slates that have yielded *Archæopteryx*, *Compsognathus*, and so many other Jurassic fossils known to fame." The wing membranes are well preserved and prove

that they were quite similar to those of the bats—smooth and contractile into folds. The tail of the type in question, at least at and near its extremity, “supported a vertical membrane developed above as well as below, and having a rhomboid or leaf-like outline.”

Professor Marsh has also discussed the homologies of the wing or manus bones of the Pterodaelytes, and reached the conclusions that “there are five digits in the hand of Pterodaelytes, although not the five often given in restorations. The first digit, the elements of which have been considered, undoubtedly supported a membrane in front of the arm. The second, third, and fourth are small, and armed with claws. The large wing finger is the fifth, corresponding to the little finger in the human hand.” (A. J. S., (3,) v. 23, pp. 251–256.)

A poisonous Lizard.

A large lizard of an orange and black color with a skin tuberculated or covered with scales, simulating the heads of nails, and hence called *Heloderma*, is a common inhabitant of Arizona. It is dreaded by the inhabitants of the Territory and deemed by them to be poisonous. The allegations to that effect, however, have been doubted by naturalists, because none of the lizards had been acknowledged to be venomous. *Heloderma* differs from other lizards, however, in having grooved teeth and the efferent ducts of the salivary glands discharging at the bases of the grooves. The best-informed herpetologists have therefore acknowledged the possibility, if not probability, of the truth of the popular belief, and Professor Cope years ago named the Arizonian *Heloderma*, *H. suspectum*, with reference to the bad reputation of the animal. Recent experiments and the personal experience of Dr. R. W. Shufeldt have demonstrated the correctness of the belief as to the poisonous character of the lizard, and we have now the certainty that the representatives of one type of lizard—the family of Helodermids with one genus and two species—are venomous. Dr. Shufeldt has recorded the effects of a bite, which was immediately attended with violent inflammation, in the *American Naturalist* for November, 1882 (v. 16, pp. 907,908).

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Variations of the Toes in Birds.

The variations from the normal structure of the foot in birds were examined by the lamented Forbes shortly before his death, and are noticed in an article published in the "Ibis" for July (1882).

Most birds, as is well known, have four toes, of which generally three are directed forwards and one backwards in the non-zygodactylous types. But one or other of the toes is liable to suppression, and the one thus atrophied is by no means always the same; (1) generally it is the hind toe or hallux, but (2) in certain kingfishers (*Ceyx alcyon*)

it is the second digit, and curiously enough (3) in one form—the Passerine genus *Cholornis*—the fourth toe is aborted.

The customary number of phalanges is “2, 3, 4, 5, in the respective digits, counting from within outwards,” but this type is deviated from in a number of instances. (1) Certain members of a family whose representatives generally develop the normal structure may deviate therefrom, as do the genera *Cypselus* and *Panyptila* among the Swifts or Cypselids, which have 2, 3, 3, 3 phalanges. (2) The Pteroclidids and typical Caprimulgids develop only 2, 3, 4, 4, phalanges, “the fourth digit being one short of the normal number of phalanges”; and (3) in the Procellariids, “the number of joints in the hallux is reduced to one,” the digital formula being 1, 3, 4, 5, except in Pelecanoides, where the hallux is “quite absent.”

Interbreeding of Birds.

Mr. Henry Seebohm thought that “the inter-breeding of birds supposed to be specifically distinct is a subject which has been much neglected by ornithologists,” and has called attention to certain facts or alleged facts bearing on the subject. “Two forms which are apparently very distinct, as *Corvus corone* and *C. cornix* or *Carduelis major* and *C. caniceps*, are nevertheless found to be only sub-specifically distinct—a complete series of examples from one extreme form to the other in each case being obtainable. They are produced by interbreeding with each other as well as with the intermediate forms. The Shrikes (*Lanius*) and Dippers (*Cinclus*) offer other illustrations, as do likewise the Nuthatches (*Sitta*). “The case of the Crows and the Goldfinches, where the extreme forms interbreed, is exceptional; but the cases where the individuals of each valley interbreed with their immediate neighbors, and where the range is great enough to make the sum of a series of small differences show a large difference in the extremes, is by no means uncommon.”

For the details respecting the species enumerated reference must be had to Mr. Seebohm’s article in the “Ibis” (4 s., v. 6, pp. 546–550). The facts he brings forward are susceptible of another explanation, but the subject discussed is of sufficient interest to demand attention.

New North American Birds.

A number of new forms of birds, previously unknown to the North American fauna, were added thereto during 1882. Most of these are the results of Mr. Ridgway’s investigations, and have been described as “subspecies” of species in the “Proceedings of the United States National Museum,” v. 4, pp. 374–379; and v. 5, pp. 9–15, 114, 344. The additions by Mr. Ridgway and others are as follows, the numbers appended indicating the position in his catalogue:

1. *Hylocichla fuscescens salicola* R.—Rocky Mountains (2a).

2. *Hylocichla aliciae* Bicknelli R.—Catskill Mountains, N. Y. (3a).
3. *Motacilla ocularis* (Swinhoe). A straggler to La Paz, Cal., from Eastern Asia (69*).
4. *Chamæa fasciata* Henshawi R.—Cal. (35a).
5. *Lophophanes inornatus griseus* R.—Middle Province U. S. (38a).
6. *Certhia familiaris montana* R.—Middle Province U. S. (55b).
7. *Certhia familiaris occidentalis*.—Pacific U. S. (55c).
8. *Catherpes mexicanus punctulatus* R.—Cal. (59b).
9. *Dendroæa Vielloti Bryanti* R.—La Paz, L. Cal. (93*).
10. *Geothlypis Beldingi* R.—L. Cal. (122*).
11. *Vireo Huttoni Stephensi* Brewster.—Arizona and N. Mex. (144a).
12. *Spizella monticola ochracea* Brewster.—Washington Terr. (210a).
13. *Peucæa ruficeps eremæa* Brown.—Texas (230b).
14. *Perisoreus canadensis nigricapillus* R.—Labrador (297c).
15. *Ornithium imberbe Ridgwayi* Brewster.—Arizona (331a).
16. *Scops asio Bendirei* Brewster.—Cal. (402e).
17. *Lagopus mutus Reinhardti* (Brehm) Turner.—Alaska, Greenland (475a).
18. *Lagopus mutus atkhensis*, Turner.—Atkha Island (475b).
19. *Ardea Wardi* R.—W. Florida (486*).
20. *Rallus Beldingi* R.—Gulf of Cal. (569*).
21. *Diomedea melanophrys* (Temm.) R.—Off coast of Cal. (701*).

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Preglacial Mammals of England.

In the English counties of Norfolk and Suffolk, along the sea-shore, are exposures of a fossiliferous belt of comparatively recent geological age, designated as the "forest-bed series," which has been quite a favorite subject for study among British geologists. It represents the "last stage" in England, previous to the glacial period, and is therefore of peculiar interest on account of the evidence which its several beds yield of the nature of the preglacial animal life of Britain. A recent monograph of its vertebrate remains has been published by Mr. E. T. Newton, the assistant naturalist of the survey, which throws much additional light on the fauna of the period. Although the molar teeth of elephants are generally the most numerous as well as the most conspicuous objects in all collections of forest-bed remains, and were among the earliest remains of mammals recorded from these deposits, the assiduous search of many trained observers has now unearthed fragments of the skeletons of "79" species, "of which 40 have been made known by the researches of the Geological Survey." In this number, however, are included several doubtfully determined forms. Such as they are—certain and doubtful—they represent 52 species of mammals (including 2 pinnipeds and 4 cetaceans), 2 species of birds (besides undeterminable forms), 2 reptiles, 4 amphibians, and 19 (or 20) fishes. The mammals alone are of sufficient general interest to

justify specification. From their remains it appears that in the age which is only separated from our own by the intervention of the glacial epoch, a fauna rich in large quadrupeds of types now confined to the tropics coexisted with many species still living in Britain. Coeval with carnivores, insectivores, and rodents that now characterize the northern fauna, were two species of horses (*Equus caballus fossilis* and *Equus Stenonis*), two species of rhinoceros (*R. etruscus* and *R. megarhinus*), a hippopotamus (*H. major*), very like, and possibly identical with, the living one of Africa; and no less than three species of elephants (*E. antiquus*, *E. meridionalis*, and *E. primigenius*). These special forms have all become extinct, although allied ones are living in tropical or subtropical countries. The ruminants of that period were also numerous, as many as 13 species of deer having been identified with more or less reason. With them were associated a species of ox (*Bos primigenius*?) and a peculiar kind of sheep, apparently related to "the Sardinian sheep (*Caprovis musimon*)," which has been called *Caprovis Savinii*. The beaver still living in Europe then also lived, but with it existed a much larger form, distinguished by a peculiar dentition (*Trogontherium Cuvieri*). It might naturally be supposed that where so many large herbivorous animals were found, carnivorous species would abound, but unquestionable remains of only three large species have been discovered—a peculiar saber-toothed tiger-cat (*Machærodus*), and two bears—the gigantic cave-bear (*Ursus spelæus*), and one that has been identified (with questionable correctness) with the grizzly of the United States (*Ursus ferox fossilis*). Ambiguous remains of a felid which may have belonged to *Machærodus* or some other form have been found; but besides these, so far as known, were only a couple of canine animals (possibly the wolf, *Canis lupus*, and the fox, *Vulpes*), the marten (*Martes sylvatica*), and, remarkable as coexisting with the tropical types enumerated, the glutton (*Gulo luscus*). Another form, noteworthy on account of its present distribution, whose remains occur in the upper fresh-water bed of the "forest series," is the *Myogale moschata*—a shrew-like mole, which is now confined to Russia, between the Don and the Volga.

Such were the forms that lived in Britain at a late geological epoch, and when specialized man undoubtedly existed in a savage or "wild" state, in his natal country at least. The climate must then have been still warm and humid, and the vegetation rank and luxurious. But a violent contrast was to supervene. The Pliocene epoch was closing, and a period remarkable for its cold and accompanying phenomena—the glacial period, or age of ice—in time succeeded. Many of the large forms that lived in the Pliocene died out; some retreated and survived farther south; and when at last modern Britain appeared with its present conditions, a comparatively scanty fauna and mostly small forms were its only heritage and final occupants. (Gill, in *The Critic* for February 10, 1883.)

ANTHROPOLOGY.

By OTIS T. MASON.

INTRODUCTION.

There is no better way to mark the progress of a science than to note the gradual change of meaning which its terminology undergoes, becoming more and more definite. Somewhere Paul Broca lays down the following rule for the nomenclature of anthropology: "Que chaque chose ait un nom, qu'elle n'en ait qu'un seul, et que ce nom ne désigne qu'une seule chose. Pour cela il suffira le plus souvent de restreindre à un sens déterminé les termes déjà usités. Ce ne sera qu'exceptionnellement que j'aurai un terme nouveau à proposer." The scientific study of man should include every investigation which can be conducted according to the rules of procedure in force among the more exact sciences, reaching backward to the remotest cosmic event which was in any manner connected with his origin, and forward as long as his hopes and fears lead him to pretend his existence, just so far as the phenomena can be subjected to repeated and accurate observation, and their results can be tabulated, and expressed in terms of reasonable constancy. The beginning of anthropology, therefore, is concerned with the origin of man, its special work is with the actual life of humanity on the globe, including human beliefs and conduct with reference to the spirit world. The work accomplished during the year will be considered in the order of the artificial scheme employed in the last summary, as follows:

- I.—Anthropogeny.
- II.—Archæology.
- III.—Biology of man.
- IV.—Psychology.
- V.—Ethnology.
- VI.—Glossology.
- VII.—Comparative technology.
- VIII.—Sociology.
- IX.—Pneumatology.
- X.—Hexiology.
- XI.—Instrumentalities.

I.—ANTHROPOGENY.

As previously defined in these summaries, anthropogeny includes all investigations concerning the time, place, causes, and manner of man's appearance, together with his physical, intellectual, technical, social, moral, and religious status at his advent.

Says M. Issaurat, in reviewing Hovelacque's "Les Débuts de l'Humanité," primitive man has left traces of his existence that give us some idea of his structure, his industry, and his manners. Furthermore, we meet now living on the globe the witnesses of prehistoric races in the lower types of men. The comparison of the characteristics of these lower types leads to interesting conclusions. It confirms, according to M. Hovelacque, the polygenism of Broca and Topinard, to wit, that the distinguishing features of certain races have values such as are made the bases of species in natural history. There were, therefore, many species of anthropoid precursors of man. M. Hovelacque also draws from modern savages some conclusions concerning the intellectual, social, and moral status of primitive man. (*Rev. d'Anthrop.*, XV, p. 521.)

Mr. Grant Allen, criticising the arguments of Dr. Mitchell and Mr. Dawkins respecting the bearing of archæological facts upon the evolution of man, thus formulates his conclusions: 1. The cave-men were not only true men, but men of a comparatively high type. 2. But the river-drift men, who preceded them, were men of a lower social organization, and probably of a lower physical organization as well. 3. The earliest human remains which we possess, though on the whole decidedly human, are yet in some respects of a type more brute-like than that of any existing savages. 4. They specially recall the most striking traits of the larger anthropoid apes. 5. There is no reason to suppose that these remains are those of the earliest men who inhabited the earth. 6. There is good reason for believing that before the evolution of man in his present specific type, a man-like animal, belonging to the same genus, but less highly differentiated, lived in Europe. 7. From this man-like animal the existing human species is descended. 8. Analogy would lead us to suppose that the line of descent which culminates in man first diverged from the line of descent which culminates in the gorilla and the chimpanzee about the later Eocene or early Miocene period. The fallacy which underlies so much of our current reasoning on primitive man is the tacit assumption that man is a single modern species, not a Tertiary genus with only one species surviving. The more we examine the structure of man and of the anthropoid apes, the more does it become clear that the differences between them are merely those of a genus or family, rather than distinctive of a separate order, or even a separate sub-order. It is pretty generally acknowledged that the divergence between man and the anthropoids is greater than can

be accounted for by the immediate descent of the living form from a common ancestor in the last preceding geological age. Therefore, there must have been a man-like animal, or a series of man-like animals, in later, if not in earlier, Tertiary times. (Grant Allen, in *Fortnightly Rev.*, Sept., p. 308.)

Another road of approach to the origin and genetic relations of man is through anomalies, criminals, and the defective class. If a certain anomaly occurs in savages, criminals, and delinquents, quite frequently, which is rare in higher races and normal in higher mammals, this is looked upon as the gradual elimination of a useless or pernicious structure. If, on the other hand, the process is reversed, and the anomalies of the anthropoids become more persistent with the elevation of man, it is regarded as the survival of a beneficial structure. This subject has engaged the attention of many distinguished anthropologists who are striving to come nearer to the true relationships of our species,—notably of M. Anoutchine, in a discussion entitled “*Sur quelques anomalies du crâne humain et de leur fréquence dans les races.*” (Published in the *Transactions of the Soc. d. Amis d. Sc. nat., de l'Anthrop., etc., de Moscou*, XXVIII, pt. 3; and reviewed in *Rev. d'Anthrop.*, V, p. 357, by C. de Merejkowski.)

Upon the subject of assassins in relation to primitive man the labors of Prof. P. Heger and J. Dalemagne upon the craniological characteristics of a number of assassins executed in Belgium should be consulted. The conclusions to which the authors arrive agree with those of M. Lombroso and M. Bordier, that the parieto-occipital brain predominates in assassins. But, according to the Belgians, criminals do not constitute even a variety of the species. The craniological characters of assassins depend chiefly upon the type or race to which they belong. It is impossible to apply to them all any theory whatever. On the other hand, craniology enables us to classify them according to the capability of amelioration, in the same way that Pinel divides the defectives. (*Ann. de l'Univ. de Bruxelles*, 1881; *Rev. d'Anthrop.*, V, p. 530.)

II.—ARCHÆOLOGY.

There is no other department of anthropology whose genuine improvement can be marked so palpably as archæology. The scientific treatment of the subject is not very old; indeed, the tendency to formulate a very large conclusion from a very small premise is still too common.

Every country with any claim to civilization boasts of its archæological sites and active research. Therefore, a very lucrative trade has sprung up in aboriginal relics, and the frauds perpetrated are already an embarrassing factor in the problems of ancient history.

A glance over the bibliography for the year shows that the tendency has been rather to research than to speculation. Explorations of the most

thorough nature have been prosecuted by the Archæological Institute of America among the pueblos of Mexico and the antiquities of Assos; by the Peabody Museum among the works of the Mound-Builders; by the American Antiquarian Society in the early history of our white settlements; by the Smithsonian Institution, and especially by the Bureau of Ethnology, not only among the pueblos, but also among the mounds. It would be impossible to mention all the thorough work in progress by local societies and individuals in all the States where antiquities exist.

The startling find of the year was the "Carson Footprints," at first claimed to have been left "on the sands of time" by a giant with a foot 18 inches long. Prof. Joseph Le Conte thus describes them: "The nearly horizontal strata in which they occur consist of beds of sandstone with thin layers of fine shale. The track layer, which is one of these latter, has been uncovered for nearly two acres, and forms the floor of the prison yard, while the stones removed have been used to build the prison. From the fossils discovered, the deposit seems to be the equus beds, by some put in the Upper Pliocene; by others, in the lowest Quaternary. It is probably a transition between the two. The whole surface of the shale exposed is covered with tracks of many kinds, but the mud was so soft that the nature of many of them can only be guessed; the most interesting are those of the mammoth and the problematical so-called human tracks. The 'human' tracks occur in several regular alternating series of 15 to 20. In size they are 18 to 20 inches long and 8 inches wide. In shape they are, many of them, far more curved than the human track, especially in soft mud. The stride is $2\frac{1}{2}$ to 3 feet, and even more. But the most remarkable thing about them, on the human theory, is the straddle, amounting to 18 and even 19 inches After careful examination for several days, the conclusion reached was that the tracks were probably made by a large plantigrade quadruped, most like a gigantic ground-sloth, such as the *Mylodon* of the Quaternary, or the *Morotherium* of the Upper Pliocene of Nevada." Similar views have been expressed by Professor Marsh and G. K. Gilbert. (*Nature*, May 31, 1883.)

The Archæological Institute of America published during the year the first volume of its classical series relative to investigations in Assos, in 1881, a neat volume of 215 pages, with illustrations and maps. It also issued the third annual report, which gives us, in addition to the usual balance sheet and list of members, the report of a special committee upon the plan of operations of the institute and the work of Mr. Bandelier in Mexico. The last-named gentleman has studied the construction, the function, and the builders of the pyramid of Cholula. He regards the structure as made of huge walls of adobe, forming immense communal buildings, like those at Pecos and other places in New Mexico, in size approaching those of Uxmal or Palenque, and

built around a vast court, in the center of which stood a great worship mound. The builders were the Toltecs, identified with the Mayas.

The fifteenth annual report of the Peabody Museum is chiefly occupied with an exhaustive paper by Professor Putnam on American aboriginal copper-working. Preceding the minute description of the objects severally, the author makes some judicious observations upon copper manufacture which are worth repeating. "In America, outside of Mexico, before the coming of Europeans, there is no evidence, as yet, that copper was used otherwise than as a substance which could be hammered and cut into many desired shapes. In Mexico, Central America, Peru, and Chili, there is no doubt that copper was both cast and hammered, and by some nations was also mixed with tin or with gold, and cast in molds; but the difficulty of melting and casting unalloyed copper is far too great to be easily overcome."

Dr. Charles Rau presented at the American Association a paper upon a stone grave in Illinois containing the skeleton of a Kickapoo Indian, thereby showing the connection of such interment with our modern Indians. The other contributions of Dr. Rau will be found mentioned in the report of Professor Baird, as well as the account of the work of the Bureau of Ethnology, and of the other special collaborators of the Smithsonian Institution.

The Museo nacional de Mexico has continued the publication of the *Anales*, containing papers mentioned in the Bibliography under the titles Barena, Chavero, Mendoza, Sanchez, Orozco y Berra, and Icazbalceta.

Dr. Daniel G. Brinton contributes to the first number of the *American Antiquarian* for the current year a paper on the probable nationality of the Mound-Builders, in which the following language occurs: "It would appear that the only resident Indians at the time of the discovery who showed any evidence of mound-building comparable to that found in the Ohio Valley were the Chahta-Muskokee. I believe that the evidence is sufficient to justify us in accepting this race as the constructors of all those extensive mounds, terraces, platforms, artificial lakes, and circumvallations which are scattered over the Gulf States, Georgia, and Florida."

Especial mention should be made of the gorgeous work of Reiss and Stübel upon the necropolis of Ancon, in Peru; of Marquis de Nadaillac's volume entitled "*L'Amérique préhistorique*;" and of M. de Mortillet's "*Préhistorique antiquité de l'homme*." The last-named work is the maturest fruit of a life devoted to archæology. Some very great improvements in the treatment of the subject are introduced, among them the attachment of the author's name to each remarkable discovery. The

following table exhibits M. Mortillet's scheme of archæological sequence:

Upper Secondary.		India; silicified forests, with cuttings (Marchesetti).
Inferior Tertiary.	Soissonien	Lignite of Montaign, boule en Craie (Melleville).
Eocene.	Londonien	
	Parisien	
	Bartonien	
	Ligurien	Siderolite of Délémont; human skeleton (Quiquerez).
Oligocene.	Tongrien	Fontainebleau sandstone; petrified man over his horse.
	Aquitainien	Limestone of Beauce, Thenay; flaked and broken flint (Bourgeois).
Middle Tertiary.	Mayencien	Gravels of Orleans; marked bones (Nonel).
		Fresh-water formation of Gannat; gashed bones (Pomel).
Miocene.	Helvetien	Fresh-water chalk of Billy; gashed bones (Laussedal).
		Sansan hill; broken bones (Garrigou).
		Marl of Anjou, Pouance; incised bones (Delaunay, Tour-nouée).
		Marl of Anjou, Chavagne-les-Eaux; incised bones (Farge).
Miocene.	Tortonien	Miocene of Dardanelles; chipped flint, scratched bones (Calvert).
		Molasse of Central France; human skeleton (Garrigou).
		Fossiliferous diggings of Pikermi; broken bones (De Ducker).
Miocene.	Molasse of Central France; human skeleton (Garrigou).	Trachytic conglomerate of Cantel; chipped flint (Tardy, Rames).
		Miocene and Pliocene deposits of Portugal; chipped flint (Ribeiro).
Upper Tertiary.	Astien	Deposits of San Valentino; wrought bone (Ferretti).
		Ossiferous diggings of Val d'Arno; scratched bone (Desnoyers).
Pliocene.	Saint Prestien ..	Strata of San Giovanni; scratched bone (Ramorino).
		Deposits of balanotus at Monte-Aperto; scratched bones (Capellini).
		Blue marl of Savone; human bones (Issel).
		Piedmont; pierced scapula of mastodon (Gastaldi).
Pliocene.	Saint Prestien ..	Red crag of Suffolk; pierced sharks' teeth (Charlesworth).
		Alluvium of California; implements (Blake), skull (Whitney).
Quaternary	Chelléen	Autry-Issard; silicified wood cut (Charnaux).
		Saint Prest.; scratched bones (Desnoyers), chipped flint (Bourgeois).
		Alluvium; human bones and objects of industry.
		Do.
Quaternary	Moustérien	Grottoes; human bones and objects of industry.
		Do.
Quaternary	Solutréen	Do.
		Magdalenien .....	Do.

III.—BIOLOGY OF MAN.

Investigations of this class include human structure, or anatomy; diseases, or pathology; questions of size, form and weight, color, and texture of parts, or anthropometry; the progress of life in the individual, or ontogeny; and the life history of the species, or phylogeny. This subject is of vast proportions. Already biological societies multiply, in which the human subject receives its share of attention as the head of the animal kingdom. In the *Index Medicus*, before mentioned, a monthly catalogue of works on human and general biology is given.

Although every portion of the body must yield results of great importance, and new structures are brought within the scope of study each year, the skull and brain are still the parts upon which the most labor is bestowed. As an example of the minuteness with which measurements are prosecuted, tables are appended exhibiting the last results of Broca's labors before he prematurely laid down the scalpel. The subject has received an elaborate treatment at the hands of his pupil, Dr. L. Manouvrier, in the *Bulletin of the Zoological Society of France*, for 1882; as well as among German anthropologists.

Paul Broca's tables of brain-weight, in grams.

Age.	Bicêtre Hospital.				San Antoine et Pitie.			
	No.	Mean age.	Mean height.	Weight.	No.	Mean age	Mean height.	Weight.
MALES.								
15-20.....	1	19	1.63	1,475	15	18.1	1.65	1,350
20-25.....	3	22.6	1.68	1,339	11	23.5	1.70	1,365
25-30.....	1	28	1.73	1,547	15	28.3	1.70	1,414.5
30-35.....	2	33.5	1.73	1,370	24	33	1.70	1,421.4
35-40.....	3	38	1.69	1,316.6	10	38	1.67	1,411.4
40-45.....	6	42.6	1.67	1,312.6	23	42.6	1.67	1,340.6
45-50.....	6	40.3	1.65	1,220	15	48.2	1.65	1,300.4
50-55.....	4	54	1.68	1,438.5	12	53.5	1.69	1,341.8
55-60.....	8	57.6	1.65	1,313	17	57.5	1.67	1,313.4
60-65.....	17	63.1	1.65	1,295.7	20	63.6	1.68	1,329.1
65-70.....	13	68.3	1.63	1,240.1	7	67.7	1.70	1,311.1
70-75.....	15	73.5	1.63	1,219.7	5	73.4	1.69	1,291.6
75-80.....	16	77	1.65	1,213.9	4	77.6	1.66	1,245.5
80-85.....	7	82.1	1.62	1,208	1	83	1.68	1,430
85-90.....	4	88.2	1.60	1,273.7				
90-95.....	1	91	1.60	1,300				
FEMALES.								
15-20.....					2	17.5	1.49	1,251
20-25.....					4	24	1.62	1,258
25-30.....	1	28	1.53	1,248	7	28.4	1.56	1,192.1
30-35.....	1	31	1.57	1,212	3	33	1.58	1,260
35-40.....	1	37	1.51	1,045	4	37.7	1.58	1,162.5
40-45.....	1	44	1.56	1,153	5	42.4	1.59	1,247.8
45-50.....	4	46.5	1.60	1,220.5	6	40.5	1.58	1,188.5
50-55.....	2	54	1.56	1,030	3	52.6	1.56	1,140.6
55-60.....	2	59.6	1.56	1,112.5	7	57.8	1.58	1,217.1
60-65.....	4	62.5	1.63	1,148.5	1	62	1.70	1,251
65-70.....	5	68.4	1.54	1,156.4	6	67.8	1.55	1,136.8
70-75.....	18	72.4	1.59	1,118.2	8	73.2	1.55	1,095.3
75-80.....	14	78.4	1.55	1,108.5	4	77.5	1.59	1,147.7
80-85.....	13	82.3	1.55	1,087.3	3	83.3	1.54	1,038
85-90.....	9	88.3	1.51	1,087.7				
90-95.....	2	92.5	1.48	1,090				

The mean brain-weight of all is about 1,325 grams for the males, and 1,142 for the females. The medium height for all is 1^m.42 to 1^m.85. Other tables are given in Broca's paper, in which age and sex are the criteria in decades, also height and sex, sex and decades, weight and age, etc. (*Rev. d'Anthrop.*, v, pp. 7, 9.)

The slowness with which crania well authenticated are collected makes it very desirable, if possible, to obtain measures upon the living subject which can be reduced to the index of the skeleton. Efforts in this direction have been made by Bicêtre, Stieda, Topinard, Virchow, Mik-

lucho-Maklay, Weisbach, and others, and notably by Broca, whose table of craniometry compared with cephalometry is given below:

Sex.	Antero-posterior diameter.			Transverse diameter.			Cephalic index.		
	Skull.	Living.	Excess.	Skull.	Living.	Excess.	Skull.	Living.	Excess.
	<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>
Male	200	201	1	148	150	2	74.00	74.62	+ .62
Do	175	176	1	136	140	4	77.71	79.54	+1.87
Do	171	179	8	151	156	5	85.30	87.15	-1.15
Do	177	185	8	156	162	6	88.13	87.56	- .57
Do	172	178	6	148	153	5	86.04	85.95	+1.91
Do	176	183	7	151	160	9	85.79	87.43	+1.64
Do	175	187	2	156	164	8	89.14	87.70	-1.44
Do	180	187	7	148	154	6	82.22	82.35	- .13
Do	174	182	8	137	142	5	78.73	78.02	- .71
Do	185	192	7	148	156	8	80.00	79.16	- .84
Do	174	181	7	138	146.5	8.5	79.31	81.00	+1.69
Female	174	178	4	144	148	4	82.76	83.14	+ .38
Do	172	178	6	146	152	6	84.88	85.39	+ .51
Do	174	180	6	144	150	6	82.76	83.33	+ .57
Do	185	192	7	136	145	9	73.51	75.52	+2.01
Do	168	176	8	142	146	4	84.52	82.95	-1.57
Do	165	172	7	141	148	7	85.45	86.04	+1.59
Do	170	178	8	134	142	8	78.82	79.77	+ .85
Do	180	185	5	148	149	1	82.22	80.54	-1.68
Average..	176.1	182.6	6.5	144.8	150.7	5.9	82.22	82.53	+ .31

It will be observed that individual differences are very large; but in the measurement of a large number of living subjects the mean will be found by deducting therefrom the average excesses.

Broca's measurements of cranial capacity.

Nationality, &c.	Number.	Males.	Number.	Females.	Difference.
		<i>c. c.</i>		<i>c. c.</i>	<i>c. c.</i>
Chipped flint age: Grenelle & Bellancourt.....	2	1,552	1	1,390	162
Solutré.....	12	1,564	2	1,395	169
Polished stone age: L'Homme Mort.....	6	1,606	6	1,507	99
Vaureal.....	5	1,533	2	1,517	216
Various.....	8	1,576	5	1,426	150
Grottes de Baye.....	25	1,534	14	1,407	127
Gauls.....	24	1,592	10	1,457	135
Merovingians: Chelles, 1st series.....	26	1,596	19	1,374	222
Chelles, 2d series.....	8	1,521	4	1,395	126
Champlien, 3d series.....	8	1,524	3	1,318	206
Parisians: City, XIIth cent.....	67	1,531	42	1,320	211
West, XIIth cent.....	77	1,559	41	1,337	222
Pariseux, Kymri region.....	9	1,539	5	1,355	184
Hollanders.....	22	1,530	22	1,390	140
Savoards of Annecy: 1st series.....	9	1,530	6	1,426	104
2d series.....	7	1,554	2	1,391	163
Total of the two series.....	16	1,538	8	1,417	121
Auvergnats of St. Nectaire.....	42	1,609	36	1,445	153
Croats of the military border, Austria.....	9	1,423	2	1,480	-57
Bas Bretons.....	32	1,564	26	1,366	198
Bretons Gallots.....	33	1,599	26	1,426	173
French Basques.....	31	1,544	16	1,298	246
Spanish Basques.....	30	1,584	23	1,395	189
Corses.....	15	1,552	8	1,367	185
Arabs.....	15	1,474	3	1,322	152
Egyptians: IVth dynasty.....	21	1,532	18	1,397	135
XIth dynasty.....	12	1,443	17	1,328	115
XVIIth dynasty.....	9	1,464	9	1,323	141
Laps.....	4	1,558	1	1,695	-137
Turkestan.....	4	1,637	3	1,352	285
Chinese.....	16	1,518	6	1,383	135
Javanese.....	13	1,590	6	1,396	194
Polynesians.....	21	1,500	15	1,381	119
Eskimos.....	9	1,535	9	1,429	106
Pariahs of Alipoor, Calcutta.....	7	1,336	3	1,114	222

Broca's measurements of cranial capacity—Continued.

Nationality, &c.	Number.	Males.	Number.	Females.	Difference.
African Negroes: 1st series.....	31	c. c. 1,462	12	c. c. 1,267	c. c. 195
2d series.....	10	1,423	7	1,246	177
3d series.....	13	1,410	4	1,237	173
Kaffirs.....	7	1,512			
Hottentots and Bushmen.....	8	1,317	5	1,253	64
Nubians of Elephantine.....	10	1,329	6	1,298	31
New Caledonians.....	23	1,460	23	1,330	130
Tasmanians.....	5	1,406	4	1,230	176
Papuans of Tond.....	7	1,467	3	1,279	188
Australians.....	10	1,347	6	1,181	166

(*Rev. d'Anthrop*, 1882, v, p. 398.)

List of measures and craniometric processes of Broca.

- A.—Sex.
- B.—Age.
- C.—Capacity.
- D.—Antero-posterior diameter, maximum.
- E.—Transverse diameter, maximum.
- F.—Cephalic index, $\frac{100 E}{D}$.
- G.—Antero-posterior inial diameter,
- H.—Difference D—G.
- I.—Bi-temporal diameter.
- J.—Bi-auricular diameter.
- K.—Difference E—I.
- L.—Frontal diameter, minimum, inferior.
- M.—Stephanic diameter, superior.
- N.—Frontal index, $\frac{100 L}{E}$.
- O.—Frontal index, No. 2, $\frac{100 L}{M}$.
- P.—Vertical or basilo-bregmatic diameter.
- Q.—Vertical maximum diameter.
- R.—Vertical index, $\frac{100 P}{D}$.
- S.—Transverso-vertical index, $\frac{100 P}{E}$.
- T.—Naso-basilar line, (NB).
- U.—Length of basilar apophysis (*Bb*).
- V.—Difference between T—U. (*Nb*.)
- X.—Anterior projection of the skull (Blumenbach).
- Y.—Posterior projection of the skull (Blumenbach).
- Z.—Total projection of the skull (Blumenbach).
- α .—Basilar index, $\frac{100 X}{Z}$.
- β .—Foramen magnum, longitudinal.
- γ .—Foramen magnum, width.
- δ .—Foramen magnum, index, $\frac{100 \gamma}{\beta}$.
- ϵ .—Basilar arc, T + β .

- ζ.—Projection of occipital crest, upper occipital curve.
 η.—Projection of the inion, external occipital protuberance.
 θ.—Asteric diameter, or occipital maximum.
 ι.—Metopism, difference between D and the antero-posterior metopic diameter.
 A'.—Sub-cerebral frontal curve, from root of the nose to the ophryon.
 B'.—Frontal cerebral curve, ophryon to the bregma.
 C'.—Total frontal curve, root of the nose to the bregma.
 D'.—Parietal curve, bregma to lambda.
 E'.—Upper occipital curve, lambda to inion.
 F'.—Cerebral occipital curve, inion to opisthion.
 G'.—Total occipital curve, lambda to opisthion.
 H'.—Supra-auricular transverse curve.
 I'.—Sub-auricular transverse curve.
 K'.—Total transverse curve.
 L'.—Horizontal pre-auricular curve.
 M'.—Horizontal post-auricular curve.
 N'.—Total auricular curve.
 O'.—Midfrontal curve, $C' + D' + E'$, root of nose to inion.
 P'.—Ratio, $\frac{100 C'}{O'}$.
 Q'.—Total cerebral curve, $O' - A' - \text{Ophryon}$ to inion.
 R'.—Ratio, $\frac{100 B'}{Q'}$.
 S'.—Fronto-sub-occipital curve, $O' + F'$, root of nose to opisthion.
 T'.—Vertical circumference, $E + S'$, total antero-posterior, including foramen magnum and naso-basilar line.
 U'.—Anterior or pre-auricular demi-circumference, $C' + T'$.
 V'.—Ratio, $\frac{100 U'}{T'}$.
 W'.—Point of the face where the prolongation of the plane of the foramen magnum falls.
 X'.—First occipital angle, or angle of Daubenton.
 Y'.—Second occipital angle, or angle of Broca.
 Z'.—Basilar angle, or angle of Broca.

FACE.

- I.—Biorbital external length.
 II.—Biorbital internal length.
 III.—Distance of the supra-orbital foramina.
 IV.—Distance of the sub-orbital foramina.
 V.—Bimaxillary minima.
 VI.—Bimaxillary maxima.
 VII.—Bimalar diameter.
 VIII.—Bijugal diameter.
 IX.—Bizygomatic width, maximum.
 X.—Orbital width.
 XI.—Orbital height.
 XII.—Orbital index.
 XIII.—Orbital depth.
 XIV.—Nasal bone, median length.
 XV.—Nasal bone, lateral length.
 XVI.—Nasal bone, upper width.
 XVII.—Nasal bone, minima width.

- XVIII.—Nasal bone, inferior width.
 XIX.—Interorbital width.
 XX.—Width of the anterior nostrils.
 XXI.—Height from the root to the anterior nasal spine.
 XXII.—Height from the anterior nasal spine to the alveolar points.
 XXIII.—Height from the root of the nose to the alveolar point.
 XXIV.—Height from ophryon to alveolar point.
 XXV.—Height of the os mala.
 XXVI.—Orbito-alveolar height.
 XXVII.—Mastoido-supra auricular height.
 XXVIII.—Auriculo-jugal distance (oblique).
 XXIX.—Auriculo-orbital distance, right (oblique).
 XXX.—Auriculo-orbital distance, left (oblique).
 XXXI.—Depth of the zygomatic fosse.
 XXXII.—Palatine vault, total maxillo-palatine length.
 XXXIII.—Palatine vault, anterior maxillary length.
 XXXIV.—Palatine vault, posterior width.
 XXXV.—Palatine vault, width to the level of the 1st molar.
 XXXVI.—Palatine vault, width to the level of the os incisif.
 XXXVII.—Palatine vault, depth.
 XXXVIII.—Distance from the posterior nasal spine or palatine to the basion.
 XXXIX.—Width of the alveolar arch inwards, and maximum.
 XL.—Width of the alveolar arch inwards and backwards.
 XLI.—Height of the posterior nares.
 XLII.—Nasal index, $\frac{100 \text{ XX}}{\text{XXI}}$.
 XLIII.—Facial index, $\frac{100 \text{ XXIV}}{\text{IX}}$.
 XLIV.—Palatine index, $\frac{100 \text{ XXXIV}}{\text{XXXIII}}$.

(*Rev. d'Anthrop.*, 1882, pp. 577-590.)

Anthropometry is one of the youngest scions of anthropology, and it not only commends itself to advanced students, but is applicable to millions of subjects, and its processes are so easily understood that any intelligent person may use them. As a result of greater definiteness in processes a more accurate nomenclature is demanded. An illustration of this is to be seen in the following classification of stature by Professor Zoja.

Genera.	Species.	Vulgar terms.	Meters.
Gigantosoma.....	Hypergigantosoma	Phenomenal.....	2.51 <i>et supra</i> .
	Gigantosoma	Giant.....	2.26 to 2.50
Megasoma	Hypogigantosoma.....	Gigantic.....	2.01 to 2.25
	Hypermegasoma.....	Approaching gigantic.....	1.91 to 2.00
	Megasoma	Very tall.....	1.81 to 1.90
Mesosoma.....	Hypomegasoma.....	Tall.....	1.71 to 1.80
	Hypermesosoma.....	Above ordinary.....	1.66 to 1.70
	Mesosoma.....	Medium.....	1.65
	Hypermesosoma.....	Below medium.....	1.64 to 1.60
Microsoma.....	Hypermicrosoma	Low.....	1.59 to 1.50
	Microsoma.....	Very low.....	1.49 to 1.40
	Hypomicrosoma	Lowest.....	1.39 to 1.25
Nanosoma.....	Hypernanosoma.....	Dwarfish.....	1.24 to 1.00
	Nanosoma.....	Dwarfs.....	0.99 to 0.75
	Hyponanosoma.....	Phenomenal.....	0.74 <i>et infra</i> .

It is not advised that this scheme be adopted without reservation, yet it does show a permanent advance in anthropometry. Furthermore, it is drawn up for Italians, but this need not embarrass the student, since he will only need to fix his standard mesosoma and arrange above and below that according to the scale.

IV.—PSYCHOLOGY.

The most perplexing of all the outstanding problems in anthropology is the explanation of the processes of feeling, thinking, and volition. On the one hand it is maintained that in course of time it will be shown that thought is a mode of material motion; on the other, this incomprehensible phenomenon is remanded to the category of occult properties, like cohesion and gravitation, which will ever elude our grasp. However that may be, man will ever aim to think this unthinkable, to achieve this impossible, and to reach after this unattainable. In prosecuting researches with reference to the mind various avenues of approach have been followed.

Out of the old phrenology has come the new, and several important works have appeared upon cerebral localization in its various aspects. The second part of H. C. Bastian's publication upon the brain as the organ of the mind was printed during the current year. Furthermore a reference to the bibliography will reveal treatises upon brain-weight and mind, heredity and psychology, growth of intellect, pre-natal education, brain-functions, sensations and their translation into thought and feeling, the various aspects of mind growth from infancy to maturity, the accurate measurement of thought, or psychometry, the phenomena of insanity as opening the door upon primitive man, and the exhibition of intelligence in animals.

Speaking of the equivalents of consciousness in nature beneath man, Professor Cope says: "The utterances of Professor du Bois Reymond, at the recent celebration of the birthday of Leibnitz at Berlin, should have a clearing effect on the intellectual atmosphere of the evolutionists. 'Consciousness,' says one, 'is to the progress of evolution what the whistle is to the engine, that makes a good deal of noise but does none of the work.' Another says, 'If the will of man and the higher animals seems to be free in contrast with the fixed will of atoms, that is a delusion provoked by the contrast between the extremely complicated voluntary movements of the former and the extremely simple voluntary movements of the latter.' One authority tells us that consciousness does nothing, and the other will have it that it does everything, rising even to the autonomic dignity of a will for atoms. They agree in believing consciousness to be a form of force; but they differ in that the first authority thinks it all dissipated, while the other holds it to be a link in a continuous chain of metamorphosis equivalent to every other link. As usual, truth lies between these extremes. Says du Bois Reymond, 'More temperate heads betrayed the weakness of their dialectics

in that they could not grasp the difference between the view, which I opposed, that consciousness could be explained on a mechanical basis, and the view which I did not question, but supported with new arguments, that consciousness is bound to material antecedents." Professor Cope says, "It will doubtless become possible to exhibit a parallel scale of relations between stimuli on the one hand and the degrees of consciousness on the other. Yet for all this it will be impossible to express self-knowledge in terms of force. An unprejudiced scrutiny of the nature of consciousness, no matter how limited that scrutiny necessarily is, shows that it is qualitatively comparable with nothing else." (*Am. Naturalist*, XVI, p. 224.)

V.—ETHNOLOGY.

Stanford's Compendium of Geography and Travel, for America, has an appendix upon the native tribes of both continents. The material was elaborated with considerable diligence by Mr. A. H. Keane, but the work is far from complete, and abounds in errors. The Bureau of Ethnology at Washington has had in preparation for several years a card catalogue naming and describing every tribe and band of aborigines ever known to have inhabited the North American continent. This is now kept in the office for reference and emendations, but it is designed to be published at no distant day.

Much valuable information has been added to what was previously known of the range and subdivision of the Innuït by Mr. Ivan Petroff, special agent of the Tenth Census. Mr. Petroff's results and map will be published in the volumes of the Tenth Census and by the Bureau of Ethnology. The author says: "In the course of my explorations, extending over a period of several years, of all the coast from Bering Straits to the vicinity of Mount St. Elias, and of the river systems, I found the Innuït occupying the coast and interior wherever nature has thrown no obstacle in the way of free navigation in their kayaks. The tribes having their homes contiguous to the Innuït are the Chugach, of purely Innuït extraction; the Oreghalenteze, of Innuït extraction, but now mixed with Thlinkit; and the Chilkhaat tribe of the Thlinkit family settled on Comptroller Bay and up the left bank of Copper River. The skulls of Innuït have been found as far south as Santa Barbara islands, California, but these belonged to prisoners taken from sea-otter hunting expeditions undertaken by English and American shippers who were furnished with Innuït hunters by the Russian authorities at Sitka. We have every reason to believe that formerly the Innuït occupied the coast as far as Icy Bay, but the constant pressure of the stronger Thlinkit tribes has caused them to recede gradually to the locations occupied by them at the present day. The glaciers at Icy Bay have proved an insurmountable obstacle, necessitating a sea voyage of two or three days before landing. The Thlinkit can accomplish this in his large dug-out provided with masts and sails. The Russians kept back the Thlin-

kits, but now they are encroaching northward. Mr. Petroff opposes Mr. Dall's view of the origin of the Eskimo, and maintains that they moved southward after the invention of the kayak. (*Am. Naturalist*, XXI, pp. 567-575.)

Our stock of knowledge gained respecting the South American tribes during the past year is exceedingly meager. Mr. Barney says respecting the natives of Colombia: "The state of Panama contains about 30,000 square miles, one-third of which is uninhabitable; the residue at the conquest (1502-1520) contained about 600,000 inhabitants in various stages of culture, from dwellers in tree tops to a degree of civilization very much superior to that of Briton at the time of the Roman conquest." The remainder of Mr. Barney's paper is devoted to the recital of the early history of these tribes, but as yet he has not told us a word about the modern Indians. (*Am. Antiquarian*, IV, Nos. 3 and 4.)

The Indians of the oriental province of Ecuador are divided into two great classes, "Indians" and "Infidels" (*Ancas, Infeles*). The former all speak Quichua, eat salt, and are semi-Christianized, whereas the latter speak the many languages of their various tribes, do not eat salt, and are not baptized. Among these are the Zaparos, Piojes or Santa Marias, Cotos, Tutapishcus, Anhishiris, Intillamas, Mequanas, Copaluncus, Tamburyacus, Payaquas, Cauranos, Pucabarrancas, Lagarto-Cochas, and Tagsha-Curarais. Most of these, except the first five, are quite unknown, having been met with only on rare occasions by traders and travellers. Some of the names given above may refer to the same tribe. The "Indians" are the Quichua, semi-Christianized people, who formed that portion of the once great Inca nation annexed by the marriage of Huayna-Capac with the Scyri princess, Pacha. Mr. A. Simson has given us a very minute description of these Napo Indians. (*J. Anthropol. Inst.*, XII, pp. 21-27.)

Mr. Gatschet has brought together and published notices by several authorities concerning white or light-colored Indians at the sources of the Amazonas, in the Cordilleras of South America. (*Ausland*, p. 887.)

VI.—GLOSSOLOGY.

Mr. Horatio Hale, the ethnologist of the Wilkes Expedition, read a paper before the American Association upon Indian migrations as evidenced by language. The fundamental proposition is, "The only satisfactory evidence of the affiliation or direct relationship of two communities, apart from authentic historical records, is their speech." When the evidence of language has satisfied us of the relationship of two peoples, the next inquiry is, Which was the ancestral stock? Is the connection that of brotherhood derived from a common ancestry? Taking language as the guide, Mr. Hale seeks to track the wanderings of the Huron-Iroquois stock, or, as he prefers, the Huron-Cherokee stock. The constant tradition of the Iroquois represents their ancestors as emigrants from the region north of the great lakes. To test this

question by language we have to inquire which is older—nearer to the primitive speech—the Huron or the Iroquois. Though we know nothing of this speech, we can reconstruct it from its offspring, and the one which is most complete in form and phonology is likely to be nearest in structure and residence to the original speech. Mr. Hale examines with great minuteness the forms of words common to the various branches of this great stock, in order to show abbreviation and differentiation as we proceed from the location of their supposed origin. (*American Antiquarian*, IV, Nos. 1 and 11.)

A language entirely new to science has recently been redeemed from oblivion. It was spoken in two dialects on both sides of the Mississippi River, between Natchez and Vicksburg, by the Taensa tribes mentioned by the French explorers and colonists of the eighteenth century. The manuscript of the *Grammaire et Vocabulaire de la Langue Taënsa* was prepared for the press by MM. J. Parisat and Lucien Adam. Mr. Gatschet informs us that the language forms a stock by itself and is remarkable for its extensive power of compounding by prefixes, by a variety of reverential pronouns, and by other forms. The number of terms embraced in the vocabulary is about 900. (*Am. Antiquarian*, IV, p. 238.)

The sources of information upon North American philology are the *Journal of Philology*, published in Baltimore; the *American Naturalist*, published in Philadelphia; and the *American Antiquarian*, published in Chicago. The largest collection of manuscripts is in the Bureau of Ethnology at Washington, a report of which is given in the first part of this volume.

The most elaborate linguistic production of the year in our country was the study of the Manuscript Troano, by Dr. Cyrus Thomas, with a historical introduction by Dr. Daniel G. Brinton. The Codex Tro or Troano was first published by the Abbé Brasseur (de Bourbourg). On his return from Yucatan, in 1864, he visited Madrid, and found this manuscript in the possession of Don Juan de Tro y Ortolano. It consists of 35 leaves of 70 pages, written on paper manufactured from the leaves of the maguey plant. Dr. Thomas briefly summarizes his conclusions respecting the manuscript:

1. The work was intended chiefly as a ritual or religious calendar. The day columns and numerals which form fully one-half of the written portion are dates, which run through a cycle of three hundred and twelve years, fixing the time when festivals should be held.

2. The figures in the spaces are in some cases symbolical, in others pictographs, and, in quite a number, refer to religious ceremonies; but in many instances they relate to the habits, customs, and occupations of the people.

3. The work appertained to and was prepared for a people living in the interior of the country, away from the sea-shore.

4. The people were peaceable, not addicted to war.

5. The taking of life, apparently of a slave, is indicated in one place;

this is the only symbol which can be construed to indicate human sacrifices.

6. The cross in some of its forms was in use as a religious emblem.

7. The movement of the figures is from right to left, and the plates should be taken in this way, at least by pairs; yet, as a general rule, the characters are in columns, to be read downward, columns following one another from left to right. When they are in lines they are to be read from left to right by lines from the top downward.

8. There is no fixed rule for the arrangement of the parts of compound characters.

9. That the characters, while phonetic, are not alphabetic, but syllabic.

10. The work was probably written about the middle or latter half of the fourteenth century.

11. The Ahau, or Katun was a period of 24 years, and the great cycle, of 312; the series commenced with a Cauac year.

12. Brasseur was right in supposing it to have originated in Peten. (*Cont. to N. A. Ethnology*, vol. v.)

VII.—COMPARATIVE TECHNOLOGY.

The transfer of General Pitt-Rivers' collection to the university of Oxford, during the current year, is an event which offers a fitting text on which to rest the chapter on technology. This study includes every form of human activity which demands a material upon which to operate and implements for its prosecution. With the growth of society there have been seasons of mutual helpfulness between the end to be attained and its instrumentalities, wherein the better social order has invented new tools; and, on the other hand, the improved invention has elevated society. General Pitt-Rivers began many years ago to gather from all parts of the world the implements of human warfare, arranging them, regardless of tribes and areas, upon a theory of evolution, elaboration, perfection. The same plan has been pursued in general and special collections, resulting in a better knowledge of the progress of invention. The motives operating in the works of men are two—the beautiful and the good, the one resulting in art, the other in handicraft. The two can hardly be separated except at their extremes, where the mere tool has no symmetry or beauty, and where the *chef d'œuvre* has no useful function. Both sorts have come over the same journey to their highest perfection. The few titles cited in the bibliography appended to this paper must not be looked upon as exhausting the subject. The enumeration of the titles of works devoted to the history of technique would far transcend the limits allowed to this entire paper. But, on the other hand, few writers upon the history of useful or ornamental art seem to realize that their subject has had an ontology and a phylogeny, that art itself has grown, and that its growth has been indissolubly connected with the history of humanity. Hence, most works on art or invention are not strictly anthropological, although their statements are of great value to the com-

parative technologist. The arrangement of the National Museum upon a technological, or anthropological basis is a work of the greatest magnitude. Indeed, by this anthropocentric scheme of a new order, all that is known or can be known may be grouped around man.

In discussing the origin and unfolding of styles in architecture, writers innumerable have confined themselves to the historic period, and have found in the rudest edifices of history the starting point of subsequent constructions. The Rev. Stephen D. Peet has gone a step backward in this search, and from his familiarity with aboriginal and prehistoric architecture is able to carry the investigation nearer to its source. By analyzing the prehistoric works of America he hopes to discover what are the essential elements of the higher orders, and so to gain hints as to their origin. He maintains that the pyramid, the pier and lintel, and the arch, as well as the column, have served an important part in architecture. The rudest predecessor of the true arch is to be seen at Uxmal, in the Algonquin huts, and in the conical bee-hive huts of Scotland. (*Am. Antiquarian*, IV, No. 4.)

A very interesting example of the aid of borrowed art in civilization is given by Mr. Griffis in his work on *Corea*. "Between the years 29 and 70, A. D., according to Japanese histories, an envoy from Shiura (Corea) arrived in Japan, and after an audience had with the Mikado, presented him with mirrors, swords, jade, and other works of skill and art. In this we have a hint of the origin of Japanese decorative art. It is evident from these gifts as well as from the reports of Chinese historians concerning the refined manners, the hereditary aristocracy, and the fortified strongholds of the Shinra people, that their grade of civilization was much higher than that of their northern neighbors. It was certainly superior to that of the Japanese, who were soon tempted to make descents upon the fertile lands, rich cities, and defenseless coasts of their visitors from the west."

Mr. Theodor Baker is the author of a work published in Leipzig, entitled "Ueber die Musik der nordamerikanischen Wilden." After examining forty-two songs and tunes obtained from at least twelve tribes, he finds that Indian melodies can be expressed by our musical scale and notes. Most of the tunes show an orderly movement, and the scales are few in number. The majority of the tunes follow the Lydian scale (c, d, e, f, g, a, b, c) and the Hypophrygian (g, a, b, c', d', e', f', g'); but in very few of them will be found all the seven notes of the diatonic scale. Every melody has the quint, or fifth, with its key-note; one-half of them have the major third, or diatone, while the flat or minor third occurs in a few only; the fourth and the sixth frequently occur, but the seventh note is infrequent. (Gatschet, in *Am. Naturalist*, XVII, p. 226.)

VIII.—SOCIOLOGY.

The catalogue of the Surgeon-General's library at Washington is a classified index of all volumes, pamphlets, and discussions upon any

part of anthropology which have found their way into that great collection. In the *Index Medicus*, under "biology" and "physiology," will be found many references to sociological subjects, and in the volume of the Index-Catalogue, issued in 1882, many more under the words "circumcision," "civilization" as related to medicine, "cosmetics," "cremation," "crime," and "criminals."

The practice of polyandry is known to have existed in many tribes of antiquity. Prof. John Avery has been collecting the evidences of its existence in modern times. It is in that part of India where the population is mostly non-Aryan and the influence of Hinduism is less prevalent, that polyandry is best illustrated. It is practiced by some of the lower agricultural castes among the Telugus, and by the Moplas and Nairs of Malabar. The most noteworthy instance found in India is among the rude tribe known as Todas. In case the husband of a female has brothers they may be admitted to a share in the wife on payment of their proportion of the dower. If they have sufficient means, they may also each purchase a wife in the manner described, and take the other brothers in as partners. Thus a group of brothers may in a perfectly lawful way have several wives in common. If a husband dies, care is taken that the widow shall not re-marry out of the family. (*Am. Antiquarian*, IV, pp. 48-53.)

One of the most thoughtful and philanthropic publications during the year upon sociological subjects is a paper by Sir H. Bartle Frere, on the laws affecting the relations between civilized and savage life, as bearing on the dealings of colonists with aborigines. Is it possible for an uncivilized race to continue to exist as uncivilized in the immediate neighborhood of a civilized race? After reviewing with great learning the immigration of the Aryan races into India and their contact with the natives of the peninsula, the reservation plan of the Chaldæans, Assyrians, Babylonians, Medians, and Persians, the shepherd kings of the Egyptians, the early conquest of Greece, the conquests of Rome, and especially the settlements of English colonies in America, India, and Africa, the writer is led to the following conclusions:

1. That it is possible for the civilized to overcome and destroy by war the uncivilized and savage race.
2. That simple proximity has led to the extinction of the savage race.
3. That the changes which have occurred in the native races consequent upon the proximity of European colonists are an advance in civilization and approximation to the types of European civilization.
4. That the essentials to development are:
 - a. Such a peace as the Romans and the English have insured to subject races, as a consequence of civilized sovereignty, bringing with it—
 - b. Protection for life and property, and practical equality before the law, leading to a substitution of individual property for tribal communalage, involving the abolition of slavery, also private rights of making war and of carrying private arms.

c. Power of local legislation to secure education in the arts of civilized life.

d. Legislation should also be directed to place such restrictions on the sale of intoxicating substances as are needed to prevent the ruining of health and the retarding the material welfare of the native community.

e. To secure all these objects an equitable form of civilized taxation is needed, sufficient to meet the expenses of administration. (*J. Anthropol. Inst.*, XI, pp. 313-334.)

Following up the extended investigations of Mr. Morgan upon the laws of consanguinity and affinity among the various peoples of the earth, so many have become interested in the subject that several attempts have been made to simplify the process of recording the results by means of graphic signs. Major Powell, of the Bureau of Ethnology at Washington, devised for his manual a series of charts on which, by figures representing males and females, aided by colors and connecting lines, the whole scheme of marriage and blood relationship could be indicated. During the past year, Mr. A. McFarlane has fallen upon another method. There are two fundamental relationships of the highest generality, namely, child and parent. These can be combined so as to express any of the complex relationships; thus, grandchild is *child of child*; grandparent is *parent of parent*; brother or sister is *child of parent*; and consort is *parent of child*, and so on. Now let *c* denote child, *p* parent, and juxtaposition equal *of*, then *cc* will equal grandchild, *cp*, brother or sister, &c. Having classified the relationships in the various methods of which they are capable, Mr. McFarlane then introduces the notation for sex, in which *m* denotes male and *f* female, placed before the noun to which it relates, as *mc mc*, son of son, &c. Subsequently the scheme is enlarged so as to include all degrees of compound relationship recognized in the English laws of marriage and descent. (*J. Anthropol. Inst.*, XI, pp. 45-63, with charts.)

It is pretty well agreed that descent was first reckoned through females, and that where descent through males exists, traces of the former regulation are evident. How this change came about is unknown, but it has excited no little curiosity among anthropologists. Mr. Howitt and the Rev. Lorimer Fison have given much attention to this subject among the Australians and the Polynesians. They term the processes of transition "orderly movements" and "disorderly movements." By orderly movements is meant a gradual and peaceful change, resulting from the rise and growth of new ideas accepted by the whole community. By disorderly movements is meant a rebellion against law, successfully maintained; or the enforced segregation of a part of the tribe, resulting in circumstances under which the old regulations can no longer be obeyed. The examination of the Australian system especially leads to the conclusion that the change from mother right to father right may have been brought about not only by orderly

processes, but also by the violent action of impulses within the community itself. (*J. Anthropol. Inst.*, XII, pp. 30-46.)

As a preparation for the statistics of crime in the United States for the Tenth Census, Mr. Fred. H. Wines prepared a pamphlet entitled "The Nomenclature of Crime, or an analytical list of offenses against the statutes of the United States and the States of the Federal Union." In the letter of transmittal, Mr. Wines suggests some cautions about drawing conclusions concerning the criminality and morals of a State from the number of arrests or imprisonments, that being punishable in one State which is venial or differently treated in another. Before speculating upon criminality, therefore, it is necessary to find out what is considered to be crime. Nearly one thousand offenses are enumerated and classified. An alphabetic index at the end of the pamphlet enables one to find each crime and to study its relations. (F. H. Wines, Ill. State Bd. of Charities, Springfield, Ill.)

IX.—PNEUMATOLOGY.

Dr. Daniel G. Brinton's *American Hero-Myths* is the most thorough work upon American Indian religion which has appeared during the year. Says the author: "What I think to be the essence of all religions is their supposed control over the destiny of the individual. At heart all prayers are for preservation, the burden of all litanies is a begging for life." "At the foundation of all myths lies the mental process of personification, which finds expression in the rhetorical figure of *protopœia*. Most of the American languages favor these forms of personification. Other rhetorical figures,—paronyms, homonyms, otosis, polyonymy, and henotheism, have lent their aid in transforming what was once commonplace or purely ideal into a concrete myth. The natives of this continent had many myths, and among them there was one which was very prominent. It is that of a national hero, their mythical civilizer and teacher of the tribe, who, at the same time, was often identified with the supreme deity and creator of the world." Mr. Brinton's interpretation of these myths of Michabo, Ioskeha, Quetzalcoatl, Itzama, Kukulcan, and Viracocha is as follows: "The most important of all things to life is Light. This the primitive savage felt, and, personifying it, he made Light his chief god. The beginning of the day served, by analogy, for the beginning of the world. Light comes before the sun—brings it forth, creates it, as it were. Hence, the Light-God is not the Sun-God, but his antecedent and creator." Out of this idea of dawn and darkness, light and knowledge, Dr. Brinton brings his theory of the creeds and cults of the North American aborigines. The same author has published "The names of the Gods in the Kiche myths, and The Chronicles of the Mayas," Vol. I.

A very learned work on comparative religion is the volume of Hibbert lectures, by Dr. A. Kuenen, entitled "National Religions and Universal Religions." In 1874, by invitation of Dean Stanley, Prof. Max

Müller delivered a lecture on Missions, in Westminster Abbey. In this address religions were classified into non-missionary and missionary religions—the former including Judaism, Brahminism, and Zoroastrianism, the latter Buddhism, Mohammedanism, and Christianity. Dr. Kuenen observes the subject from a somewhat different point of view; that is, he does not ask them what they aim to be, but what they are essentially. With respect to Judaism, therefore, he is led to a different result, which in its prophetic element presents the character of universality. Mohammedanism, on the other hand, weighed in the Kuenen balance is found wanting.

The Rev. J. Owen Dorsey, formerly missionary among the Omahas, has been engaged for two years past under the direction of the Bureau of Ethnology in collecting myths from the various Dakotan tribes among whom he has labored. In this work he is assisted by others in the several tribes on our reservations. The object of Major Powell in this is to gather a very large quantity of well-recorded myths, from which a true philosophy of American priscan religion may be deducted. Nothing exhibits more plainly the oneness of the human race than a comparison of myths. Turning to one of Mr. Dorsey's Iowa traditions we read: "Once upon a time there was a man whose family consisted of himself, his wife, and a daughter about twelve years old, and a son three years younger than the daughter. The father kills the mother, cooks her, and gives her to the children for venison. The children pursue him like a fate, are helped in their travels by the ghost of their mother, until the tribe into which the father fled are brought to want." The incident of the naming of the animals is a very charming part of this story. This body of myths will appear in Major Powell's Contributions to North American Ethnology. (*Am. Antiquarian*, IV.)

The visit of Mr. Frank Cushing to the East with a band of Zuñis, in order to pay their respects to the great Ocean, or Father of Waters, was an event of no little importance in the history of mythology. Mr. Cushing has temporarily expatriated himself in order to become familiar with the Zuñian social life. In this he has been most successful, having been initiated into their mysteries and sacred orders. His researches will form a part of the publications of the Bureau of Ethnology.

X.—HEXIOLOGY.

The amount of modifying influence which the conditions affecting the respiratory and digestive organs of man are capable of exerting within a given period of time is a subject of the utmost importance to the anthropologist. Closely related to this inquiry is that which discusses the unity or the plurality of human species. If the total force of the environment has been sufficient within the period of human existence to bring about those hereditary characteristics which mark off the races of men, then we have no need of two or five or many origins. On the other hand, if the differentia of the races of men have the exalted value

of those upon which students of natural history are wont to found species—that is, if they were in existence before men were men, and were not brought about since—then polygenism is the true explanation of race difference. However that may be, the whole question depends upon the proper study of environment as to its influence upon living beings.

Of course, we may study this subject from two points of view. If a balsam apple be allowed to grow in any bottle whatever, it will exactly fill the space. Now, we may regard the bottle as shaping the apple or the apple as fitting the bottle. Likewise with life and its environment. Professor Hæckel calls this housekeeping of organisms, *œcology*; Karl Semper, universal physiology; Mivart, hexicology. The terms “biology,” “physiology,” “ergology,” and even “psychology” have also entered into this scrutiny of organic beings in the presence of environment. They also show the points of view from which the student regards this complex relation.

In a discussion upon the growth of children, Mr. George W. Peckham, of Milwaukee, takes up the relation of man to his surroundings. “The size of an organism is the result of inherited tendencies as modified by the two varying factors of waste and repair. To the sum of all the conditions which regulate the rate at which reintegration and disintegration take place the name ‘environment’ is applied. It occurs to me that by far the greater portion of an individual’s surroundings are determined for him by the degree of density of population in the locality in which he lives. That climate has any considerable effect in modifying growth, in the face of facts, seems quite improbable. Theoretically a low temperature ought to stunt men, since a large amount of energy would be expended in maintaining bodily heat. Taking a wide survey of the facts we find that the western Eskimo, the negroes of Guinea the Australians, the Patagonians, and the Kaffirs all have an average height of over 170 centimeters. In Europe the non-dependence of stature upon latitude is patent. The rate of growth is such that the boys are taller until the twelfth year and heavier until the thirteenth. Between thirteen and fifteen the girls are taller and heavier; after fifteen the boys exceed the girls in weight and stature. Children of pure American descent are taller than children of foreign-born parents, but are lighter than those of German parents. The height of American-born men is more modified by conditions accompanying density than by all other influences, race excepted; urban life tending toward a decrease of stature.” (*Sixth An. Rep. Wis. Bd. of Health*)

XI.—INSTRUMENTALITIES.

All sciences have their instruments of precision, which are but aids to the perceptive faculties, the memory, and the reason. The anthropologist, for each division of his subject, has his implements, his graphic methods, and his symbols. It is very interesting to note how the per-

fecting of these has kept pace with the improvement of each subject of inquiry. Indeed, the great difference of opinion among the French and the German craniologists is not so much respecting the importance of certain parts as it is with reference to instrumentation.

One of the most useful aids to progress is co-operation and division of labor. This is effected by societies and their publications. Indeed, it may be safely said that this subject is sufficiently appreciated, and the continuation of the present activity of harmoniously co-operating societies will bring together a mass of well-conducted observations of the highest importance. It is contemplated to organize an international bureau of anthropological bibliography. This will be a work of the highest usefulness, for which this and other summaries, the incomplete efforts of individuals, are only the preparation.

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PAPERS RELATING TO ANTHROPOLOGY.

THE GUATUSO INDIANS OF COSTA RICA.

By DON LEON FERNANDEZ, of *San José C. R.**

My expedition to the country of the Guatuso Indians resulted happily. We succeeded in penetrating to the very *palenques* (habitations) of the Indians, who fled to the forest on our approach, having abandoned all their instruments, arms, provisions, and utensils. By following the tracks of the Indians we managed to visit several of their *palenques*, but it was not possible for us to surprise one of them. Notwithstanding the ferocity and courage with which the Guatusos have been credited, they made no attempt to resist or do us any harm, doubtless because of our numbers, and that they took us at first for *huleros* (rubber men), who are for them the creatures most abhorred, on account of the depredations which have been committed, children seized and taken to Nicaragua to be sold as slaves, men murdered, women violated, and other cruelties committed which are hardly credible in this age.

After many excursions, during which we scoured the borders of the rivers Pataste and La Muerte, the principal affluents of the Rio Frio, both navigable, we encountered a party of Nicaragua *huleros*, who, practiced in the business, had surprised an Indian and had him tied up to a tree like a beast. After some information was obtained from them, through respect for Señor D. B. A. Shiel, bishop of Costa Rica, who was at the head of the expedition, they offered the Indian for use as a guide in our excursions.

Another party of our expedition succeeded, the same day that we met the *huleros*, in surprising another Indian who was secured after much difficulty and resistance.

The two Indians were brought together in our camp, where we treated them in the best manner possible. Giving them clothing and various presents, we made them understand, through the means of the interpreter who accompanied us, that we were not *huleros* (*chiuti*) but brothers (*tzaca*), that we were going to do them all good and deliver them from the attacks of the *huleros*, and concluded by asking them to take us to the *palenques* (*upola*) where their families were, that we might give them the various objects which we showed, especially the knives and

* Translation of a portion of a letter written by Don Leon Fernandez, on November 24, 1882, to Dr. J. F. Bransford.

axes, with which they seemed so much pleased. They agreed to do so, and next day we set out in search of their *palenques*, they serving as guides.

They trifled with us, intending, once away from the camp, to escape, and made us walk uselessly until 9 o'clock at night without having encountered a single Indian or seen a *palenque*. Our return to camp, through the thick forest and the darkness of the night, we owed to the ability of a Tucurrique Indian who accompanied us.

Convinced that we could do nothing through the two Guatuso Indians, we resolved to send them overland to San José with a part of the expedition, while fourteen of us, taking advantage of the boat of the *huleros*, embarked at the mouth of the Pataste to descend the Rio Frio, then the San Juan, and to ascend the Rio San Carlos. It took us sixteen hours to descend the river to the village of San Carlos, on Lake Nicaragua. It is a splendid river, without a rapid, and the course of the current is barely perceptible, with sufficient depth for navigation by steamers for a long distance above the point of our embarkation. Bordered by level and most fertile lands, as proven by the luxuriant vegetation, with abundance of fish and game, there truly may be enjoyed those savage tropical scenes which, unfortunately, are disappearing, and which are so keenly relished by those who, while appreciating the advantages of civilization, love nature.

Nothing of interest was observed in the descent of the San Juan and ascent of the San Carlos.

The bishop had the two Guatuso Indians in his house for some time, with others that we had managed to rescue, found in Nicaragua, that had been seized and sold by the *huleros*. In company with them he made a second expedition with brilliant results, as, this time, he managed to see the greater part of the Indians in their own habitations, to speak with them, and inspire them with confidence. On his return several of the Indians accompanied him as far as the Rio San Carlos, where has been established for them a depot of clothing and hardware. Parties of Indians have continued to come to this post to provide themselves with hardware principally, and some have ventured as far as San Ramon, but they have not yet had the boldness to come to San José, for fear of the cold.

Some soldiers that were afterwards sent to the territory of the Indians to protect them against the incursions of the *huleros* were very well received.

So it may be said that the conquest is made, and that the Republic has taken possession of a large and important tract of territory, which is called to a prosperous and not distant future, especially in view of the probability of the early opening of the Nicaragua canal.

The lands occupied by the Guatusos are very extensive, level, fertile, and intersected by navigable rivers, with a slight incline from the right bank of the San Juan River to the central Cordillera, which divides

the waters of the Atlantic and Pacific. It has all imaginable climates between that of the fresh and bracing region of San José and the heat of the borders of Lake Nicaragua.

The Guatusos cultivate largely the plantain, which is their principal article of food, maize, cacao, zuca (manioca), tobacco, sugar-cane, cotton, agi (chile), &c. They make hammocks and nets of cabuya (agave). They are robust, agile, well formed, and of good character. They are pure Indians and not white, as has been claimed, although in some cases was noticed a trace of white or negro blood. Their number cannot yet be approximately calculated, but is not less than six hundred.

I am now occupied in the study of their language, and hope to publish my results in the third volume of the "*Documentos.*"*

NOTE, BY J. F. BRANSFORD.

Next after the Lacandones of Guatemala the Guatusos of Costa Rica have been the most mysterious Indians of Central America, and have furnished material for numberless extraordinary stories by travelers in that section. In finally settling the question of color, race, &c., Don Leon Fernandez and the bishop of Costa Rica have done a service to science, but they have given a dreadful blow to future writers of entertaining yarns about Costa Rica and Nicaragua.

This tribe, spoken of as Guatusos or Pranzos, or Rio Frio Indians, inhabit the valley between the main Cordillera, that strikes the San Juan at Machuca, and the volcanic range, which, in northwest Costa Rica, is near the Pacific. The valley is drained by the Rio Frio, which enters Lake Nicaragua less than half a mile from the point where the San Juan leaves it.

In looking up the literature on this subject, as well as on all questions concerning Central America, we turn naturally to Squier,† and are rewarded with a summary of what was known of these people up to 1858.

According to Mr. Squier, the first allusion to the fierce warriors of the Rio Frio was in a report to the King of Spain about 1719, by Diego de la Haya, governor of Costa Rica. Afterwards there was a legend that they were de-cendants of Indians who withdrew from Esparza when it was destroyed by buccaneers in the latter part of the seventeenth century. In 1750 Padre Zepeda, a Franciscan of Guatemala, spent several months with the Guatusos, who treated him kindly. He claimed to have seen more than five hundred houses. In 1756 the guardian of the convent of Esparza reported the results of Zepeda's trip, and was instructed to follow up the discoveries. He started, but got lost. In 1761 four men, spoken of as Sambos,‡ who were captured in the mount-

* *Collección de Documentos para la Historia de Costa Rica*, por Don Leon Fernandez. San José, Costa Rica.

† *The State of Central America*, by E. G. Squier. New York, 1858; page 405.

‡ That they were really Sambos is of course hardly probable.

ains, were taken to Esparza and confirmed the account of houses, &c., given by Zepeda. They showed acquaintance with certain doctrines of the church, which they said had been taught them by a Padre Adam. This padre turned out to be a young man, who, after attending college at Leon, for some reason fled to the Rio Frio country, where he lived and died, not being permitted to return to his home. The cura of Esparza and a missionary started for the mysterious valley, led by the Sambos, who abandoned them as soon as they were well into the forest. In 1778 the enthusiastic Fraile Lopez made his first attempt to enter the country, over Orosi, but failed. He next tried by boat up the river, but at the sight of the first raft of the Guatusos, his boatmen turned and paddled their best down stream, refusing to listen to his entreaties to be landed. In 1782 he made a third attempt by way of Tenorio, but, after wandering in the forest for seventy-five days, he came out on Lake Nicaragua. In 1783 Tristan, bishop of Nicaragua, accompanied by Lopez, made an expedition up the river. Lopez went ahead in a canoe, and was attacked. Some of his men jumped overboard, and the others dropped in the bottom of the boat. When the Guatusos saw the devoted friar standing with only a crucifix in his hand the shower of arrows ceased and he was allowed to land. His canoemen hastened to rejoin the bishop, and we hear no more of the heroic Lopez.

Finally, Col. Trinidad Salazar, of Nicaragua, informed Mr. Squier that in 1849 he took two boats with soldiers up the Rio Frio. After traveling for several days he was attacked from ambush, was wounded, and his party repulsed.

Our next authority, Froebel, who visited Central America after Mr. Squier, gives a version of Salazar's experience, in which all were killed except the colonel. He was informed that not only were no foreigners allowed by the Guatusos to enter their country, but members of their tribe who had been in captivity were killed when they returned. "They are said to be of fair complexion, a statement which has caused the appellation *Indios Blancos*, or Guatusos, the latter name being that of an animal of reddish brown color, and intended to designate the color of their hair."*

Froebel also gives the very romantic experience of a German youth with these Indians—the Pocahontas story adapted.

Mr. Squier, writing again in 1860, says that the valley of the Rio Frio "is estimated to be at least 150 miles long by from 80 to 90 broad." "Of the Indians, called Guatusos, inhabiting this district, of whom nothing is positively known, the most extraordinary notions are entertained by the people of the adjacent states. They are reputed to be above the ordinary stature, with comparatively light complexion, and red hair; and tales are told of some of their women having been seen by hunters

* *Seven Years' Travel in Central America*, by Julius Froebel. London, 1859; page 24. See also his *Aus America*, Leipzig.

and others as fair and beautiful as the fairest Europeans.”* While Mr. Squier gave no credit to such reports, he thought that in isolation their character, habits, language, religion, &c., had probably remained unchanged, and would reward the successful explorer.

Vigne, writing in 1863,† simply states that according to hearsay there is a tribe of fair Indians, supposed to be descendants of Spaniards, two days’ boating up the Rio Frio.

That entertaining writer, Frederick Boyle, says: “Everything connected with this fierce race is enveloped in awful mystery, but it is curious that all accounts give them an origin far from their present seats. The story current in Costa Rica cannot fail to interest the Englishman, even if he be not converted to a belief in its truth. When Sir Francis Drake retired to the Pacific shore after the sack of Esparza, say they, a large body of his men mutinied in mad hopes of holding that town against the creole forces, and resting peaceably there. Drake left them to their fate. But when the Spanish army assembled and the mutineers found themselves nearly surrounded, they hastily retired through the forest of Merivalles.”‡ Their intention was to reach the Mosquito coast, but they were never heard of in that region, and many people believed that they stopped on the Rio Frio.

Another story given to Boyle, to account for the color of the Guatusos, was that the Indians made a descent on Spanish settlements and carried off thousands of women. That story was rejected. Before his arrival in Nicaragua an American filibuster and three Frenchmen had tried the river. After ascending for several days they rounded a sharp turn and came suddenly on an Indian who was standing on his raft spearing fish. Apparently not at all disconcerted he picked up his bow and drew an arrow to the head. Then for some reason dropped that arrow and took another, but before he could shoot he was fired on and killed. The white men not caring to encounter Indians of this resolute character turned back. They described him as looking like a Comanche.

The naturalist Belt saw five Guatuso children in Nicaragua who had the common Indian features, though he thought they seemed unusually intelligent. He believed the name of the tribe had nothing to do with the color of their hair, but had been acquired as in other cases where the name of an animal is borne.§

Mr. William M. Gabb, who has given the best account of the Costa Rica Indians,|| said he had seen several persons who had visited the valley of the Rio Frio, but their stories were too wildly extravagant to be entitled to repetition. General Guardin, President of Costa Rica,

* *Historical Magazine*. Boston; vol. IV, page 65. See also in *Nouvelles Annales de Voyage*, 1856, tom. CLI, pp. 6-12.

† *Travels in Mexico, South America, &c.*, by G. T. Vigne. London, 1863; vol. I, page 77.

‡ *A Ride Across a Continent*, by Frederick Boyle. London, 1868; page xx of preface.

§ *The Naturalist in Nicaragua*, by Thomas Belt. London, 1874; page 38.

|| *American Philosophical Society Proceedings*. Phila.; vol. 14, page 433.

told Mr. Gabb that the Guatusos encountered by him on a military expedition in their country, were ordinarily of the color of Indians, but there were some exceptions of comparatively white skins and brownish or reddish hair. Guardin said that when Esparza was sacked by English freebooters a number of the inhabitants, many of whom were white, took refuge in the mountains and were heard of never more.

A Guatuso boy who lived for awhile at Alajulla was very sullen, and neither coaxing nor threats could induce him to answer questions in regard to the language of his people.

Mr. Gabb said that lately the rubber men had ascended the river in their boats to a point within three days' walk of Las Cruces, on the Pacific side of the Cordillera, the once fearless warriors having tired of the game of bows and arrows against buckshot and bullets.

The list of authors who have had something to say about these Indians is quite extensive, but I will give extracts from only one more—the first to allude to white Indians on the Isthmus. Speaking of occasional specimens, Wafer says: "They are white and there are of them of both sexes; yet there are but few of them in comparison of the copper colored, possibly but one to two or three hundred. They differ from the other Indians chiefly in respect of color." "Rather a milk-white, lighter than the color of any European, and much like that of a white horse." "Their bodies are beset all over with a fine short milk-white down." "Their eyebrows are milk-white also, and so is the hair of their heads, and very fine withal."* He reported them smaller and less strong than other Indians, and sluggish during the day, but skipping through the forest as fast by moonlight as others did by daylight.

In late years the rubber hunters have ascended the river and roamed the country, robbing and shooting until the formerly courageous Guatusos seem utterly cowed. The writer of this note saw two in Nicaragua in 1877. They were rather darker than the average Indian. One of them, a boy at Castillo Viejo, was decidedly intelligent, and from him were obtained a number of words of his mother tongue, a list of which was afterwards sent to Mr. Gabb.

Don Leon Fernandez started on his expedition in April, 1882, and finally settled the question. And now we may look for an early and satisfactory account of habits, &c., which have probably been preserved nearly as they were when Columbus made his discovery.

Mr. Squier thought that as natives of Ometepe and Solentiname of Aztec stock, were taken as interpreters on the various expeditions from Nicaragua, the Guatusos would probably prove to be of kindred race; a belief which was strengthened by the fact that the captured Sambos were understood by the Indians of Esparza, who, if not themselves Nahuatl, had settlements of that people in their neighborhood.

* *A New Voyage and Description of the Isthmus of America*, by Lionel Wafer. London, 1699; page 134.

During five winters spent in the interior of Central America, the writer of this note did not see an Albino among the Indians.

Torquemada, in giving the traditions of the wanderings of the Cholutecos or Chorotegas in Central America, says that one party left the main body and reached the Atlantic. After following the coast of Nicaragua and Costa Rica, they turned back across country in search of the fresh water sea (Lake Nicaragua), of which they had heard so much.* Possibly this party left settlers in the region of the Rio Frio.

However, light will soon be thrown on the subject by the study of their language now prosecuted by Señor Fernandez.†

ANCIENT REMAINS IN WHITE RIVER CAÑON.

By R. T. BRON, M. D., of *Camp Apache, Arizona.*

Since writing the description of the ruins in White River Cañon in 1878, other discoveries have been made, an account of which follows.

In the autumn of 1878, two burial-places were discovered, one near the ruins at the mouth of the cañon, about three miles down the stream from Camp J. A. Rucker. This cemetery consisted of one hundred or more tumuli of stones varying in height from one foot to three feet, and scattered irregularly along a small valley.

Above the ruins at Camp Rucker, about three-fourths of a mile, the second cemetery is to be seen on the left bank of White River. This burial-place is situated on a bluff about 60 feet above the bed of the stream. It was covered with a growth of pines, some of which are over 18 inches in diameter and many of them are growing out of the mounds. It was in this last-named cemetery that an excavation was made in the largest mound, supposed to contain the remains of some notable person. The length of the structure was about 15 feet, the breadth 8 or 10 feet, and the height 4 feet. It was formed of cobble-stones thrown together. After the stones were removed an excavation was made 4 feet deep into the soil. During the digging, at a depth of 18 inches, bits of broken pottery were found, but no bones. Growing out of this mound was a large pine tree, 4 feet in girth. In the immediate neighborhood of this mound the piles were larger than at other places.

Two or three smaller mounds near the mouth of the cañon were examined, and fragments of pottery were taken from each, but no bones or any relics. The cemetery in the cañon seems to have belonged to the three settlements, as it is almost equidistant from each, about half a mile. The one in the valley at the mouth of the cañon must also have belonged to the two or three settlements in its vicinity.

The remains of buildings are much more numerous than was indicated in my last annual communication. On careful search they were found

* *Monarquía Indiana*, by Juan de Torquemada. Madrid, 1723; tom. 1, page 333.

† Students interested in this and neighboring tribes will do well to consult Hubert H. Bancroft, *Native Races of the Pacific States*, page 747, *et seq.*; Wagner & Scherzer, *Costa Rica, &c.*, and especially Benzoni, who gives an excellent account of the expedition of Gutierrez.

to be scattered over more than 600 acres. They are not close together or uniformly distributed, but in separate groups. Large quantities of broken pottery are scattered around the foundations, some of it very prettily marked. The foundations are similar to those previously described. Rows of upright undressed stones, metates, and a few mortars were discovered. One of the mortars, near a small stream, had been hollowed out in a shelf of solid rock and was 300 feet distant from the remains of buildings.

Judging from the pottery found in the tumuli, the people must have cremated their dead and buried the ashes in urns without any of their trinkets or other property. The large mound explored certainly had not been disturbed, and yet revealed no relics.

The Apache Indians, who have inhabited this region since the coming of the Spaniards, do not cremate the dead but bury in secluded places, and singly; they endeavor to remove all traces of the interment.

In giving the number of the mounds I have not over-estimated, for doubtless a careful search would reveal many more. Some of them are quite small, not containing more than a ton of stone.

MOUNDS IN HENRY COUNTY, IOWA.

By GEORGE C. VAN ALLEN, of *Mount Pleasant, Iowa.*

The following is a description of three Indian mounds located on Section 34, Township 72, Range 7 West, in Henry County, Iowa. The hill is about 1,000 feet long, and 300 feet wide from the base on the east to the fence on the west, and is about 120 feet above the level of the corn-field. Major Bereman, of this place, visited these mounds in June, and from one took out a quantity of bones, teeth, and charcoal. Some of the bones were charred and some sticks only partly burned. There seemed to be no order in the burial. The bones were nearly in a heap, and showed that more than one person had been burned and buried there. On July 20th a small party visited the place, took the measurements, and made some further excavations, but found nothing beyond some pieces of soft bone, a few bits of charred wood, and a pinkish-white arrow-head. No stones were found that seemed to us to have been arranged in any order, but a few were scattered at random throughout the mound. No. 1 is 50 feet north and south by 41 feet east and west; No. 2 is 43 feet north and south by 49 feet east and west; No. 3 is 40 feet north and south by 40 feet east and west. The distances from center to center are 107 feet and 50 feet. The height is from $4\frac{1}{2}$ to 5 feet at the center. South of No. 3 are the remains of two mounds begun, about one foot deep at the center.

MOUNDS IN CARROLL COUNTY, ILLINOIS.

By JAMES M. WILLIAMSON, *of Thomson, Ill.*

In the town of York, Carroll County, Illinois, is a group of five very remarkable mounds. They are situated on the bluffs, 300 feet above the bottom-lands on the east side of the Mississippi River, from which they are distant about $2\frac{1}{2}$ miles. They are built upon a high ridge of ground running in a due line from southwest to northeast. The first mound on the southwest is about 50 feet in diameter, and they grow smaller until the last one of them is only 10 feet across.

In September, 1882, I procured help and opened the first one by digging a trench directly through, beginning on a level with the base of the mound. After trenching about 8 feet we came to some fragments of burned clay, the pieces being as hard as burned brick, and resembling it very much in color. On digging in a little farther we came to fragments of rotten bone and teeth, but soon met with other bones in a better state of preservation. Digging in still farther we presently came to a perfect charnel-house of bones, most of them well preserved. We took them out as carefully as we could, and procured twenty-two crania, some of them very large indeed, and many of them in a good state of preservation and well shaped. All the other bones were in a fine state of preservation, and I have no doubt that this mound yet contains the skeletons of one hundred or more of the ancient mound builders of Carroll County.

The next mound opened was the last of the five on the northeast end of the ridge and is the smallest of the number. In this, at the depth of $6\frac{1}{2}$ feet, we came upon another mound or cist of burned clay, $3\frac{1}{2}$ feet wide at the base, $7\frac{1}{2}$ feet long, and 20 inches high, this being so hard that it was almost impossible to penetrate it; but by slow work we tore it to pieces and found that it contained the remains of a body which had been burned. I brought away many of the bones; they are charred and very hard. Fragments of the skull are as tough as the thickest pottery. Over this mound of burned clay were ashes to the depth of nearly two inches, intermixed with charcoal. The body had evidently been laid on the surface of the ground, and the clay packed around and over it, after which the fires were kindled. This inside mound could have been taken out whole if we had exercised forethought. The other three mounds I have not opened yet, but shall do so in early spring. I expect from them some rich developments; they are all covered with heavy timber and hard to get at, as many of the roots from the oaks penetrate the skulls. Inside of the burned cist I found many fragments of pottery and flint implements, convincing me that the class of mound-builders inhabiting Northern Illinois broke all their implements, utensils, ornaments, &c., at the time of burying their owners, for in all my mound opening in this section I have never found a whole piece of pottery and but few whole stone implements or ornaments, but vast quantities of broken ones.

MOUNDS OF THE MISSISSIPPI BOTTOM, ILLINOIS.

By WM. MCADAMS, JR., of *Otterville, Ill.*

The first exploration to be described relates to two remarkable mounds the first of which is on the Illinois River bottom, 15 miles from the mouth. It is oval in outline, 175 feet long and 50 feet wide on the level top, the sides sloping gradually down to the bottom. At the depth of 16 feet we came to a basin of clay filled with clean white sand. This basin was 25 or 30 feet long, and 20 wide. Covered up in the sand was a wagon-load of raw material for stone implements, flints, quartz, chalcedony, jasper, some of these in large pieces and very fine. The flint was from broken nodules, three of which, weighing from 20 to 40 pounds, were entire. These flint nodules were white without and dark brown within, like the flint nodules in the chalk. Some of the material was blocked out for implements. Lying on the sand were three large sea-shell vessels holding two quarts each. At the north end of the basin were found two skeletons in a sitting posture on the sand. The one on the east was that of an old man, judging from the teeth and obliteration of the sutures of the skull. The skeleton at his side was that of a young woman with beautiful even teeth. Around the neck of the old man was a string of shell beads of curious form, the perforation not going entirely through the bead, but out laterally. A few beads were scattered around. On the old man's breast was a circular plate of copper, about 4 inches across, also an ornament of copper like a large sleeve-button or spool 2 inches across the disks. These were much corroded. At the left side of the old man lay a beautiful pipe of mottled catlinite in form resembling many figured from the mounds, the curved base forming the stem. The skull, which I was very anxious to preserve, was broken, but the upper portion was saved. There were ashes and evidences of fire around the basin, indicating that fire had been used in the funeral ceremonies.

The second was a remarkable mound previously unexplored, situated on the Mississippi bluff in Calhoun County, Illinois. It was not a large mound, being only about 25 or 30 feet across the top, and 3 feet high. The bones found in it were very old and much decayed, and there seemed to be ten or twelve bodies buried in it. From this mound were taken seven ceremonial axes. They are of porphyritic granite, and are 5 to 6 inches long. There were four of the regular axe pattern, and two with narrow wings on the side of the central column, and one with jags at the two ends, like feet. One is of quartz and the other two are of a variety of quartzite. The lines on them are straight and true, the perforation passing through the center. They are very smooth and highly polished. Four copper axes of the celt pattern were found, plainly showing that they were hammered out from native ore. They are somewhat corroded. Three spear-points, with notched bases 6 inches long, were also unearthed, two of white jasper and one of red.

In addition to these our find included thirty-five clipped implements of white chert, varying from 8 to 10 inches in length, three polished axes, a plummet, and a stone tube. It is quite uncommon to find axes in a mound. These were taken from the base of the mound. There were no beads, shells, pipes, or ornaments found.

The country about the mouth of the Illinois and Missouri River is a good locality for mound exploration, especially on the highlands, but those in the bottoms are much the richest in relics. Fifteen miles from the mouth of the Illinois River is a group of six mounds in the river bottom; the largest of these was explored by the writer, and a pipe, copper ornaments, shells, &c., recovered. A ceremonial ax, however, was taken from a mound on the highland. On the Illinois River bottom, 35 or 40 miles from its mouth, is another group of eleven mounds, which are larger than those of the first group. Arrangements have been made with the owner of the field, and digging in them will soon commence. Some of the most promising mounds, however, are within a day's drive of Otterville, on the American bottom, between Alton and Saint Louis. Some valuable relics have been obtained here, yet very few, if any, of these large mounds have been explored.

The mounds, group No. 1, described below are situated on the Illinois River, 40 miles from its mouth. They are ten in number, and are in the lowlands or bottom, just beneath a precipitous bluff and near the river bank.

An excavation was made in No. 8, 13 feet deep, which revealed ashes in considerable quantity, alongside of which was an arch of flat stone covering a skeleton not very well preserved. The skull was broken and lying on a thin shingle-like piece of cedar, colored green with copper. Some of the bones were green also, but no copper implements were found, they being entirely oxidized. Nearly a quart of shell beads, some large, others small, were found at the head as well as at the feet of the skeleton. An excavation in No. 7 to the depth of 13 feet revealed nothing. No. 4 is a conical mound, flat on top with a depression in the center. At the depth of 16 feet two crumbling skeletons were imbedded in a light-colored marly earth, showing marks of stratification, as if water had been used in its deposition. The white and dark colored laminae, which I have not before seen in a mound, were not half an inch in thickness. The same stratified earth was found near the skeleton in No. 8. No relics of any kind except the human bones occurred in mound No. 4.

No. 2 is a double mound much lower in the middle, and seeming to be two mounds joined together. In this an excavation was made 18 feet deep, and tunnels carried under a good part of the mound, but nothing of value was found except burned stones, some ashes, and a few river shells. The mounds were very hard, and the excavations were made as we descended. Yet this long search yielded little or nothing. The author camped among the mounds with five young men, but in spite of good tools the young men got discouraged, and further exploration was

reluctantly postponed. The largest mound of the group, No. 1, is 20 feet high, and unexplored, as are the remainder of the group not mentioned.

In mound No. 8, about 7 or 8 feet below the surface we found two skeletons, apparently an intrusive burial. With one were some arrow-points and a piece of plumbago nearly an inch square. With the other skeleton was an earthen vessel broken and crushed.

There are many mounds on the bluff adjacent to the group in the bottom. They are composed of earth and flat stones, and from one of them were obtained several perfect skulls, two of them very interesting on account of their peculiar shape, one broad and flat, the other narrow and long. From this mound was also obtained a fine piece of pottery in good preservation and perfect, excepting a small piece broken from the rim by the spade. It is different from any hitherto found. The vessel is of a dark, nearly black color, and seems to have been burned. It contained the inevitable spoon of shell from the adjacent stream. Near the vessel were secured flint implements, such as arrow-points, scrapers, bunts, knives, &c. The skull was broken in many pieces and beyond recovery. The flint and shell-spoon on one side have a siliceous, stony crust. This incrustation is also on the inside of the earthen vessel. From the fields in this vicinity were obtained a number of stone implements.

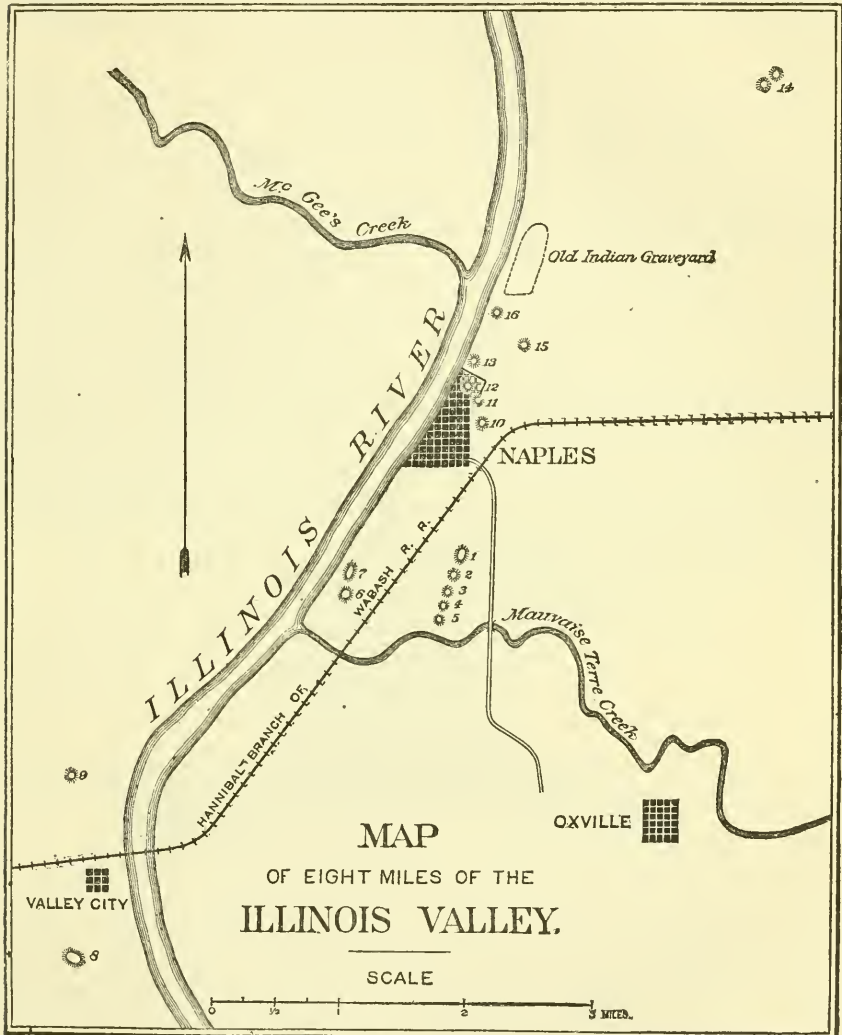
ABORIGINAL REMAINS NEAR NAPLES, ILL.

By JOHN G. HENDERSON, of Winchester, Ill.

A number of years ago Dr. Clark Roberts, of Winchester, Ill., had in his possession some singular pipes, which upon examination proved to be relics of the mound-builders. This, however, is a rather unfortunate title, as the history of nearly all savage races shows them to have been mound-builders. The same locality, by disease, famine, emigration, or war, may have been depopulated and again re-peopled by other races, each of which in its turn may have erected mounds for religious purposes, as sites for temples or dwellings, points of observation or monuments over dead heroes. The word *mound-builder*, therefore, is calculated to lead to error by the implication that the habit of mound-building was peculiar to one prehistoric race, and that all the mounds of the great valley of the Mississippi are relics of one lost and forgotten people. In this paper the term *mound-builder* is applied to no particular race or nation, but to those who in ancient times occupied the Mississippi Valley, and there erected earthworks of any kind.

As the bulk of all that is known of the ancient inhabitants of this valley, especially of their curious and beautiful pipe-sculpture, was obtained by Squier and Davis from the mounds of Ohio, the importance of the discovery of similar articles on the banks of the Illinois River, the ancient Høukiki of the Algonkins, was fully appreciated by the writer,

and Dr. Roberts kindly placed them at his disposal, giving all the information he could relative to them. The relics were obtained from a mound at Naples, Ill., where several years ago the writer resided and heard of the finding of these relics, especially the turtle-pipe. Dr. Roberts's courtesy determined at once a visit to the place in order to examine carefully the character of the mound, and to find anything



Map. Fig. 1.

that had been overlooked or thrown aside by the parties who first explored it. Accordingly, in February, 1876, in company with Mr. Merrill, the author visited the spot with the necessary implements for making a thorough examination. On a sand ridge, about one mile southeast of Naples and about three-quarters of a mile from the river,

are five mounds, represented in the accompanying map, Nos. 1, 2, 3, 4, 5.

The river bed is near the center of the space between the bluffs or highlands, which are at this place 7 or 8 miles apart.

The following figure shows the relative position of the bluffs, river bottom, river bed, and sand-ridge on which the mounds are located:



FIG. 2. Section of bluffs, &c., on Illinois River.

Nos. 2 2 represent the bluffs capped with *loess*; 3, the river bed, and 5 the sand ridge. This ridge is between a fourth of a mile and half a mile in width, about 30 feet higher than the level lands on either side, and runs a little east of north, parallel with the river. The mounds are nearly parallel with the ridge. The one farthest to the north, No. 1 (Fig. 1), is a regular oval, 132 feet long, 98 feet wide, and about 10 feet high. It was, no doubt, originally much higher, as it has been plowed over for years, and the top is composed of sand. Mound No. 2 is the one from which the pipes and other relics referred to were taken. This one, and Nos. 3 and 4, are covered with a small growth of hickory and oak trees. No. 2 is 86 feet in diameter and about 11 feet high. No. 3 is 90 feet in diameter and 11 feet 4 inches high. No. 4 is 66 feet in diameter and about 4 feet 8 inches high. No. 5 is 50 feet in diameter and 3 feet 6 inches high. Mound No. 3 is composed of very hard ash-colored clay. No. 2, from which the pipes were taken, is shown in the following outline cut (Fig. 3), which represents its present condition:

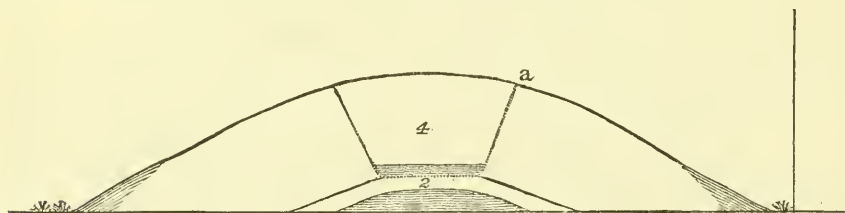


FIG. 3. Section of mound near Naples, Ill.

The inclosed space marked 4 represents the excavation made by former explorers. In the present exploration the diameter of the mound, 86 feet, was first obtained and then its height, using for this latter purpose a spirit-level and pole, as represented in the cut, placing the level on the margin of the excavation at *a*. Its height proving to be about 11 feet and the depth of the old excavation about 7 feet, 4 feet remained in order to reach the original surface. The removal of a large amount of forest leaves that had accumulated in the hole revealed for the first foot or more, soil that had tumbled down from the walls of the excavation. Next was encountered a stratum about 18 inches in thickness, composed of clay, black soil, and sand, in separate

patches, indicated by 2 in the above cut. Below this was a layer of black soil, in which were found human bones, the head of one femur, the head and about 6 inches of the upper end of the other, one of the vertebræ, both clavicles, ribs, and other bones, but all very much decayed. Pieces of the skull were found, but so much decayed that only the outline was indicated on the earth. The size of the femur and other bones refuted the current tradition in the neighborhood that the original excavators found bones of giants in this mound. No ashes, charcoal, or any other indication of fire appeared. There was no altar. It seemed to have been simply a burial mound, the body having been placed on the ground and covered with a layer of black soil.

The first explorers found three pipes and two copper axes, of which two pipes and one copper ax were secured. The thorough excavation before mentioned prevented the determination of the exact position of the bones. The occurrence of the bones of only one individual led to the conclusion that the mound was erected as a memorial over the remains of a single chieftain or hero.

The relics discovered in mound No. 2 are probably as fine specimens of carving as have ever been found anywhere belonging to that ancient people, and they are in no way injured by the action of fire. Three pipes and two copper axes were found in the mound at a depth of about 15 feet. The following cut represents one of the pipes, intended to resemble the raccoon (*Procyon lotor*).

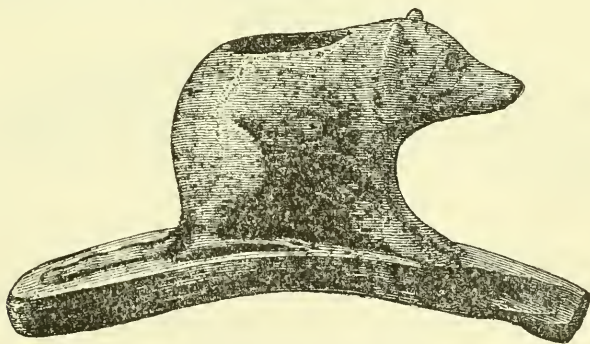


FIG. 4. Raccoon pipe, from Naples, Ill.

This raccoon pipe is made of very hard stone, and is polished as smooth as glass, and every feature of the animal is perfect. The bars on the tail, the claws, the position of the fore and hind feet are all correct; even the markings of the face are properly indicated by lines cut in the stone. But above all, the artist has caught the very expression of the animal which he was imitating.

Such artistic skill in the manipulation of the hardest and most intractable material into beautiful and graceful forms could only be obtained by long study and patient toil.

One of the most remarkable things about this specimen remains to be described, for it is not shown in the cut. The native workman, for some reason, began drilling the hole for the stem at the rear end of the curved base, so that the nose of the animal would be *from* the smoker, but, by accident, the under side of the material chipped out. Too much labor had been expended on the specimen to throw it away. He therefore made a neat plug of the same material, stopped up the hole with it, and then drilled a hole, as is almost invariably the case, in the front end, so the animal would face the smoker. The right front corner of the curved base is broken off, the fracture beginning at the stem hole, and, it may be, that this other hole was an attempt to repair the pipe after it was broken, and that, when the artist chipped out the lower side of the hole, he gave up the work and plugged up the partially drilled hole. Whatever may have been his object this neatly fitted plug is another proof of the skill of the workman.

The other pipe taken from the same mound is no less perfect. It represents the common hard-shell turtle of the American rivers, as shown in Fig. 5.

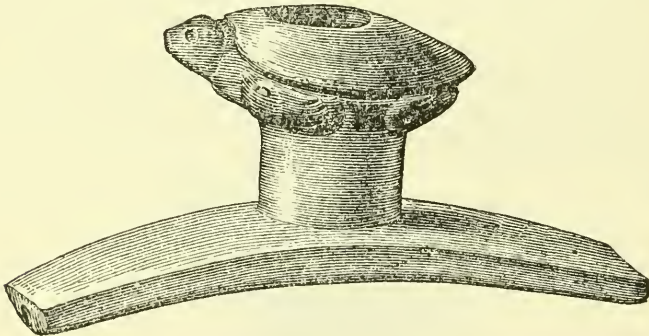


FIG. 5. Tur le pipe, from Naples, Ill.

The cut shows but faintly the beauty of this specimen—the nostrils, the head partially drawn back, the consequent fold of skin in the rear of the skull, the paddle-like feet, the claws, the tail folded around and against the body on the underside of the rear of the shell—all are perfect. In one of the eye-holes is a copper bead representing the eye ball, the other one being lost.

Professor Baird pronounces this turtle pipe to be made of catlinite. There has been some question whether any articles made of this substance have been found in any locality of undoubted antiquity; the shape, however, is precisely that of the other mound pipes. There is no question as to the antiquity of the specimen, however.

Judged from the figure on p. 423, of "*Flint Chips*" of a turtle pipe, found in the mounds of Ohio, by *Squier and Davis*, the Naples specimen is far superior to that one in fidelity to nature. The copper ax, Fig. 10

a and *b*, is 8½ inches long, 3⅝ wide at the cutting edge, 2 inches wide at the top, and nine-sixteenths of an inch thick. It is made of pure copper. On one side the salts of the copper have preserved the cloth that lay against it.* The warp and woof, Fig 10 *c*, are distinctly marked. On the other side of the ax are preserved, in the same manner, feathers over the whole surface. This feather cloth was extensively manufactured by the Red Indians of two hundred years ago, but is now, like the manufacture of pottery, to most tribes a lost art.

For the manufacture of textile fabrics the aborigines used the inner bark of the mulberry tree (*Morus rubra*), cedar (*Juniperus Virginiana*), cypress (*Taxodium distichum*), red elm (slippery elm) (*Ulmus fulva*), the bass-wood (*Tilia Americana*), the papaw (*Asimina triloba*), and the outer bark of the Southern cane (*Arundinaria macrosperma*). The Southern Indians used the silk plant (*Apocynum cannabinum*), while the California Indians manufactured their textile fabrics of *Agave Americana*. The natives of North America also wove the hair of the buffalo, the wolf, the dog, the brown lynx, and Virginia opossum (*Didelphys Virginianus*).

It is difficult to determine whether the threads on this ax are of bark or wool, though they seem to be the latter. In the Mitchell mound, in Madison County, Illinois, specimens of cloth were found of both materials, while the size of the mound, copper implements, and contents generally, indicated that it was of great antiquity.† In no one of the instances, except in the Mitchell mound, is there any trace of feather cloth. The reverse side of this copper ax is covered with the imprint of feathers. The body, no doubt, was wrapped in a bark mantle, one side of which was covered with feathers in the style in which the Indians of the Mississippi Valley manufactured feather cloth.

Out of hundreds of references on the subject the following are selected as probably throwing some light on the manner in which the tenant of this mound was clothed for his final rest.

Jones' *Southern Indians*, pp. 84, 85; Hayward's *Tennessee*, vol. 11, p. 163; *Archæologia Americana*, vol. 1, p. 303; Bradford's *Amer. Antiquities*, p. 30.

Other mound pipes have been found in the vicinity of Naples, and among the number that shown in Fig. 6.

Of this pipe Dr. Charles Rau says: "It is certainly the finest mound pipe thus far known. I have handled a hundred times the mound pipes of the Squier and Davis collection (now in the Blackmore Museum, Salisbury, England), but none of them equaled the specimen in question. Not having been exposed to the action of fire like the Ohio pipes, it has suffered no damage whatever, and is as perfect as on the day

* See Jones' *Southern Indians*, p. 225; S. S. Lyon, *Smithson. Rep.*, 1870, p. 399; Foster, *Prehistoric Races*, p. 223.

† Upon this point consult *Flint Chips*, p. 420; Lapham's *Antiquities of Wisconsin*, p. 47.

when it was made." Certainly a relic so highly spoken of by such competent authority justifies all the information relative to it which could be obtained.

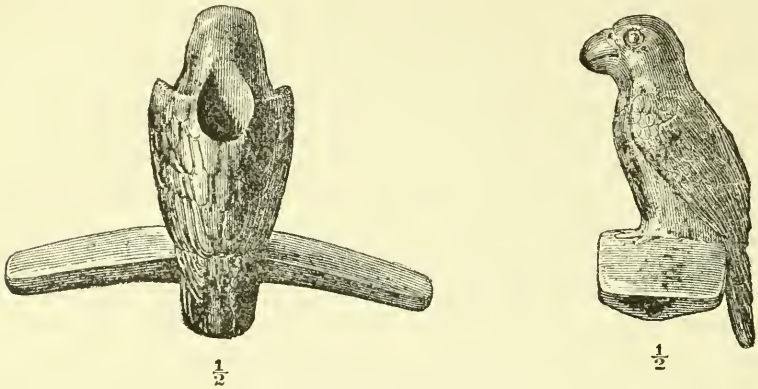


FIG. 6. Eagle pipe, from Naples, Ill.

On the right bank of the Illinois River, about 300 yards below Griggsville Landing, rises a lofty bluff fully 300 feet above the level of the river. On the summit is a beautiful, oval mound, 150 feet long, 92 feet wide in the middle, and 25 or 30 feet high. The following outline, Fig. 7, will give an idea of its appearance.

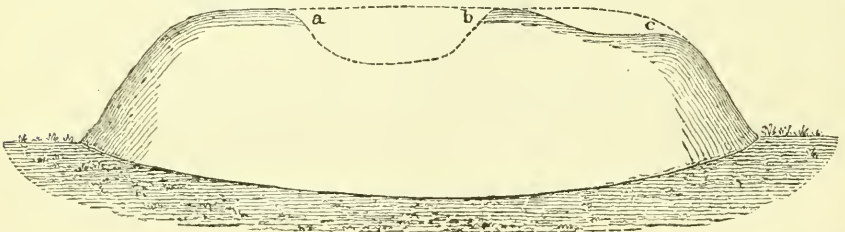


FIG. 7. Large oval mound, near Naples, Ill.

Daniel Burns, John W. Windsor, and others, about forty years ago, were engaged in digging a grave on this mound, when the spade turned out a stone bowl about 6 inches in diameter across the top and about 4 inches deep. Deposited in the bowl was found the eagle pipe, another bird pipe, a frog pipe, and a copper gouge about 6 inches in length. This locality has afforded many valuable relics of prehistoric man, and it is a matter of regret that they did not fall into the hands of persons who knew or appreciated their scientific value.

Just south of the large mound above described, on the next point, are five circular mounds about 30 feet in diameter and 10 or 12 feet high. Indeed, within a radius of 5 miles from Naples there are at least fifty mounds, very few of which have ever been opened.

After the foregoing description of these mounds and the articles found in them was written, the Smithsonian Institution, in December, 1879, began a through exploration of them. On the 10th of December, Mr. Merrill and

the writer, with six laborers began work on mound No. 3 of the plat. In 1876, we had started a trench on the northeast side of the mound, about 2 feet wide, intending to carry it to the center, but the hardness of the material and want of time compelled us to desist. A part of our men were put to work in this trench, and the others began to sink a shaft about 8 feet square in the center of the mound. The earth was so hard that it was impossible to use a spade or shovel except for throwing it out after loosening with the pick. When within about 18 inches of the original surface a whitish substance was encountered resembling ashes. This substance was in a layer several inches thick, about 2 feet wide, and 10 or 12 feet in length north and south. The workmen in the center of the excavation reached the red sand of the original surface and then began carefully to enlarge the hole to the size of our shaft. Shortly, upon the west side, the pick struck the elbow of a skeleton. The arm, slightly bent, was resting in a natural position by the side. Carefully removing the earth the whole length of the skeleton, we found that the bones were those of an aged man about 5 feet 8 inches in height. The body had been placed at full length on a small elevation of sand, the head a little to the west of south,

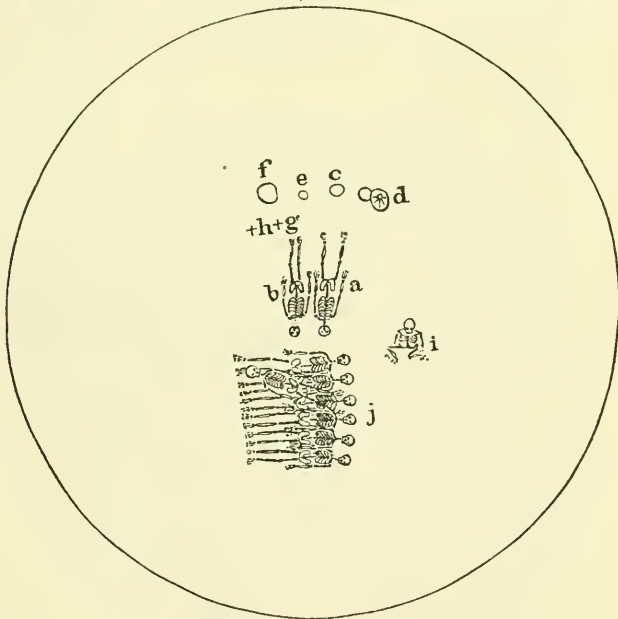
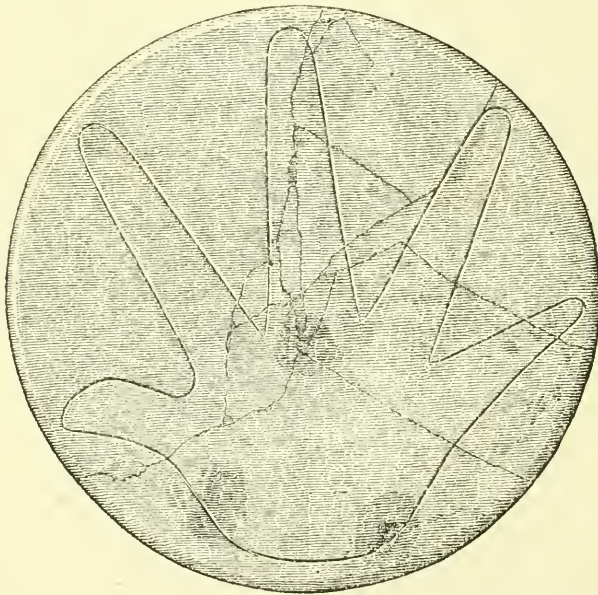


FIG. 8. Diagram of mound No. 3, near Naples, Ill.

a, male skeleton. *b*, female. *c*, two large, dark, chert nodules. *d*, circular plate with hand engraved on it. *e*, piece of galena. *f*, circular plate of mica. *g*, arrow-points and knives. *h*, copper ax. *i*, skeleton of woman (?). *j*, skeletons.

both arms in a natural position, resting by his side. The bones were greatly decayed. The skull had been mashed flat and broken into a great many pieces by the weight of the earth above, so that several were lost. The porous ends of the leg bones were completely decayed so that they crumbled to dust on exposure to the air. The processes for

the attachment of ligaments indicate a man of great strength, while the tibias do not show any of the unusual flattening described by Mr. Henry Gillman, but are of the usual form, and the lower part of the humerus was not perforated in the manner described by the same author. The skull, from its great thickness, was capable of being restored by gluing the edges of the fragments together. This skull is represented in Fig. 24, *a* side view, *b* back; the top, in *a*, Fig. 26. Near this skeleton was another, lying in the same position as the first. The two bodies were placed side by side, and the latter, judging from the delicacy of the bones and teeth and the thinness of the skull, was that of a woman. In the preceding cut (Fig. 8) *a* and *b* represent the position of these skeletons. From the appearance of the teeth the woman was in the prime of life. Both of the bodies were buried in the mound with the flesh upon the bones, as every bone was found in its proper position. Near the feet of the male skeleton, at the point marked *c* in the cut, were found two large nodules of dark chert resembling the true flint of Europe. One of these was but slightly clipped, while the other had been split in two near the middle, and but one half deposited in the mound. This half nodule was lying face downward, and resting upon it and the ground was a remarkable specimen, which may be designated a "sun-symbol." It is a white stone, perfectly round, $12\frac{8}{12}$ inches in diameter, about one-half inch thick



$$\frac{1}{4}$$

FIG. 9. "Sun-symbol," from mound near Naples, Ill.

in the middle, and 1 inch upon the edges, slightly concave upon one side, and having upon the other a figure of a human hand. An idea of its appearance will be obtained from Fig. 9.

The outlines of the hand are cut into the stone between an eighth and

a sixteenth of an inch in depth, and then the inclosed space was cut down, or rubbed down, to about half the depth of the outlines. In this manner the hand was shown very distinctly. The edge at the thumb was resting on the ground, and at the little finger on the top of the chert nodule; thus the hand faced the east, the fingers pointing toward the south. The mass of superincumbent earth had broken this disk into several pieces, as there was when buried nothing under the middle to support it. To the left of this specimen and the nodules of chert were found a piece of galena weighing about $7\frac{1}{2}$ pounds, and a circular piece of mica about 14 or 15 inches in diameter and about one-half inch thick.

Still further to the left, at the points marked *g* and *h* in the cut, were found two copper axes (Fig. 10, *a-b*, *d-e*), one weighing $7\frac{1}{2}$ pounds and measuring $10\frac{1}{2}$ inches in length and $4\frac{1}{2}$ in width at the cutting edge. Fig. 10, *c*, shows the texture of matting found around the copper axes.

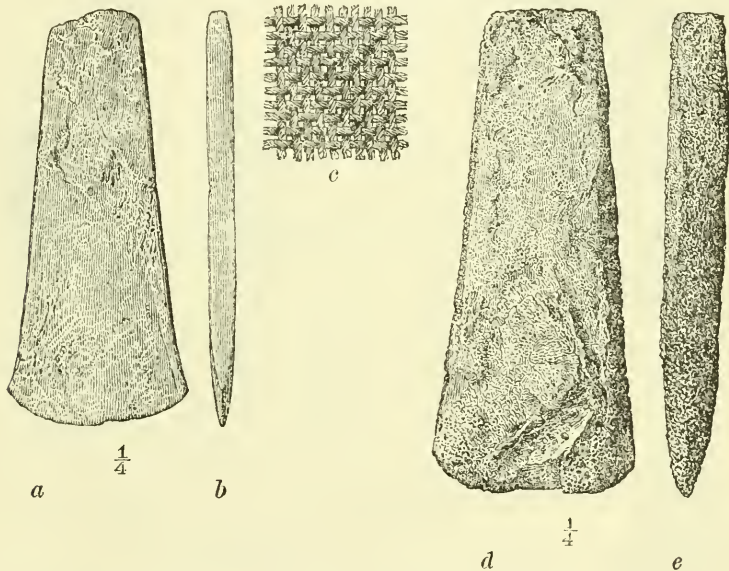


FIG. 10. Copper axes and matting, from mound near Naples, Ill.

With this ax were found four very fine arrow-heads (Fig. 12); two knives (Fig. 11 and Fig. 13, *b*); a finely worked spear-head (Fig. 13, *a*); and a very fine chipped ceremonial ornament (Fig. 14, *a*). The latter consists of a dark piece of chert, with two wings upon each side. The base and point are a modified form of the arrow-point.

There was also found a regular mound pipe made of a soft, white stone, very much decayed (Fig. 14 *b*.) The articles that were buried with these two persons are all represented in Figs. 11, 12, 13, and 14. A little southeast of the heads of these skeletons, at a distance of about 8 or 10 feet, at the point marked *i*, in Fig. 8, was found another skeleton in a sitting posture. Judging from the character of the bones and

skull, this was probably a woman. Those bones which extended upward into the hard dirt are in an excellent state of preservation.



FIG. 11. Chipped knife, from mound near Naples, Ill.



FIG. 12. Arrow-heads, from mound near Naples, Ill.



FIG. 13. Spear-head and knives, from mound near Naples, Ill.

Those in contact with the sand were much decayed. The skull was broken to pieces; yet with patience it was restored. The bones, both of the

skull and other parts of the skeleton, are clean and white—even the spongy ends of the femora and other bones being perfect.

Resting against the skull of this skeleton, with the point downwards, was found a fine wrought bone awl (Fig 15, *a*). Unfortunately the point was broken off, and it was probably deposited in the mound in the condition in which it was found. The portion recovered was probably placed in the hand of the person at the time of burial. This awl, together with five or six others of somewhat similar character found in the same

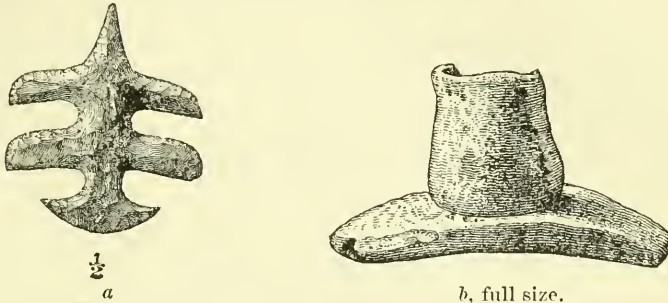


FIG. 14. Pipe and flaked ornament, from mound near Naples, Ill.

mound, were all made of the metatarsal bones of the elk (*Cervus canadensis*). The one marked *a* in Fig 15, is $9\frac{5}{12}$ inches long, and was, when

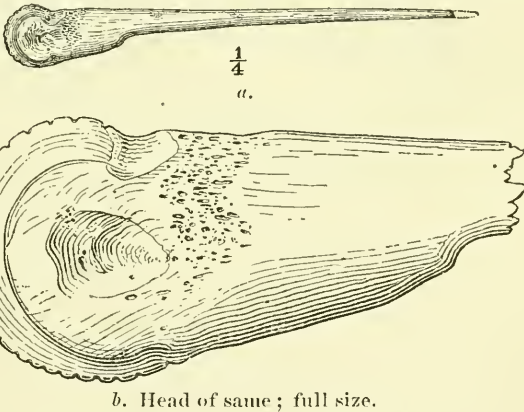


FIG. 15. Bone awl, from mound near Naples Ill.

perfect, about 10 inches long. The metatarsal bone was split down through the center and the implement made of one of the halves. It is



FIG. 16. Bone awl, from mound near Naples, Ill.

finely polished and is so well preserved that, with the point restored, it would be as useful an implement as it was the day it was manufactured. Around the circumference of the lower end are cut twenty-six notches.

The part of the bone selected for these implements and the method of

their manufacture are shown in Fig. 17, which represents the end of the metatarsal bone of the elk found in mound No. 6. A wedge was driven into the opening at the end, and the bone split in two along the middle line, each half afterward being converted into an implement by scraping and rubbing. Ten or twelve of these large bone awls were found in mound No. 1, sticking in the sand around a single skeleton. One of these is painted red and retains its brilliant color.

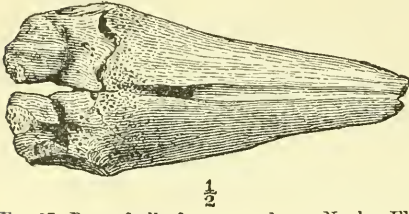


FIG. 17. Bone of elk, from mound near Naples, Ill.

One of these is painted red and retains its brilliant color.

A small bone awl, represented in the following cut, half size, was found in mound No. 15.



FIG. 18. Bone awl, from mound near Naples, Ill.

Lying at right angles to the two skeletons already described in mound No. 3 were six or eight others, all with their feet to the west, except one, which was at least 15 inches below the surface sand, stretched out at full length, with the head to the northwest and feet to the southeast. No object of any kind was found with these skeletons. The bones were greatly decayed, and the skulls so far gone as to render the fragments almost worthless for any scientific purposes. The posterior portions had been much distorted, probably by the pressure of the earth. The fragmentary frontal of one bone is remarkable for the heavy superciliary ridges and retreating forehead, while another has the bone of the nose almost perfect, showing the feature to have been very prominent. The latter specimen is very similar in this particular to Fig. 65 in Foster's "Prehistoric Races." The comparison of the Dunleith mound skull with the Neanderthal skull in that figure seems to be very unfair to the former. By elevating the posterior portion of the fragment until the skull assumes a normal position, the difference between it and the Neanderthal specimen will be found to be very great.

No animal bones or fragments of them were found, and no evidence of any funeral feast or any funeral ceremony in which fire was used.

Mound No. 4 was opened by sinking a shaft about 8 feet square in the center several feet below the original surface. Nothing was found but a few fragmentary human bones greatly decayed and one fine, white chert arrow-point, represented in the following figure (half size):



FIG. 19. Chert arrow-head, from mound near Naples, Ill.

Mound No. 5 was opened but nothing found. The earth in mound No. 4 was of the same character as that in No. 3.

The oval mound, No. 1, was explored in April, 1881 by beginning a trench at the north end and carrying it to the original surface and through to the south end. Lateral trenches were opened at intervals, and from these and the main one a complete exploration was made by tunneling.

Near the center of the mound a single skeleton was found in a sitting position, and no objects were about it except a single sea-shell resting in the earth just over the head, and a number of the bone awls already described sticking in the sand around the skeleton. The individual had been seated upon the sand, these awls stuck around him in a circle, 4 or 5 inches in the sand, and the work of carrying dirt began. When the mound had been elevated about 6 inches above the head, the shell was laid on and the work continued. Although the many perfect bone implements found in this mound fully repaid the expense and labor of exploration, some disappointment was felt, since, from the size and beauty of outline of the mound, we expected some fine discoveries in the way of pipes, copper axes, &c. This mound was raised to about the height of 6 feet with hard clay, and then finished with sand. The skeleton was about 10 feet below the surface. The shell, a fine specimen of *Pyrula perversa* with the inner whorls removed, so as to be used for a drinking cup, is represented in the following figure :

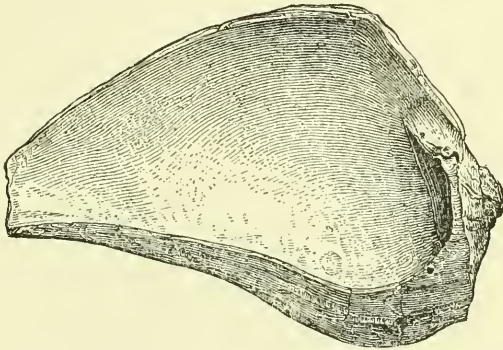


FIG. 20. *Pyrula* drinking-cup, from mound near Naples, Ill.

Mound No. 6, upon the river bank, is the finest in the vicinity. It is a truncated cone, about 136 feet in diameter at the base, 15 feet high, and 30 feet across the top. It is perfectly symmetrical, and from the success in the mounds upon the high ground great hopes were entertained of this, though the anticipations were not realized, yet what was found and the information we obtained fully paid the expense of opening the mound. The character of the earth was the same as that found in mound No. 3, but still much harder. More than once the workmen had to take their steel picks to the blacksmith shop and have them dressed. It was impossible to use the spade or shovel until the original surface was struck. These mounds were intended as enduring monuments to the dead, and for that reason were not built of the surface loam, or sand, which would soon be destroyed by washing, but of clay, and no doubt a part of the workmen engaged in their erection were employed in carrying water and pouring it on the mound as the work progressed. This, with the constant tramping, would account for the hardness of the material. At a depth of 7 or 8 feet, bits of rude pot-

tery were encountered now and then all the way down to the base of the mound. None were found of sufficient size to indicate the form of the vessels, but, as they undoubtedly were made by the people who built this mound, they were carefully preserved. The material and appearance of these specimens are precisely those of specimens found in an old aboriginal cemetery on the bank of the river nearly opposite the mouth of McGee's Creek. (See plat, Fig. 1.) The outer edge of one pot was ornamented with slight notches made by pressing a stick or some other object into the soft clay. Judging from the fragment there was no other ornamentation on this vessel. Upon the inside, about three-fourths of an inch from the top, at intervals of about 1 inch, holes were made nearly through the vessel, not far enough, however, to cause any elevation of the corresponding portion upon the outer surface, as is the case in another fragment from this mound. The latter is ornamented with an oblong imprint similar to those in Fig. 22, *c*. Another piece from this mound shows a part of some figure traced upon the surface, but the fragment is too small to determine what it was. When near the base of this mound the men encountered a skeleton extended at full length with the head to the southeast. The bones were so greatly decayed that not even the fragments could be removed.

No moisture having ever penetrated to the base of this mound since its erection, the condition of these bones, as compared with those from mound No. 3, was looked upon as an indication of the greater age of the former. Even the molars were so decayed that they could be crushed between the finger and thumb. Yet the fallacy of such testimony, so often quoted by explorers, was fully demonstrated by finding in the sand below the base of this mound a perfect skull. A shaft about 10 feet square was sunk to the original surface, but, except the scraps of pottery and the skeleton referred to, nothing was found. The surface line was sharply defined as the mound was made of dark-colored clay, built on a plain of red sand. Upon encountering this red sand it was decided to explore the whole base of the mound by tunneling, which was done thoroughly by one of my men who was a coal-miner. With a little lamp upon his cap, and with short shovel and pick, he went everywhere in the sand under the base of the mound, at the same time chipping off from a foot to 18 inches of the clay roof over his head. By so doing it was found that at intervals of from 6 to 8 feet all over the base of the mound, for a space of 30 feet in diameter, there were pockets of ashes in the sand; that is, a hole about $2\frac{1}{2}$ feet wide was scooped out to the depth of about 8 inches and filled with ashes. In these ash heaps were found numerous fragments of bone, many of them split in that peculiar manner practiced by savage man everywhere, for the purpose of obtaining the marrow. In these ash beds were also found a humerus of the wild turkey and about half of the skull of a skunk. In the sand near one of these ash beds was a human skull almost perfect but quite fragile. By the exercise of great care in handling it was washed and

covered with a thin solution of glue. It is figured below, both side and back view, also from above, Figs. 24, *e* and *f*, and 26, *e*. There was also found a perfect awl or piercing instrument (Fig. 15, *b*), made of the left half of the right metatarsal bone of the elk (*Cervus Canadensis*). A part of the larger end crumbled a little after bringing it to the air. It is $12\frac{7}{12}$ inches long, and would have been an effective weapon to use in close combat. From a burial mound in Tennessee Dr. Jones took a needle, as he styles it, or piercing implement measuring 14 inches in length.* "It had" he states "been fashioned with great care from the tibia of the American deer, and was probably used for piercing leather." The larger number of the fragments of bone found in this Naples mound were those of the deer.

Mound No. 7 is within 60 feet of No. 6, on the west. It is now of an oblong shape, being longest from north to south, but this is due to the fact that the western half of it has been removed by the washing of the river. This mound was opened in one place to the original surface but nothing was found at the time, except fragments of bones split in the same manner as those in mound No. 6. Among these were fragments of the humerus, tibia, radius, ribs, and vertebra of the deer (*Cervus virginianus*). The humerus and femur of the wild turkey were found intact, also two femora of the beaver, the ulna of a large bird not identified,

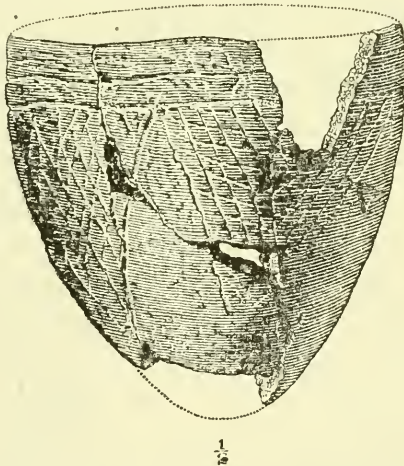
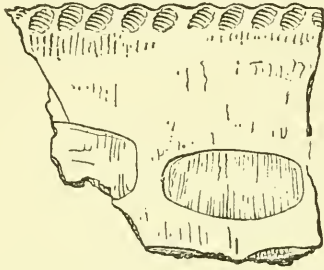


FIG. 21. Earthen pot, from mound near Naples, Ill.

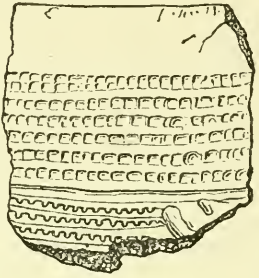
and the ulna of a small feline probably the skunk. All these fragments were found mixed with ashes and pieces of charcoal, indicating plainly that they are the remains of a feast. No fragmentary bones were met with, and nothing to indicate cannibalism. Of the other mounds of this vicinity only one was explored. This was No. 15, which is about 60 feet in diameter and 6 feet high. A shaft about 8 feet square was sunk

(* *Explorations of the Aboriginal Remains of Tennessee*. By Joseph Jones (Smithsonian Contributions to Knowledge, vol. XXII, p. 61.)

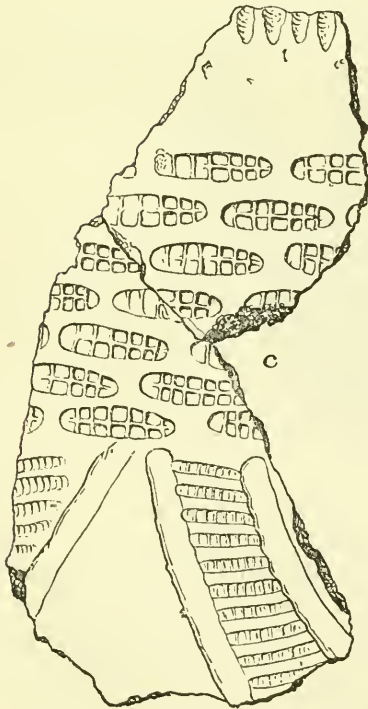
to the original level, developing the fact that it was a burial mound. The bones were so greatly decayed as to render it impossible to preserve even any fragments of the skulls. Large numbers of fragments of pottery were found, but no whole vessels. The material and many of the markings resemble those of specimens, already referred to, from the old cemetery on the margin of the river, distant about 300 yards. Judged from the fragments, the majority of the vessels would hold about $2\frac{1}{2}$ gallons each. One, however, was not much larger than the half of a cocoanut-shell and of about the same shape, Fig. 21.



a

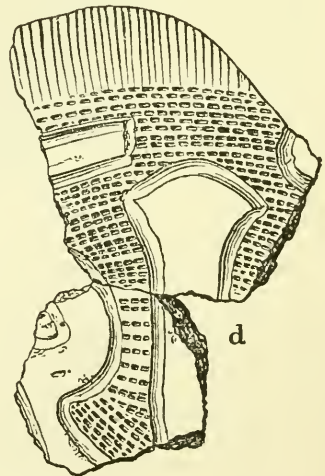


b



c

(1/2)



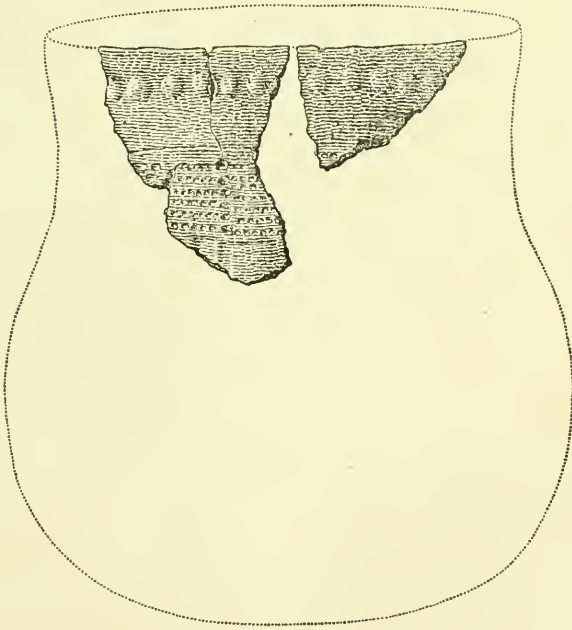
d

FIG. 22. Pottery fragments from mound near Naples, Ill.

It is of a dark color, about one-quarter of an inch thick, symmetrically made, and ornamented with lines about the sixteenth of an inch in depth,

arranged as to form small lozenges about half an inch in length. The spaces so ornamented are four in number, large at the top and tapering to a point at the bottom, ending near the pointed end of the cup. The smooth intervening spaces form a four-pointed star, folded over the bottom of the cup, as shown in the cut. The preceding figure represents fragments of pottery from mound No. 15. The pieces *a* and *c* are each ornamented with figures stamped into the soft clay. One fragment from mound No. 6 was ornamented with a similar figure; also several fragments from the ancient cemetery above alluded to.

It is difficult to determine what was used to make this impression, but it must have been something of vegetable growth, serving as a natural stamp. From the character of the imprints on the fragment from mound No. 6, it seems that the stamp was somewhat pliable, as some of the figures seem distorted. The pottery must have been designedly broken and deposited in mound No. 15, as no whole vessels were found and not enough fragments of any one to restore it. From a careful examination of fragments from the mounds, as well as those from the ancient burial-place, it has been possible to determine the size and form of many of them. The most usual size held from $2\frac{1}{2}$ to 3 gallons, and was shaped as in the accompanying cut, restored from fragments found in mound 15.



$\frac{1}{4}$

FIG. 23. Pottery, from mound near Naples, Ill.

Fragments from mound No. 6 measure at the rim, one 9 inches and another about 6, while those from mound 15 give the following: $10\frac{3}{4}$

inches, $10\frac{1}{2}$, $9\frac{1}{2}$, $8\frac{3}{4}$, and $6\frac{1}{2}$; and specimens from the ancient burial-place give diameters of 20, $14\frac{1}{4}$, 12, $9\frac{1}{2}$, 8, and 5 inches, respectively. The bead-like dots around the margin of Fig. 23 indicate holes punched from the inside of the vessel at intervals of about three-fourths of an inch, made with the end of a round stick about the size of a lead-pencil. The dots upon the outside indicate corresponding elevations made by the point of the stick being pushed nearly through. This method of ornamentation was found upon specimens in mounds Nos. 6 and 15, in specimens from the ancient cemetery, and in fragments found on an old village site, 3 miles west of Winchester.

The theory of a uniform typical skull-form for all the nations of the New World presented by Dr. Morton in his great work *Crania Americana*, so ably seconded by Dr. Nott in *Types of Mankind* indorsed by Humboldt, and for a time acquiesced in by American ethnologists, first challenged by Professor Retzius in 1859,* and again by Dr. Daniel Wilson in 1862,† may now be considered to have been completely overthrown.

It may be safely said that examples of all the various forms which the mania for skull classification has distinguished may be found among the various tribes of the New World yet living, as well as in crania exhumed from the ancient burial-places of extinct tribes.

Although the material for generalization is yet scanty, the same may be affirmed of the mound-builders and stone-grave race. The plan heretofore followed in attempting to establish a typical skull-form both for the modern Indian and the mound-builders is wholly unsatisfactory and fallacious. Let us assume an experiment exceeding in magnitude anything yet attempted in that line, for upon the theory adopted, the greater the number of skulls examined the more the probability that the typical form ascertained is the correct one; and if we find this experiment open to great sources of error which we have no means of eliminating, we may safely conclude that the attempts made upon a much smaller scale have failed to furnish us any reliable information. Let us take one thousand skulls, ten skulls from each of one hundred tribes scattered from Hudson's Bay to Patagonia. We tabulate all the various measurements, longitudinal, parietal, frontal, vertical, &c., and by this means strive to obtain a typical skull. It may be that not five of the whole number conform to this type, and it may be that each of these belonged to one tribe. In attempting thus to establish a typical skull-form for a hundred tribes we assume a fact which does not exist, viz, that there is an average uniformity in the skull-forms of the various hundred tribes, or, in other words, that the average variation of skull-forms is the same in all these tribes. Secondly, we assume that the ten skulls taken represent fairly the variations of skull-forms in the particular tribe. This may be true or it may not. For example, every skull obtained may, by

* *Smithsonian Report*, 1859, p. 264.

† *Ibid.*, 1862, p. 240 *et seq.*

accident, belong to the brachycephalic type, while the skulls of the tribe may be equally divided between that form and the dolichocephalic. With these facts before us examine any table of measurements yet made of American crania and calculate the chances of error. There are not in all the public and private collections fifty undoubted mound-builder skulls, assuming that the builders of the great mounds and earth-works were a different race from the modern Indian. With a view of ascertaining the probable number of such skulls in the country, in January, 1880, the author mailed a circular letter to a large number of private individuals and public institutions, about seventy in all, requesting answers to two questions:

- 1st. How many genuine mound-builder skulls are in your collection?
- 2d. How many that are supposed to be mound-builder skulls?

In a very large majority of the cases the answer to even the second question was "not one!" while the exception was rare, indeed, where persons claimed to be in possession of skulls of the first character. The four greatest public collections are the *Academy of Science*, Philadelphia; the *Smithsonian Institution*, at Washington; the *Peabody Institute*, Cambridge; and the *Davenport Academy of Science*, in Iowa. In these public collections are many labeled mound-skulls, simply from the fact that they came from the base of a mound, without any reference to its size or other articles taken from it. In estimating the number of undoubted mound-skulls, those of this character are excluded. Assuming a difference in the race who built the great mounds and earth-works of the Mississippi Valley and the modern Indian, a skull taken from a mound of this character may belong to the one or the other. Applying the test suggested in the circular above alluded to, which is the best the nature of the subject will admit of, that is, "to only class as genuine those that are found in connection with other objects that unquestionably belonged to the mound-builders," the number of genuine mound-builder skulls is reduced by two-thirds.*

Dr. Foster fell into a grave error when he classed as "authentic skulls of the mound-builders" those obtained from low mounds on the banks of the Des Plaines River, of Illinois. These mounds were elevated only about "2½ feet above the surrounding plain," and no objects were found in the mounds which are looked upon as peculiar to the mound-builders. Yet he classes these skulls as genuine mound-builder remains, figures some of them in his work; and in the winter of 1869-1870 presented to

* Dr. J. F. Snyder, a gentleman who has devoted a great deal of thought to this subject, suggests that "this test appears very unsatisfactory, for the difficulty of distinguishing 'objects that unquestionably belonged to the so-called mound-builders' is necessarily as great as to distinguish their crania." The force of this criticism is admitted; yet if we find a skull at the base of a great mound, and with it copper axes, pipes with the peculiar curved base, and such articles as were found by Squier and Davis in the mounds of Ohio, we may safely assume that the mound was built by the same race that erected those of similar character in which similar articles were found.

the Chicago Academy of Sciences "the generalization as to the former existence on this continent of an anomalous race, characterized by a remarkably depressed forehead."*

Judge Force suggests that "Dr. Foster's argument is very good, but he failed in the first step; he failed to get crania of the mound-builders."†

Dr. E. H. Davis remarked before the American Ethnological Society in 1859, that "in more than one hundred mounds opened by Mr. Squier and himself, they had found only one or two skulls in good preservation."‡

The assumption of the existence of a typical mound-skull implies that there was one homogeneous race, or tribe, that built all the great mounds and earth-works everywhere in the Mississippi Valley, or that the mounds were the work of various tribes, and that the typical skull of each separate tribe was the typical skull of every other tribe. The first hypothesis is wholly untenable. The variation in form of these earth-works would indicate that they are the work of different peoples. The peculiar characteristic of the Ohio works is the great squares and circles nowhere else found of such magnitude or in such numbers; while that of Wisconsin is in the wonderful animal effigies, spread out like picture-writing upon a grand scale on the prairies and in the central and southern portions of the vast valley. These works culminated in great *teocalli*, such as the great mound at Cahokia and that of Seltzertown, in Mississippi. I know that it has generally been accepted without much investigation that the center of this widespread race was in Ohio, and that the wonderful animal mounds of Wisconsin were the work of the same people, built probably as a pastime as they went to and returned from the copper mines on Lake Superior. This is wholly unwarranted by the facts. Mound-building upon the scale of these great earth-works, anywhere in the Mississippi Valley, was a slow and laborious process. The extensive earth-works of Ohio were erected by a people who lived on them and about them. The same may be said of the animal mounds of Wisconsin. The erection of such magnificent works of art, considering the stage of the civilization of the workmen, far beyond the borders of their territory, where they would never be seen by members of their own tribe, except by those engaged in commerce or on the war-path, is incredible. The great burial mounds on the banks of the Illinois and other tributaries of the Mississippi contain the bones of those who lived in the vicinity, and the wonderful *teocalli* in the center and south were erected in the midst of the homes of their builders. The fact that the mounds of Ohio were first explored, and the result of that exploration given to the world in a magnificent volume by the Smithsonian Institution, is one of the reasons why that locality has been frequently spoken

* *Prehistoric Races*, pp. 275, 282.

† *Indians of Ohio, &c.*, p. 64.

‡ *Hist. Magazine*, vol. III, p. 264.

of as *the* great center of the population of the mound-builders. The fact is, it was *a* great center of an ancient population. Wisconsin was another great center of another population, while Southern Missouri was still another great center of a different population, judging them by the character of the mounds and the works of art found in them. Tennessee may be considered as another center of a distinct population; and we have no reason to believe that one of these was more densely populated than another.

Having shown that belief in the existence of one uniform, homogeneous race with a common skull-form, all over the Mississippi Valley, is

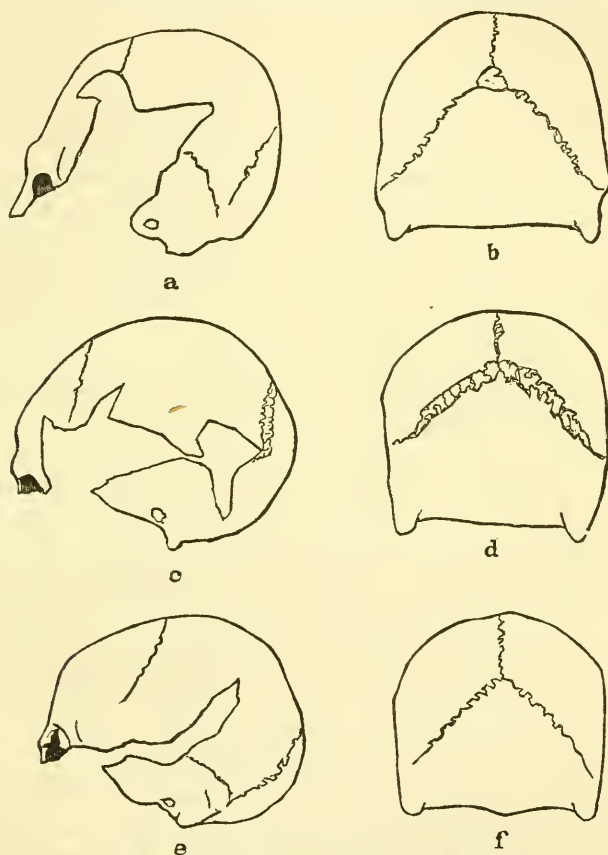


FIG. 24. Mound-builders' skulls, from mound near Naples, Ill.

wholly untenable, in order to warrant us in still looking for the typical mound skull we must assume either absolute uniformity of forms belonging to each tribe, or uniformity in variation, and that, from one or the other of these causes, the typical skull of one tribe was the typical form of every other. The first of these latter hypotheses, absolute uniformity of skull-form, has never been found existing in a single tribe, and it would be a miracle to find, not only uniformity in a single tribe

of these ancient mound people, but that the same uniformity extended through all the various tribes. Compelled to abandon the idea of a single widespread people for whom we can assign a typical skull, and compelled to relinquish the idea of absolute uniformity of skull-forms in numerous tribes, we are driven to the only remaining hypothesis—that of uniformity in variation in the various tribes; and I think it can easily

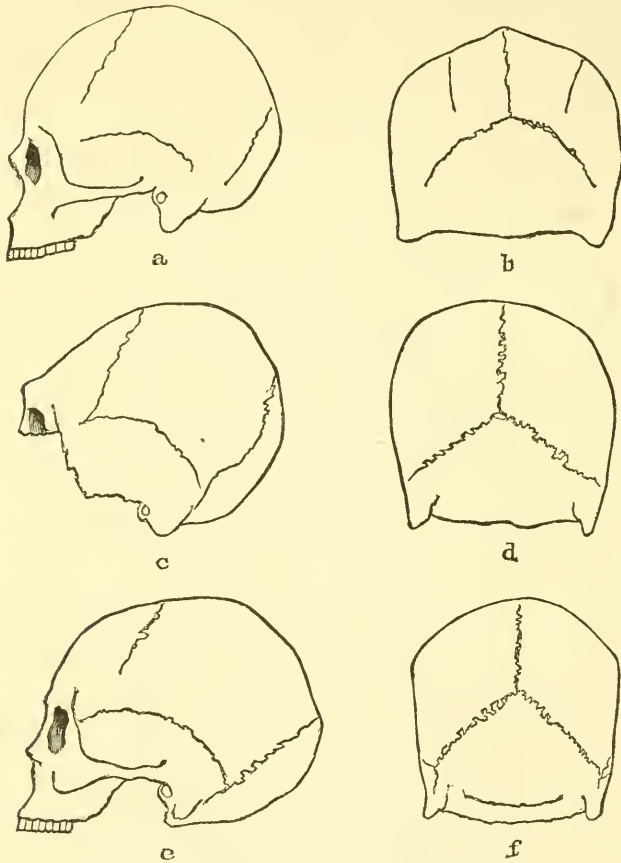


FIG. 25. Crania from mounds near Naples, III.

be shown that the probabilities of the existence of such fact are very slender.

Lieut. W. H. Dall* has perfectly expressed my ideas in regard to variability of skull-forms, and the difficulties in attempting to establish typical forms.

This "factor of individual variation" is strikingly illustrated by the two skulls taken from mound No. 3, at Naples, the one a very brachycephalic and the other a dolichocephalic skull, undoubtedly of

* On succession in shell-heaps of the Alentian Islands, in *Contributions to North American Ethnology*, vol. 1, pp. 70, 71.

the same people who built the mounds, as there is not a possibility that either could have been an intrusive burial. These skulls are shown in Fig. 24, *a* and *c* side views, and *b* and *d* back views; and in Fig. 26, *a* and *c* top views.

The vast difference between these two skulls can only be understood by an examination of them, and no better illustration could be found of the futility of attempting to establish a typical form for the mound-builders.

In figure 25, *a* is the skull of a modern Indian buried just below the surface in a mound in the town of Meredosia, 5 miles from Naples, and

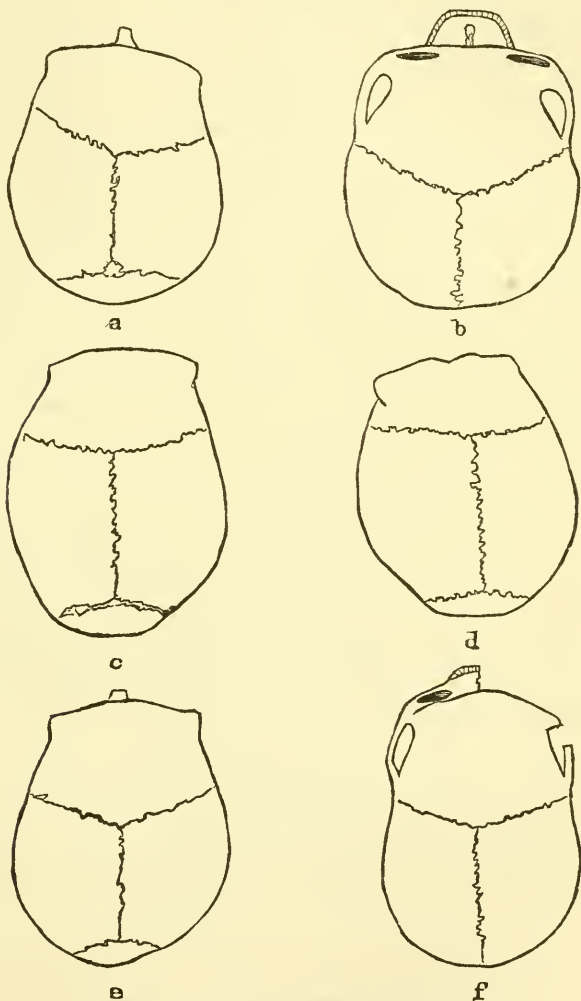


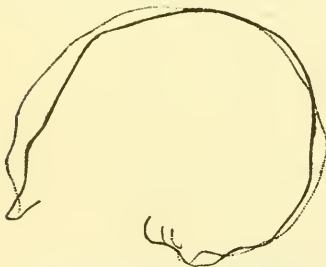
FIG. 26. Mound crania, from mounds near Naples, Ill.

is only figured here for comparison with the others. It is a short, wide skull, and admirably corresponds with the ideal Indian skull of Dr.

Morton. *c* is a remarkably distorted skull from a low mound on the bluffs 3 miles west of Winchester. The cut accurately indicates the side view, but the distortion sideways cannot be shown by a figure. The top of this remarkable specimen is shown in Fig. 26, *d*.

It is not pretended that this skull belonged to the same people who built the Naples mounds. Indeed from the decayed condition of the Naples specimens, protected as they were from moisture, we may safely say that a skull buried at the same time only 3 feet below the surface would have completely disappeared. Any one who has ever made and tabulated the usual measurements of half a dozen skulls must have been conscious of the fact that these measurements are as inadequate as wood-cuts to indicate differences in forms instantly recognized by the eye. For example, exactly the same parietal diameter may exist in a skull perfectly symmetrical as in one greatly distorted; or again, exactly the same occipito-frontal circumference may exist in a low, dolichocephalic skull and a brachycephalic one with elevated vertex, or the horizontal circumference be identical in a round head and a long one. I have figured three undoubted mound skulls and three more modern ones, and below furnish a table of the most usual measurements, with but little expectation that those who read this article will get any clear idea of the vast difference in some of these skulls, differences which can only be appreciated by examination of the skulls themselves.

To show the great difference in a side view of two skulls, taken from the same mound, the outlines of both are given in the same cut, Fig. 27.



The dotted line represents the skull marked No. 2, and the other outline, skull No. 1, both from mound No. 3. For the purpose of still further elucidating the variations in these forms, the following table of measurements of three of the Naples mound skulls and one skull of a modern Indian is appended, the latter taken by me from near the the surface of a mound in

FIG. 27. Outlines of mound crania. the town of Meredosia 6 miles north of Naples.

	L. D.	P. D.	V. D.	F. D.	I. M. A.	I. M. L.	O. F. A.	H. C.
Modern Indian.....	6.88	5.58	5.25	4.75	14.25	5.16	13.08	20.25
Mound-builder (mound No. 6).....	6.66	5.05	5.16	4.75	13.66	5.16	13.16	19.75
Mound-builder (mound No. 3).....	6.05	5.25	5.16	4.75	14.16	5.41	13.66	19.66
Mound-builder (mound No. 3).....	7.008	5.05	5.41	5	14.16	5.008	14.008	20.58

Many writers have spoken of the soundness of teeth of the mound-builders. Dr. T. S. Sozinsky* says: "The dental profession was unknown to the mound-builders, and they had no need for it; for toothache and all such diseases were troubles with which they were but very little

*"The teeth of the Mound-Builders." *Dental Cosmos*, vol. 20, p. 496.

acquainted." Dr. Farquharson* mentions the invariable soundness of teeth in the remains found in the Davenport mounds. The fallacy of drawing general conclusions from insufficient data is well proven by such statements. A few mounds were opened in the vicinity of Kansas City, and all the teeth found were sound, and the general statement is at once made that diseased teeth were unknown to the mound-builders. Dr. J. J. R. Patrick, of Belleville, Ill., who has had a fine opportunity for observation, says: "It is the exception to find a sound set of teeth. . . . The marks of alveolar abscess are common; loss of molars and bicuspid are frequent, with complete absorption of the sockets."† The writer's observations, which have been limited, accord exactly with those of Dr. Patrick. The lower jaw belonging to skull No. 2, from mound No. 3, shows an alveolar abscess under the second molar upon the left side, and loss of all the molars upon the right, with complete absorption of the alveolar processes. The second molar upon the left was diseased, a cavity extending entirely through the crown. In this specimen there was no complete loss of teeth before death, but the second and third molars upon the right side are badly decayed, and while Dr. Sozinsky's statement, that "the dental profession was unknown to the mound-builders," probably was quite correct, yet the owner of these teeth could vouch for the fact that at least one of their number knew what it was to have the toothache. The teeth of all the specimens found are worn quite flat upon the crowns, and this remark applies to the cuspid and bicuspid of all the specimens found except one. Dr. Patrick, in the paper above quoted from, says he has but "two skulls in which the front teeth lap over each other; in all the other cases the masticating surface of the upper jaw fits perfectly that of the lower, and so with all the teeth that are not missing. The incisor teeth do not lap, but impinge on each other at their cutting edges like the molars, and are worn quite flat, so that when we look along the surface of mastication we perceive that it is almost a perfect plane." This is an exact description of nearly every specimen from these Naples mounds, there being but a single one (No. 154) in which the incisor teeth are chisel-shaped like those of our own race. This form of the front teeth is not peculiar to the mound-builders, but is characteristic of savage races generally. The disuse of the front teeth for the purpose of severing mouthfuls of food from the mass, consequent upon the use of the knife and fork, together with change of food, has materially modified the process of mastication and the form of the teeth.‡

From the authorities cited it will be found that the ancient Peruvians

* *Smithsonian Report*, 1874, p. 363.

† *Dental Fallacies*, a paper read before the Missouri Dental Association by Dr. John J. R. Patrick, pp. 8, 9.

‡ Upon the teeth of savage races, see D'Orbigny; *L'Homme Américain*, vol. 1, p. 128; *Flint Chips*, p. 62, note; Morlot, in *Smithsonian Report*, 1860, pp. 312, 313; *Indigenous Races*, p. 297; Lubbock's *Prehistoric Times*, p. 533; Baneroff's *Native Races*, vol 1, pp. 25, 46, 163; Wilson's *Prehistoric Man*, 2d ed., pp. 454, 455.

and Egyptians, the primitive men of Denmark and Great Britain were, and that modern savage races still are, characterized by this peculiar form of the front teeth, and from these facts in advance we might have foretold the form of those of the mound-builders.

Having fully described these mounds and their contents, so far as explored, it only remains to offer some general conclusions as to the character and habits of the people who built them. There is no evidence that the mounds numbered 1, 2, 3, 4, and 5 were built by the same people who erected Nos. 6 and 7; for, except the finding of bone awls similar in form, made from the metatarsal of the elk, there was nothing common to the two groups. It is true that Nos. 1, 2, 3, and 4 of the first group, No. 6, and probably 7, of the second, were all burial mounds, yet the funeral ceremonies, as indicated by Nos. 3 and 6, were wholly different. It is clear that one distinguished man of the tribe was buried in mound No. 3, and that the other persons, twelve or thirteen in number, were sacrificed to go with him to the land of souls. In a circle around his feet were placed the most valuable of his possessions, under the belief they would be of use to him; beside him was placed his wife; near him in a sitting posture his sister or some other near female relative, and at his head half a score of his most trusty attendants. Even the laborers assisting in the exploration seemed to understand that this man was the one important personage over whom this monument was erected. There were no broken or split animal bones, no charcoal, and nothing else to indicate a funeral feast. With the exception of the single bone awl, no object was found near any of the skeletons, except at the feet of the one named; and the skeleton of this one, and that of her alluded to as his wife, were deposited on a little hillock of sand, while those at their heads were apparently laid on and against its sloping sides. The bones and skull indicated a man of great age, which is confirmed by the character of the teeth, several of them being badly decayed, and in one place the alveolar processes completely absorbed. Again, the burial of the remarkable stone disk with the human hand inscribed upon it, an object requiring long and patient labor in its manufacture, also points to the importance of this personage.

As before remarked, the funeral rites practiced by the people who built mounds Nos. 3 and 6 seem to have been wholly different. In the latter case there is evidence of a great funeral feast upon the flesh of the deer, the elk, the wild-turkey, the skunk.*

In the use of fire and the careful deposit of the ashes in little pockets scooped out of the sand, there is no evidence that any of these Naples mound-builders were "an agricultural people." The weapons deposited with their dead are those used in war and the chase, and are very

*Lawson (*Description of N. Carolina*, p. 197) says of the skunk: "The Indians love to eat their flesh, which has no manner of ill smell when the bladder is out." Mr. Comfort (*Smithsonian Report* 1871, p. 394) suggests relative to the skull of a skunk found in a mound by him, that it probably was attached to a medicine bag.

similar to those used by savage races everywhere. The finding of copper axes (Fig. 10), too, indicates no great advancement toward civilization, for there are more instances on record of articles of this metal found in the hands of the Indians than in the mounds. The fact is, but little copper has ever been found in the mounds, and it is absurd to contend that the few specimens met with show that the builders of the mounds habitually used copper implements and were the authors of all the prehistoric mining upon Lake Superior. A writer recently remarked in the *Virginia Gazette*, that "the mounds and old grave-yards and camping grounds of the prehistoric races of our country have been pretty well ransacked, and so far all the copper relics found in the United States put together would not weigh half a ton." Dr. Charles Rau, the best authority in matters relating to American archæology, in an admirable paper upon *Ancient Aboriginal Trade in North America*,* says: "The use of copper was comparatively limited, and cannot have exerted any marked influence on the material development of the natives." Neither does the fact that some textile fabric was manufactured by these people, as shown by the specimen adhering to the copper ax found in mound No. 2, indicate any advance beyond the aborigines of the New World at the date of the discovery. In a paper on *The Textile Fabrics of the Ancient Inhabitants of the Mississippi Valley*, read before the American Association at Boston last year, the author showed conclusively from historical sources that textile fabrics of some character were manufactured by the aborigines from the lakes to the Gulf at the period of first contact with civilized man, and that many of these fabrics (Fig. 10, c), especially those made by the village Indians of the Lower Mississippi, surpassed in quality any specimens yet taken from the mounds.

Fragments of bone, teeth, and horn from the mounds, the faithful representation of animals left us in the pipes of the mound-builders, and the immense animal mounds have enabled us partially to reconstruct the fauna of the period of the builders of the mounds. A careful examination of recorded facts enables us to present the following list:

Mastodon.(?)—Shown in sculptured pipes from Davenport mounds, and upon a tablet from a mound in same vicinity.¹ Represented in immense bas-relief upon prairies of Wisconsin. A tooth was found in stratum overlapping a mound in Missouri.²

Buffalo.—Professor Shaler³ says that the buffalo was not here in the time of the mound-builders, but the spinous processes of this animal have been found in a mound in Dakota.⁴ It is represented in the animal mounds of Wisconsin,⁵ and the teeth of the buffalo have been

* *Smithsonian Report*, 1872, p. 350.

¹ *Proceedings Davenport Academy of Science*, Vol. XI, Plate II.

² *Eighth Annual Report Peabody Museum*, p. 45.

³ *Amer. Naturalist*, vol. 4, p. 159.

⁴ *Smithsonian Report*, 1871, p. 394.

⁵ Lapham's *Antiquities of Wisconsin*, p. 69, and Plate XLV, No. 1.

found in the drift of Maine.¹ It is singular, however, that this animal is not represented in the sculptured mound pipes, yet the same remark applies to the moose, the porcupine, the rabbit, the skunk, and other animals, a part of which are known to have been familiar to the builders of some of the mounds.

Moose.—Perforated teeth from mound on Saint Clair River, Michigan.²

Elk.—Bone implements from mounds of Ohio,³ and from mounds Nos. 1, 3, 6, and 15, Naples, Ill. The head of the elk is also faithfully represented in a sculptured pipe from Ohio mound.⁴ Skull of elk found by Sidney S. Lyon in a mound in Union County, Kentucky.⁵

Deer.—Bones found by Prof. F. W. Putnam in a mound on the Wabash River, Indiana.⁶ Bones found by the writer in mounds Nos. 6 and 7, Naples, Ill. Awls made from bone of deer found by Sidney S. Lyon in Union County, Kentucky.⁷ Horn found in a mound at the same place.⁸

Bear.—Fragment (head) from sculptured pipe found in Ohio mounds.⁹ Drilled teeth from same mounds.¹⁰ Drilled teeth and radius from Illinois mound.¹¹ Bones found by Prof. F. W. Putnam in a mound on the Wabash, Indiana.¹²

Wolf.—Sculptured pipes from Ohio mounds.¹³ Drilled teeth from same mounds.¹⁴ Skull of prairie wolf in mound in Dakota.¹⁵

Dog.—Skull from mound in Illinois.¹⁶

Panther.—Fragment of pipe from Ohio mound,¹⁷ also a pipe from Davenport mound.¹⁸ Teeth found in a mound in Kentucky.¹⁹

Wildcat.—Sculptured in Ohio pipes,²⁰ and drilled teeth from same mounds.²¹

¹ *Amer. Naturalist*, vol. 1, p. 268, note, and Vol. 6, p. 98, note.

² *Sixth Annual Report, Peabody Museum*, p. 17.

³ Squier and Davis, *Ancient Monuments*, p. 220, Fig. 119.

⁴ Squier and Davis, *Ancient Monuments*, p. 257, Fig. 161.

⁵ *Smithsonian Report*, 1870, p. 395.

⁶ *Foster's Prehistoric Races*, pp. 137, 138.

⁷ *Smithsonian Report*, 1870, p. 395.

⁸ *Ibid.*, p. 403.

⁹ Squier and Davis, *Ancient Monuments*, &c., p. 271. Fig. 189; *Flint Chips*, p. 430 Fig. 69.

¹⁰ Squier and Davis, *Ancient Monuments*, p. 234, Fig. 131.

¹¹ *Second Annual Report Peabody Museum*, pp. 15, 16.

¹² *Foster's Prehistoric Races*, p. 137. Represented in the animal mounds of Wisconsin. Lapham's *Antiquities of Wisconsin*, pp. 65, 70 and Plate XLV, No. 4; Squier and Davis *Ancient Monuments*, p. 130, and Pl. XL III, No. 8.

¹³ Squier and Davis, *Ancient Monuments*, p. 271, Fig. 190; *Flint Chips*, p. 431, Fig. 74.

¹⁴ Squier and Davis, *Ancient Monuments*, p. 234, Fig. 131.

¹⁵ *Smithsonian Report*, 1871, p. 394.

¹⁶ *Second Annual Report, Peabody Museum*, p. 16.

¹⁷ Squier and Davis, *Ancient Monuments*, p. 257, Fig. 160.

¹⁸ *Proceedings Davenport Acad. of Science*, vol. 1, Pl. IV, No. 11.

¹⁹ *Smithsonian Report*, 1870, p. 403.

²⁰ Squier and Davis, *Ancient Monuments*, p. 257, Figs. 158, 159, 160.

²¹ *Id.*, p. 234, Fig. 131; *Flint Chips*, pp. 452, 480.

Raccoon.—Fragment of pipe from Ohio mound¹ and pipe from mound No. 3, Naples, Ill. (*Ante*, p. —, Fig. —.)

Opossum.—Bones found by Prof. Putnam in a mound on the Wabash River, Indiana.²

Beaver.—Three sculptured pipes from Ohio mounds.³ Bones found in mound No. 7, Naples, Ill. Skull found in mound in Dakota.⁴

Muskrat.—Skull in mound in Dakota.⁵

Otter.—Fragment of pipe from Ohio mound.⁶

Mink.—Either this animal or the weasel, which is very similar in form, is represented in an animal mound of Wisconsin.⁷ Some of the animal forms represented in mounds are easily recognized, while others are hard to determine. For example, Squier and Davis say of one: "It human figure."⁸

may have been intended to represent a bird, a bow and arrow, or the

Skunk.—Fragment of skull from mound No. 6, Naples, Ill. (*Ante*., p. —), and skull found in mound in Dakota.⁹

Squirrel.—Mound pipe from Ohio.¹⁰ From the marking on the side it may be that this specimen was intended to represent the flying squirrel, *Pteromys volucella*.

Gopher (*Spermophilus Franklini*) Sabine.—Ohio mound pipe.¹¹ Several species of this family are so nearly allied that it is not certain which was intended to be represented.

Manatee.—Seven sculptured pipes from Ohio mounds.¹²

Walrus.—Pipe from Ohio mound.¹³

Alligator.—Drilled teeth found in Ohio.¹⁴

Turtle.—Pipe from Ohio mound.¹⁵ Pipe from mound No. 2, Naples, Ill. (*Ante*, p. —, Fig 5.) Bones found in mound on the Wabash River, Indiana, by Prof. F. W. Putnam.¹⁶ Represented in animal mounds of Wisconsin.¹⁷

¹ *Flint Chips*, p. 430, Fig. 68.

² Foster's *Prehistoric Races*, p. 137.

³ Squier and Davis, *Ancient Monuments*, p. 257, Fig. 155; *Flint Chips*, p. 428, Fig. 63.

⁴ *Smithsonian Report*, 1871, p. 392.

⁵ *Smithsonian Report*, 1871, p. 394.

⁶ Squier and Davis, *Ancient Monuments*, p. 257, Fig. 156.

⁷ Lapham's *Antiquities of Wisconsin*, Plate XXIX.

⁸ Squier and Davis, *Ancient Monuments*, p. 130.

⁹ *Smithsonian Report*, 1871, p. 394.

¹⁰ *Flint Chips*, 428, Fig. 62.

¹¹ Squier and Davis, *Ancient Monuments*, Fig. 157; *Flint Chips*, p. 428, Fig. 61.

¹² Squier and Davis, *Ancient Monuments*, pp. 251, 252; Figs. 153, 154; *Flint Chips*, p. 429, Figs. 65, 66.

¹³ Squier and Davis, *Ancient Monuments*, p. 271, Fig. 192; *Flint Chips*, p. 430, Fig. 67.

¹⁴ Squier and Davis, *Ancient Monuments*, p. 282, Fig. 197.

¹⁵ *Flint Chips*, p. 423, Fig. 43.

¹⁶ Foster's *Prehistoric Races*, p. 137.

¹⁷ Lapham's *Antiquities of Wisconsin*.

Frog.—Sculptured figure in mound pipe of Davenport collection,¹ and pipe taken from mound No. 8, at Naples, Ill.

Toad.—Sculptured figure in mound pipes of Ohio.²

Serpent.—Coiled around sculptured pipes from Ohio mounds.³ Represented in an immense earthwork, Adams County, Ohio,⁴ and in the animal mounds of Wisconsin.⁵

Rattlesnake.—Carved on Ohio pipes;⁶ carved figure found in Ohio mound,⁷ and figures carved on shells found in mounds of Tennessee.⁸

Lizards.—Represented in animal mounds of Wisconsin.⁹

Shells.—Many marine species have been exhumed from the mounds. The *cassis*, *fulgur perversus* of Lamark, the *oliva*, *marginella*, and *natica*, and probably *strombus* found in mounds of Ohio.¹⁰ Splendid specimen of a *fulgur perversus* taken from mound No. 1, Naples, Ill. Large numbers of these have been found in mounds near the mouth of the Illinois River by the Hon. William McAdams, many of which were exhibited by him at the Boston meeting of the American Association. Shells of the common mussel were found by the writer at the base of mound No. 3, Naples, Ill. Great numbers of beads made from the species *marginella*, *oliva*, and *natica* have been found in the mounds.¹¹ Of fluviatile species the mounds of Ohio have furnished *unio ellipticus*, *rectus*, *verrucosus*, and *ovatus*, "all existing at the present time in the neighboring streams."¹²

Bald eagle.—Sculptured pipe from mound No. 8, near Naples, Ill.¹³

Eagle.¹⁴

Hawk.—Sculptured pipes from mounds of Ohio.¹⁵

Owl.—Three species, viz: "Great owl, horned owl, and the little owl" are recognized in the sculptured pipes from the Ohio mounds.¹⁶

Turkey buzzard (*Carthartes aura*).—Sculptured pipe from mounds of Ohio.¹⁷

Wild turkey.—Bones found by the writer in mounds Nos. 6 and 7, Naples, Ill.

¹ *Proceedings Davenport Academy of Science*, vol. 1, p. 118, and Plate IV, Fig. 5.

² Squier and Davis, *Ancient Monuments*, p. 268, Figs. 183, 184, 185.

³ Squier and Davis, *Ancient Monuments*, pp. 248, 268, Figs. 143, 186.

⁴ *Id.*, p. 96, Plate XXXV.

⁵ Lapham's *Antiquities of Wisconsin*, pp. 37, 38.

⁶ Squier and Davis, *Ancient Monuments*, &c., p. 268.

⁷ *Id.*, p. 276.

⁸ *Fifth Annual Report Peabody Museum*, pp. 17, 18, and *Id.*, vol. 2, p. 89.

⁹ Lapham's *Antiquities of Wisconsin*.

¹⁰ Squier and Davis, *Ancient Monuments*, p. 283; Foster's *Prehistoric Races*, pp. 234, 235.

¹¹ Squier and Davis, *Ancient Monuments*, p. 233.

¹² Squier and Davis, *Ancient Monuments*, p. 284.

¹³ Squier and Davis, *Ancient Monuments*, p. 259.

¹⁴ Squier and Davis, *Ancient Monuments*, p. 70.

¹⁵ Squier and Davis, *Ancient Monuments*, p. 259, and Fig. 165; *Flint Chips*, p. 428, Fig. 60.

¹⁶ Squier and Davis, *Ancient Monuments*, p. 259; *Flint Chips*, p. 427, Fig. 57.

¹⁷ Squier and Davis, p. 260, and Fig. 171; *Flint Chips*, p. 427, Fig. 58.

Prairie hen (Cupidonia cupido), Linn.—Sculptured pipe from Ohio mound.¹

Also, pipe from Davenport mound, Iowa.²

Quail (Ortyx virginianus).—Sculptured mound pipe from Ohio.³

Toucan.—Sculptured pipes from Ohio mounds.⁴

Parroquet.—Sculptured pipe from Ohio mound.⁵

Cedar bird, (Ampelis cedrorum).—Sculptured pipes from Ohio mound.⁶

Swallow.—Sculptured pipes from Ohio mound.⁷

Night heron.—Sculptured pipe from Ohio mound.⁸

Wood duck (Aix sponsa).—Head sculptured upon Ohio mound pipe.⁹

Prof. C. W. Butler, comparative anatomist, Champaign, Ill., very kindly identified for me the bones found in the Naples mounds.

From the foregoing list it may easily be surmised that all the animals found in the Valley of the Mississippi upon the advent of the white race were familiar to the builders of mounds, also possibly some whose habitat was far distant, such as the mastodon and walrus of the north or the manatee, the toucan and tropical shells of the south.

From the "finds" in the Naples mounds we can plainly see that considerable commerce was carried on by their builders, as we here find a shell from the coast of Florida, obsidian from Mexico, lead ore from Wisconsin, copper from Lake Superior, and mica from the Alleghanies. It was once contended that the great age of the mounds was shown by the fact that they had never been found upon the latest or lowest river terraces. This statement has been disproved, however, as in more than one instance in the west they have been found upon the lowest terrace. The largest mound explored at Naples is in the low-lands upon the very brink of the river. Man naturally selects elevated positions for burial sites. Mounds of observation would be built upon the highest points, while other mounds, whether for houses, temples, or for whatever purpose they might be built, would as a rule be placed beyond the reach of overflows. These suggestions sufficiently account for the usual absence of these ancient works upon the low-lands along the rivers.

This locality is also rich in finely-worked stone implements. None, however, have come from the mounds, but some of the finest articles of chert were found a few feet below the surface at the foot of the bluff upon which the eagle-pipe mound is situated. Below this about

¹ *Flint Chips*, p. 425; Fig. 51.

² *Proceedings, Davenport Academy of Science*, vol. 1, Plate IV, No. 14.

³ *Flint chips*, p. 425, Fig. 50.

⁴ Squier and Davis, *Ancient Monuments*, pp. 260, 266, Figs. 169, 178; *Flint Chips*, p. 426, Figs. 53, 56.

⁵ Squier and Davis, *Ancient Monuments*, p. 265, and Fig. 172.

⁶ Squier and Davis, *Ancient Monuments*, p. 265, and Figs. 173, 174; *Flint Chips*, p. 424, Fig. 48.

⁷ Squier and Davis, *Ancient Monuments*, p. 260, and Fig. 167; *Flint chips*, p. 424, Fig. 47.

⁸ Squier and Davis, *Ancient Monuments*, p. 259, Fig. 164; *Flint Chips*, p. 425, Fig. 52.

⁹ Squier and Davis, *Ancient Monuments*, p. 260 and Fig. 168.

two miles was the ancient quarry from which the chert was taken to manufacture knives, arrow-heads, and spear-heads. At the base of the Burlington limestone bluff are found hundreds of fragments of chert implements, broken and cast away by the workmen, amidst thousands of chips. The material was obtained from the nodules in the limestone and worked on the spot, but whether by the ancient mound folk or the more modern Indian there is nothing to indicate. In an old book called the *Navigator*, the writer, Patrick Kennedy, who passed up the Illinois River in the year 1773, says "The Peories wintering-ground is

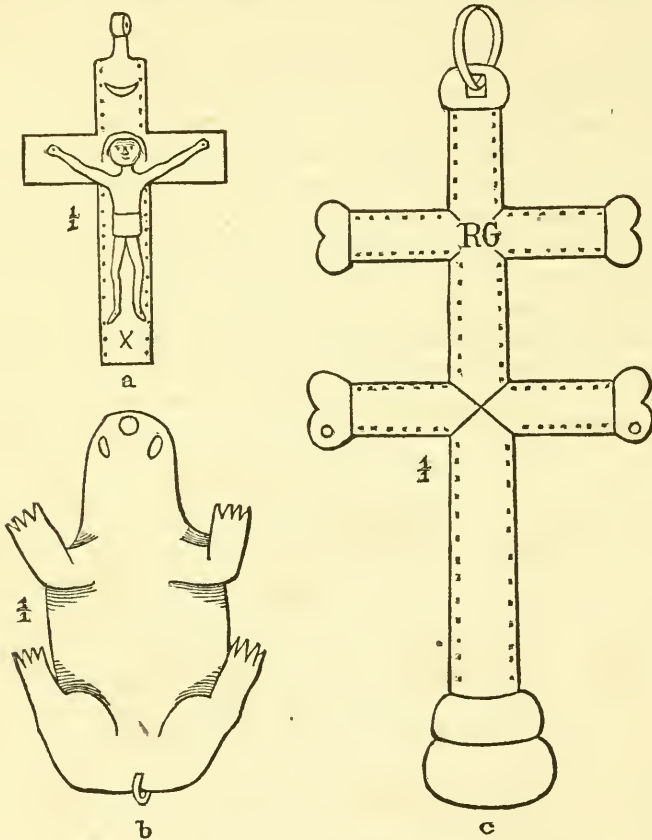


FIG. 28. European objects from mounds.

48 miles from the Mississippi. . . . Pierre Island is some distance above, near which, from a hill on the western side, the Indians procure a *flèche* or arrow-stone, with which they make their gun flints and point their arrows." On an old map, furnished to Governor Edwards in 1812 by John Hoy, a Frenchman, is found a creek marked *Pierre à la Flèche*. In a letter to the Secretary of War, May, 1812, Governor Edwards called this creek the Arrowstone. It is now known as Flint Creek. The French no doubt derived the name from the Indians,

and that *Pierre à la Flèche* was a translation of the equivalent Algonkin. With these facts as a starting-point, the writer found the "workshop," which probably had been the scene of busy labor for centuries.

Upon the banks of the river at Naples are the burying-grounds of the modern Indian, in which have been found many stone implements intermingled with civilized manufactures, such as beads, knives, crosses of silver, and other articles indicating traffic with the French during, probably, the latter part of the seventeenth and the first half of the eighteenth centuries. Some of these articles are shown in Fig. 28.

The above are all in the private collection of Richard H. Keener, esq., of Naples, Ill., who first gave the writer information relative to the former exploration of mounds in the vicinity. The pottery exhumed from this ancient cemetery shows that it was the common burial-place of the race that built at least a part of the mounds, while the above and similar articles of French manufacture show that the same place was used as a burial site by the modern Indian. The same reason that prompted these ancient races to select this locality as the resting-place of the dead caused our own people to locate their cemetery within a few hundred yards of the ancient one and upon the same ridge, just as the modern city occupies the ancient village site, and the highways of travel follow the ancient trails, the bones of races, separated by thousands of years, in time mingle together and molder into common dust!

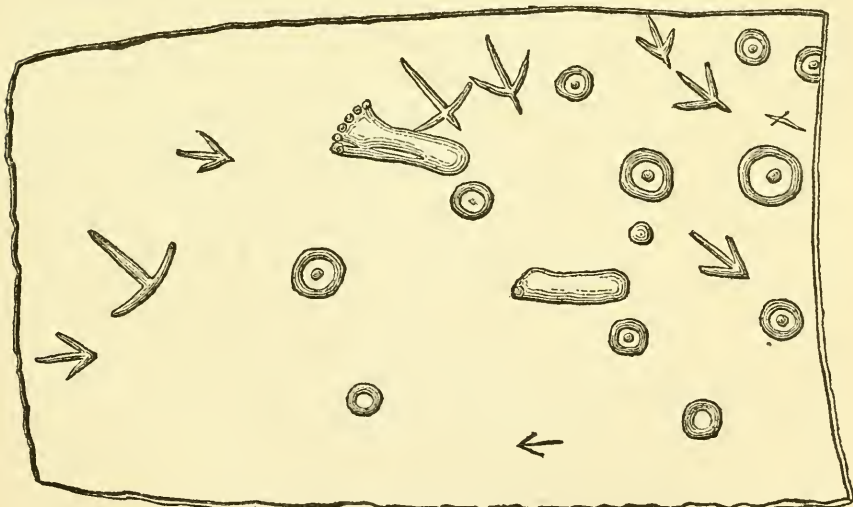


FIG. 29. Pictographs on slab from rock-shelters near Naples, Ill.

Though not immediately connected with this subject, yet possibly the work of the same race who built the Naples mounds, attention is called to foot-prints and other marks on a limestone slab found in a rock-shelter on the east side of the Illinois River, about 10 miles below Eagle-pipe mound. This slab originally formed a projecting shelf in the rock-shelter, but is now broken off and stands on its edge at the opening

of the shelter.* From the preceding cut, Fig. 29, it will be seen that there is a remarkable similarity between the tracks and other markings upon this rock and those of the Barnesville and Newark "track-rocks" of Ohio, as figured in the *Ohio Centennial Report*, pp. 91, 92, 93, 95, and pp. 58 and 59 of the *Journal of the Anthropological Institute of New York*.

Mr. J. H. Salisbury† maintains, "that the ancient bird-track character belonged to the mound-builders is evident from the fact that it is found among their works constructed of soil on a large scale. One of these bird-track mounds occurs in the center of the large circular inclosure near Newark, Ohio, now standing in the Licking County Fair Grounds." On the lowlands, half a mile south of this rock-shelter, are sixteen mounds, in a straight line, running a little east of north, and directly toward the rock-shelter. These mounds are all about 2½ feet high and about 25 feet in diameter. Nothing has been found in them. Those toward the south are composed largely of slabs of Burlington limestone obtained from the neighboring bluff, while those toward the north are composed wholly of earth. Another similar row of mounds is found in Scott County.

In conclusion, I will add, the dividing line between the *mound-builders* and the modern Indian—that is, the Indians of the Mississippi Valley of two hundred years ago, and especially those inhabiting the lower part of that great valley, is not so distinct as is generally supposed. It is almost the universal opinion of those who have made the subject a study that the mound-builders were not the ancestors of the red Indian, but, on the contrary, were a distinct race, much further advanced in civilization, and that by choice or pressure of barbarous tribes from the north they abandoned their homes, or that they were exterminated by war, famine, disease, or domestic dissensions. Fully imbued with this idea, the writer began the study of the relics of this nameless race, but in the end has been compelled to abandon this received opinion and to conclude that the mound-builders were the ancestors of the southern tribes. There is no distinctive feature, whether physical or anatomical, whether in art or custom, that would stand the test of criticism as peculiar to that ancient race. If the comparison is made between the earthworks, implements, copper ornaments, pottery, and other relics of the mound-builders and the works and character of the modern Indian, with a straw hat on his head, a Mackinaw blanket and calico shirt about his shoulders, skinning animals with a steel knife of yankee manufacture, cooking his food in an iron pot from the same source, and all the manhood that was ever in him crushed out by fire-water and contact with the worst elements of civilization and fear of a dominant race, then, indeed, the line is distinct and well marked; but if instead of the modern Indian we substitute the red man, who lived

*A plaster cast of this track-rock was presented to the Smithsonian Museum in 1878.

† *Centennial Report*, p. 96.

in the valley of the Mississippi two or three hundred years ago, as described by the chroniclers of De Soto's expedition, or by the followers of Loyola, who, carrying the cross through prairie and desert and wilderness, ever had an eye open and a pen ready to record the character, customs, habits, and superstitions of the strange race about them, then the line of demarkation fades away, if it does not entirely disappear. Here we find mound-builders, fort-builders, manufacturers of stone implements, pottery, bark-cloth, feather-cloth, ornaments—in short, a race of men dependent on their own resources for supplying their wants of every nature, physical or mental.

A dying race—a race crushed out by the struggle of nations for room in the world, with no human heart to appreciate and no historian to record its wrongs, its own virtues lost, and to its vices added the vices of civilization, is not a fit subject for the scientist, but rather for the moralist.

THE GLIDWELL MOUND, FRANKLIN COUNTY, INDIANA.

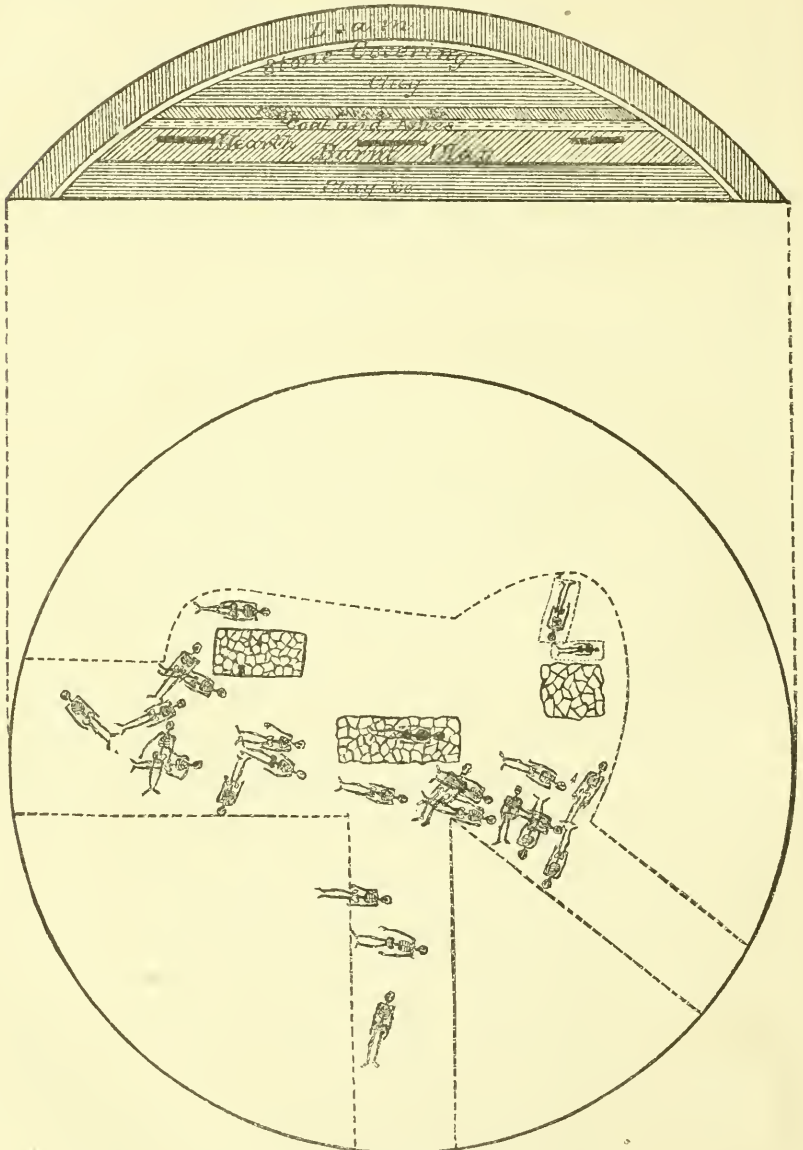
BY DR. G. W. HOMSHER, of *Fairfield, Ind.*

This mound is two miles south of the village of Fairfield, Franklin County, Indiana, and is situated upon a very high hill, or bluff, and on the East Fork of the White Water River. It faces the river on the east side, almost opposite the mouth of Wolf Creek. To the south and east of the hill is Templeton's Creek, both creeks emptying into the White Water. On the south side and at the foot of the hill are two very fine springs which never run dry.

From the water's edge of the river to the summit of the hill is 796 feet. Surrounding the hill, facing the river and Templeton's Creek are five terraces, commencing at a ravine on the north side of the hill, passing across the west side, thence around the south side, about two-thirds of the distance. Time and constant washing have obliterated them beyond that point.

These terraces originally were from 30 to 50 feet wide, but at the present time they measure, commencing at the base of the hill, the first, 32 feet in width; the second, third, and fourth, 24 feet in width; and the fifth, 48 feet in width. The distance from the water's edge to the first terrace is 300 feet; from the first to the second is 64 feet; from the second to the third, 80 feet; from the third to the fourth, 104 feet; from the fourth to the fifth, 80 feet; and from the fifth to the summit of the hill is 168 feet. On the west side (where these measurements were taken) the bank facing the river is almost perpendicular. It is almost impossible for one to climb the hill from the fifth terrace to the summit on the west side, or that side facing the river. These terraces are also broader on that side and are the least washed, in fact, there are no gullies cut down through the hill or terraces. Large oak, maple, elm, hickory, iron-wood, beech, and gum trees are growing all over them.

From the summit of this hill one has a grand view of the valley extending north about 7 miles, and can see the locations of other mounds that dot the hill-tops and second terraces of this beautiful and productive valley, and those along Wolf Creek and other tributaries that empty into the White Water.



A.—The Glidwell Mound, Franklin Co., Ind.

The Rev. J. P. MacLean, of Hamilton, Ohio, claimed these so-called terraces to be land-slides, but acknowledges those surrounding the fortified mound on the Templeton hill to be the work of the mound-builders. Now, the terraces surrounding the fortified mound on Tem-

pleton's hill are five in number, the same as that of the Glidwell mound; their width ranges from 24 to 30 feet. The distance from one to another is from 60 to 120 feet. Again, it is not likely that three terraces surrounding the same hill would measure the same in width and run parallel with each other from one side to another, and be land-slides. Such, it will be noticed, is the case with the second, third, and fourth of those surrounding the Glidwell hill.

Furthermore, no land-slide has been found across any of the hills or bluffs, along the White Water, without a break at least every hundred or two hundred feet. But such is not the case in any of the above-mentioned five terraces, which measure from 700 to 900 feet in length, without a break or gully, and they are sufficiently wide to drive two road-wagons side by side from one end to the other. The similarity of the two fortified mounds is almost complete. The measurements of the length of the terraces and the height from the water's edge of the

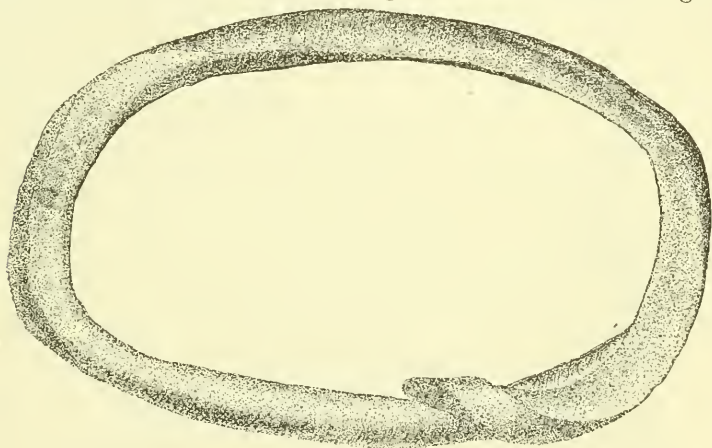


FIG. 1.—Copper bracelet from Glidwell Mound.

Templeton hill was not taken, but the Templeton hill is much higher than the Glidwell hill, and commands a fine view of the White Water south to Brookville, where the East and West Forks unite into one stream.

The first time the writer visited the Glidwell mound was in April, 1871. It was then 15 feet high and 60 feet in diameter. Mr. T. L.

Dickerson assisted in taking these measurements. The composition of the mound is of fine brick or compact clay, which has been brought from Wolf Creek, almost three-quarters of a mile from the mouth of the creek and one mile from the summit of the hill or mound. This mound was covered with flat, shelly limestone, one overlapping another, similar to shingles



FIG. 2.—Copper ring upon a roof. Over this was a deposit of loam varying from $1\frac{1}{2}$ to 3 feet. On the west side are still standing two iron-wood trees about 13 inches in diameter, also a large maple. On

the north side, about one-third the distance up the mound is a large maple $2\frac{1}{2}$ feet in diameter. On the east side are large beech, maple, and iron-wood trees. At the edge of the mound and on the south side is a stump of a large maple, very much decayed. There are five distinct strata (see vertical section): No. 2 is 5 feet thick and of compact clay; No. 3 is $1\frac{1}{6}$ feet thick and is composed of ashes and clay; No. 4 is 8 inches, and consists of ashes and coal; No. 5 is $2\frac{1}{2}$ feet thick, and made of burnt clay; No. 6 is $2\frac{3}{8}$ feet deep, and composed of clay and burnt stones. Between the strata Nos. 4 and 5 were three hearths made of sand and limestone, one in the center, one in the northeast, and the third in the northwest part of the mound. (See foregoing sketch, A.)

In June, 1879, in company with Mr. T. L. Dickerson and Thomas Glidwell, the writer sunk a shaft 12 feet deep into the center, and in the course of the work removed one skeleton with several fragments of pottery and one fine copper bracelet (Fig. 1). The copper had been pounded into a thin sheet and then rolled. A similar one, but smaller, was found some time afterwards by Mrs. A. Crist in the same mound, and is now in Mr. A. W. Butler's collection (Fig. 2). The above-mentioned skeleton was 6 feet 3 inches below the slabs or rock covering (base section, center figure, head to the east.)

In July, 1880, the writer visited the mound in company with Mr. C. W.

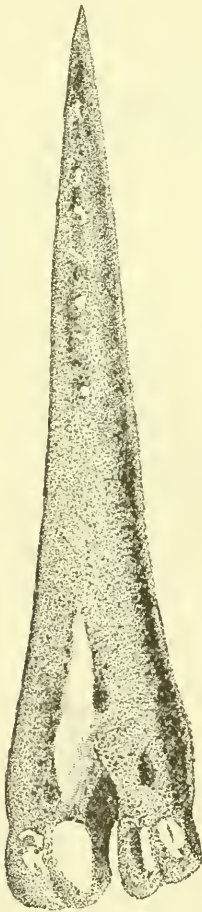


FIG. 3.—Bone awl from Glidwell Mound.



FIG. 4.—Arrow point from Glidwell Mound.

Ruse, and commenced a trench 5 feet wide in the southeast side, about 5 feet from the base (base section, dotted line), and trenched to the center. When within 3 feet of center shaft we came upon and re-

moved a skull, which was 5 feet from the top of the mound and 3 feet below the rock covering. But, strange to say, no other part of the skeleton could be found, or any marks of decayed bones. After the center shaft was reached it was sunk 2 feet deeper, and trenched back to the place of beginning. In the process six skeletons were removed in a very good state of preservation, two with heads to the east; one to the south; one to the north; one to the southeast; one to the northeast. Over one skeleton, whose head pointed to the east, were laid two others (see base section), the head of one to the south, of the other to the north. With this group were found one bone bodkin or needle (Fig. 3); two

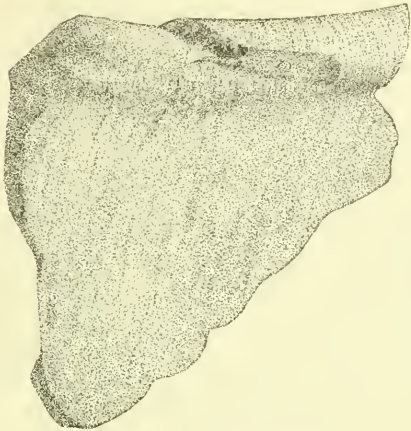


FIG. 5.—Pottery from Glidwell Mound.

arrow-points (Fig. 4); several pieces of animal bones, with a few fragments of pottery (Fig. 5).

In August, 1880, in company with Mr. J. E. Snider, the writer continued his investigation by commencing a trench on the west side about 4 feet from the base (base section, dotted lines), and trenched to the center shaft, removing four skeletons. Three of these lay with their heads to the east; one with the head to the south, or rather a little to the southeast (see base plan of sketch

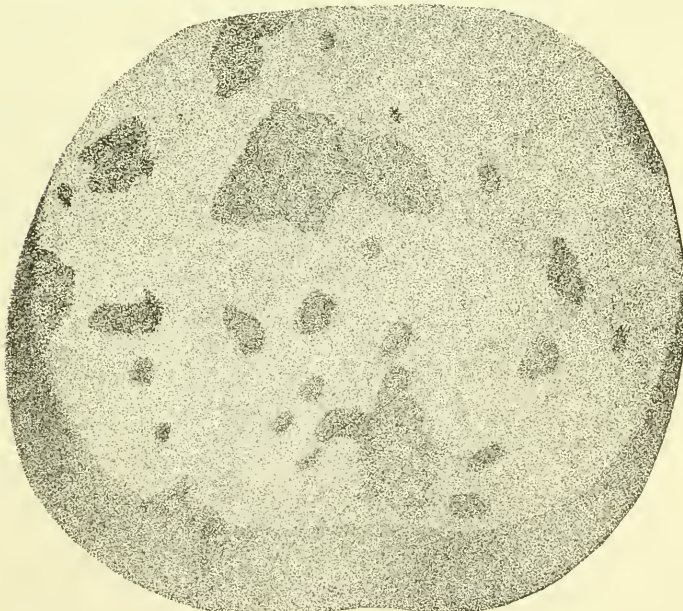


FIG. 6.—Turnt disk from Glidwell Mound.

burnt disk (Fig. 6), one pendant, etchings on one side, diagonal lines on reverse (Fig. 7). The six skeletons removed with Mr. Ruse's assistance



FIG. 7.—Pendant from Glidwell Mound.

were 6 feet 9 inches below the rock covering. The four removed with the aid of Mr. J. E. Snider were 5½ feet below the rock protection, near the enter of the mound.

May 10, 1881, the Rev. C. W. Hargett and Mr. E. Osborn helped to open a trench 6 feet wide on the south side of the mound, and 2 feet below the surface surrounding the mound (see base plan of first sketch A,—dotted lines), and continued to the center shaft. At this time were removed four skeletons. With the second skeleton, under the lower jaw, were found two beads (Fig. 8) made of the *unio* shell, split deer or elk bones (Fig. 9), and a few chips of flint, or chert. The first skeleton was 4 feet below the rock protection; the second 4 feet 7 inches; the third 6 feet 5 inches; the fourth, near the center, was 6 feet 10 inches below the protection.



FIG. 9.—Chert chip from Glidwell Mound.



FIG. 8.—Bead from Glidwell Mound.

August 23, 1881, by the assistance of the Rev. C. W. Hargett, Lewis Mullien, and William Hippard, an infant skeleton was found 7 feet below the rock covering, and a little north of the center hearth, in a direct line with the northeast and northwest hearths. (See base section.) Over this skeleton had been placed two large flat stones. The bones were very much decayed, so much so that there could be removed only a few fragments of the skull. The skeleton measured in length 3 feet 1½ inches. No ornaments of any kind were found with this skeleton. It lay with the head to the east. To the east of the skeleton, a

small stone hearth was discovered, made of small round stones, principally sandstone. August 29, 1881, Mr. A. W. Butler and Rev. D. R. Moore commenced near the center and trenched to the west side, following the old trench made by the writer and Mr. J. E. Snider. In doing so they removed three skeletons or parts, one lying with the head to the north, one northwest, and one northeast. (See base section.)

September 5, 1881, with the aid of Mr. A. W. Butler, digging was commenced again at the place where Mr. Butler and Moore left off,

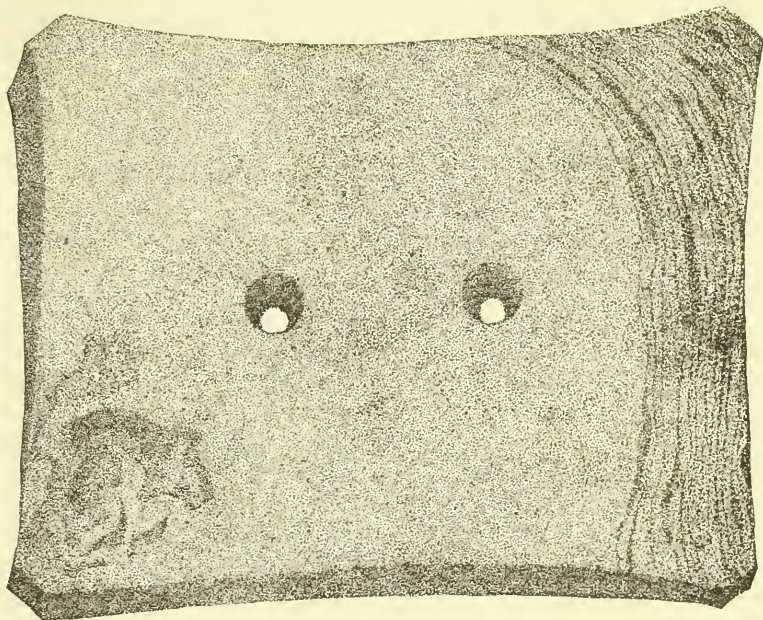


FIG. 10.—Slate "gorget" from Glidwell Mound.

and continued to the north and east; two skeletons were removed one with the head to the northeast, one with the head to the east, and one overlapping across the middle the one whose head pointed to the east. A fine gorget (Fig. 10), about one-fourth of a large celt, some fragments of pottery, and animal bones were found.

September 12, 1881, the same party again visited this mound and continued investigations. Two skeletons were removed, one with the head to the north, one with the head to the east. (See base section.) A stone hearth was found in the northwest part of the mound. This hearth was made of small bowlders. A little north of the covering of the infant was removed a skeleton of an adult, protected similarly to that of the infant, the head pointing to the south. The skeletons removed by Mr. Butler and the writer were from $5\frac{1}{2}$ to 6 feet below the rock covering. The fragments of pottery removed from this mound bore, no ornamental etchings or moldings upon them. They were unglazed, both externally and internally, and were made of fine quartz sand or pulverized quartz, pulverized shell, and fine, compact clay. The bone bodkin is evidently made from the bone of the deer. The only parts of the above-named

skeletons which could be recovered were the crania, and they badly decayed. In fact only one was removed in such a condition that it could be put together, and that one is deposited in the museum of the Brookville Natural Historical Society. The prominent features of that are an exceedingly narrow forehead, receding, with an extremely broad occiput, zygomatic arch large and prominent, inferior maxillary large and massive.

I find the characteristics mentioned by Mr. Gillman (*Smithsonian Report*, 1875) in about four-fifths of the humeri and tibias removed from this mound, but in the several parts of the skull no perforation as spoken of by the above-named gentleman.

The dotted lines show that part of the mound that has been removed. All that outside of these lines has been reserved for future investigations.

REMAINS ON WHITE WATER RIVER, INDIANA.

By GEORGE W. HOMSHER, M. D., of *Fairfield, Ind.*

The mounds, workshops, cemeteries, block-houses and camping grounds herein described are located on the East Fork of White Water River, in a portion of Brookville, Springfield, Bath, and Blooming Grove Townships, and in all parts of Fairfield Township, Franklin County, Indiana; in all of Harmony, with a portion of Center and Liberty Townships, in Union County; and also, in portion of Jackson and Jennings Townships, of Fayette County.

The East Fork of White Water River is a beautiful stream, whose head waters originate in the northeast part of Wayne County, Indiana, flowing in a southern direction through Wayne, Union, and Franklin Counties, to a point near the center of Brookville Township, just south of the town of Brookville, where it joins the West Fork. These united form the White Water which runs in a south and east course across the southern part of the township until it crosses the southern boundary line near the southeast corner, thence south and west until it empties into the Ohio River near Lawrenceburg. Both branches and their tributaries are noted for the richness of the soil, as well as for the great number of mounds, workshops, cemeteries, &c., that are distributed upon their upper and lower terraces from their sources to their mouths. In touching upon the location of the structures, &c., reference will be made to the townships and sections. And in this report the range, as well as the survey and description of each structure is given. Thus by the aid of the map all the ancient structures may be visited without any difficulty whatever.

In a paper read before the Brookville Natural Historical Society, the writer touched upon the mounds, workshops, cemeteries, &c., of a portion of Brookville, Springfield, Bath, and Fairfield Townships, of Franklin County. The society appointed a committee to prepare a complete map of the county, locate each structure, and give a description thereof.

As this committee has not made a report, in this communication will be presented the latest survey, which includes the townships mentioned above. The distance from Brookville to mound No. 80, the most northern here described, is 16 miles. The townships of Liberty, Center, and Union, of Union County, have been only partially investigated. Several tumuli are said to exist within these townships, but the exact location is not known. Just east of Brookville is a very high hill, whose headland juts out to the river, and from the apex of this hill, one looking south has a grand view of the White Water below the junction of the two rivers, and of a few of its tributaries, for several miles. To the west and northwest, up the beautiful valley of the West Fork, the eye becomes tired with the picturesque landscape of the whole valley, whose second and third terraces are dotted o'er with ancient earthworks, both single and in groups. Again, looking north, up the East Fork, we behold another enchanting scene, whose lofty hills hug close the clear waters from either side as it winds its way through the fertile valley and along its course.*

The writer has spent many pleasant hours investigating the last resting places and other structures of a people who once spent their time here in fishing and hunting, and in the cultivation of the cereals upon which they partly subsisted.

Mound No. 2 is in Sec. 5., T. 9 N., R. 2 W., near the southwest corner of the southwest quarter section, almost directly opposite the bridge that spans the river at the base of the hill, on the west side of the river, and between two ravines, one on the north and the other on the south side of the hill. This is known as the Templeton's Fortified Mound, an account of which was given by Edgar Quick in the Smithsonian Report for 1879, and by Dr. Rufus Hayman in the Geological Report of Franklin County, Indiana, of 1869. The Doctor's report is, to some extent, incorrect, so far as the description of the work is concerned. This mound is on the top of a very high hill, not less than 375 or 400 feet high. It is built on a plateau, back from the apex of the hill at least 500 yards, and partly surrounded by a semi-circular wall on the east side and a ditch on the west. The semi circle extends across the plateau from the ravine on the north side to the ravine on the south side. This semi-circular wall is very distinct, measuring, in some places, 3 feet in height. The ditch on the inside of the wall was formed by the removal of the dirt to construct the wall. It measures, in some places, from 2 to 2½ feet in depth. If there was a wall of any description on the west side it has been obliterated. About 250 yards on the west side is a very wide ditch, from 9 to 10 feet, symmetrical from one end to the other, and about 3 to 4 feet

* Mr. C. C. Royce, on his map showing the cessions of land by Indian tribes to the United States, in the annual report of the Bureau of Ethnology for 1879-1880, lays down the junction of the East and West Forks just south of Connorsville, and about midway of the lines of the old boundary line and the 12-miles purchase. This is a mistake. The two forks unite within the territory known as the Wayne purchase.

deep. In it and on its banks are growing some very large trees. Surrounding the hill are five terraces, commencing some distance up the ravine on the side of the hill facing the north, thence passing around the hill facing the south, extending some distance up the ravine on the south side of the hill. These terraces vary in width from 20 to 40 feet, and from one to another as you ascend the hill the distance is 50 to 75 feet. The length of those terraces also varies from 600 to 800 yards. The outlines and formation are defaced but little, only a few gullies having cut their way through them to mar their symmetry. The whole hill is covered by a very heavy forest, and trees are growing upon the terraces and hillside that will measure from 4 to 4½ feet in diameter; in fact, this hill in outline is similar to the Glidwell Fortified Mound, with the same number of graded ways or terraces. The construction of these graded ways, with semi-circular walls and ditch, is conclusive evidence that this hill, at one time, was an ancient fortification. The original height of this mound, by measurement of the several strata, is 10 feet, and the diameter at base 40 feet. It is composed of brick clay, ashes, and charcoal. The mound has been badly mutilated by curiosity seekers; skeletons have been thrown out promiscuously and broken, which no doubt with a little care could have been removed intact. Mr. James Rucker, who took great interest in the study of archæology, informed the writer, in regard to the positions in which the subjects were laid in this mound, that they were placed promiscuously throughout that portion of the mound which has been mutilated, and all within the clay forming the base stratum. He himself removed several, but not knowing how to treat them properly, they were broken into fragments in his efforts to preserve them, and, deeming them of no value, he threw them out with the dirt among the rubbish.

A portion of the mound still remains undisturbed. This will afford an opportunity perhaps to secure a portion of the remaining objects which have been entombed therein. From this mound there is a good view of the uplands between the two forks of the White Water, also mounds 1, 3, 4, 5, 6, and 12 can be seen.

Number 3 is on the same side of the river, about one-half mile north, and located in Sec. 4, T. 9 N., R. 2 W., midway of the west part of the northwest quarter section 4, on Mr. George Templeton's farm. This mound is a little more than half way up the hill, in the center of a depression about the shape of a horseshoe. Above, below, and on each side of the depression it has about the same angle of descent as that of other parts of the hill. This is the only mound the writer has ever seen built midway of a hill.

Number 4 is in the northeast corner of the southeast quarter Sec. 9, T. 9 N., R. 2 W., on Mr. Jeff. Logan's farm, on the second terrace formation. Originally it was about 6 feet high, with a base diameter of 50 feet; but it has been under annual cultivation for about forty years, which has almost obliterated it. A few more years will level it with

the surrounding earth. As to whether bones of any description have ever been found in this mound during the process of tilling or otherwise no information can be obtained. Mr. James Rucker, when living, secured a great many arrow-points, axes, &c., from the field in which this mound is located.

Number 5 is in T. 9 N., R. 2 W., near the southwest corner of the southwest quarter section 2, on Mr. James Logan's farm, and on the highest terrace formation, on the west side of a small creek that runs through the farm and empties into the south fork of Templeton's Creek at Locks Chapel. This mound is 4 feet high, 30 feet in diameter at the base, and is composed of fine brick clay. From this mound, looking to the east, one can see mound No. 6 in the northeast corner of the southeast quarter Sec. 1, T. 9 N., R. 2 W., which is also on one of Mr. James Logan's farms, on the highest terrace formation. This mound is 4 feet high, with a base diameter of 40 feet, and is composed of brick clay.

Number 7 is in T. 9 N., R. 1 W., Sec. 6, midway between the east and west quarter section lines, of the southeast quarter, and only a few rods from the north quarter section line. The height is $4\frac{1}{2}$ feet, the diameter at the base 30 feet, and it is composed of brick clay.

Number 8 is in T. 9 N., R. 1 W., Sec. 5, near the northwest corner of the northwest quarter section, close to the Billingsville and Springfield pike. The field in which this tumulus stands joins the pike, and is known as the mound field. The height of the structure is $6\frac{1}{2}$ feet, the diameter at the base 50 feet, and it is composed of brick clay.

Number 9 is in Sec. 35, T. 10 N., R. 2 W., in the southwest corner of the northeast quarter, on the north side of the south fork of Templeton's Creek, on the highest terrace formation, and on Mr. Mark Mullen's farm. The height is 5 feet, the diameter at the base, 45 feet, and the composition compact clay.

Number 10 is in the same section, northeast of No. 9 but a few rods, on the same farm. The composition is compact clay.

Number 11 is a circle, in Sec. 25, T. 10 N., R. 2 W., midway between the north and the south quarter-section lines of the northeast quarter, and 10 rods from the west quarter-section line, on the side of the south fork of Templeton's Creek, and on Mr. Henry Fry's farm. This circle is 80 feet in diameter and $242\frac{1}{2}$ feet in circumference. The embankment forming the circle is $2\frac{1}{2}$ feet high. On this embankment are hickory trees from 3 to $3\frac{1}{2}$ feet in diameter. Within the circle or embankment there is not a tree, but outside of it on every side are heavy woods. This circle, like others examined, was constructed for protection to the dwelling, and not for an arena in which, or around which, were performed various ceremonies. Probably it was not constructed for a protection during a war among the tribes; but after the erection of the dwelling the savages dug this circle just inside of their building, so that in case of rain the water would be carried off and not run within, thus securing to the occupant a dry and comfortable floor. Otherwise, the ground

within being tramped down, would be lower than that outside, and, when it rained, the water would run within the wigwam and make a wet and disagreeable floor. Their conceptions were acute to all the comforts of life, for we see in all their work comfort and protection so far as it was in their power to secure and apply that which surrounded them.

Number 12 is in Sec. 33, T. 10 N., R. 2 W., on the east side of the river, midway between the west and east quarter-section lines of the southeast quarter, and near the north line of the same quarter. This is the noted Glidewell mound,* which is not only a fortified mound, but was also used for burial purposes. No doubt it has also been used as an observatory or signal mound, from the fact that from the top there is a grand view of the valley and uplands of Wolf Creek. Looking south and southwest, west, and north, can be distinguished mounds 2, 3, 4, 13, 14, 15, 16, 18, 19, 20, 25, 26, 27, 28, 29, 49, 50, 41, 42; workshops 57, 58, 59, 60, 61, 63; cemeteries 64, 65; camping grounds 70, 73, 75; stone graves 54, 55. A fire burning upon this mound could plainly be seen at all these points, and perhaps at others were it not for the intervention of a heavy forest that has grown up since these mounds were constructed. They are all in a line with this mound, and a few of them can be located from the Templeton Fortified Mound No. 2; perhaps all could be were it not for the same intervention.

Number 13 is in Sec. 33, T. 10 N., R. 2 W., midway between the east and west quarter-section lines of the northwest quarter and 40 rods from the north line, on the west side of the river. It occupies a very prominent ridge that projects out to a small creek on the north side that empties into the river on Mr. Alex. Johnston's farm and second terrace formation. This mound is 8 feet high with a base diameter of 40 feet. On top of this structure is a very large maple tree. From this summit, and only thence, are to be seen mounds 51, 52.

Number 14 is in Sec. 32, T. 10 N., R. 2 W., in the northeast corner of the northeast quarter of the section, on the highest terrace formation, also on Mr. Johnston's farm, better known as the Hall farm. This mound is 5½ feet high, with a base diameter of 46 feet. The composition is compact clay.

Number 15 is in Sec. 5, T. 9 N., R. 2 W., midway between the north and south quarter-section lines of the northwest quarter of the section, and 6 rods from the west line, on the highest terrace formation, on the west side of Berris's Creek, on Mr. Chas. Conrad's farm, and in plain view of the Glidewell mound No. 12. This mound is 4 feet high, with a base diameter of 35 feet and composed of compact clay.

Number 16 is in Sec. 32, T. 10 N., R. 2 W., near the corner of the southwest quarter, in the highest terrace formation, north of Wolf Creek and

* This mound is fully described in the preceding article, with drawings, giving vertical and horizontal sections, and showing position of skeletons exhumed, &c.

east of a small creek called Monday Branch, on Mr. Phil. Snider's farm. The hill or headland on which this mound is built projects out to this small stream called Monday Branch. The tumulus is 8 feet high, with a base diameter of 60 feet, and composed of compact clay, coal, and ashes. Five distinct strata were encountered, varying from 7 to 20 inches in thickness. No bones of any description were found, nor ornaments or fragments of pottery, in fact nothing that would go to show that it had been used for burial purposes. It was simply a signal mound. Taking the location and surroundings into consideration a better site could not be found on the East Fork of White Water River, one that commands as large a scope of country as this, of both uplands and valley. To the east, west, north, and south, the hill towers above a majority of the surrounding forest, with nothing to obstruct the grand view that is presented to the eye from all points of the compass. One hundred and fifty yards northeast of the mound is an excellent spring of never-failing water. From this mound can be distinguished mounds 12, 14, 15, 17, 18, 19, 20, 27, 28, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 45, 46, 47, 48, 50, 53, 76, stone grave 55, workshops 57, 59, 60, 62.

Number 17 is in Sec. 13, T. 12 N., R. 13 E., 20 rods from the boundary line, midway between the north and south section lines, and on the south side of a small branch that empties into Monday Branch, second terrace formation, on Mr. Jacob Master's farm. This mound is oblong, 75 feet long, 5 feet high, and 35 feet in diameter at the center. It is simply a heap of fine compact clay; no ashes or charcoal were discovered in trenching it both ways longitudinally and diagonally. It could not have been used as a signal mound, for it is in the hollow of a small ravine, and only to be seen from No. 16.

Number 18 is in Sec. 31, T. 10 N., R. 2 W., midway of the north part of the section, 10 rods from north section line, and near the township line that divides Fairfield and Blooming Grove, on the former boundary line that divided the Territory of Ohio and Indiana. ("This line was established at Greenville, Ohio, treaty in 1795,") and it is also in that territory known as the "Twelve-mile purchase." The mound is on the farm of Mr. Jacob Master, sr., and has been under annual cultivation for the past forty years. Mr. A. Buckley, who settled this farm, informed the writer that when he cleared the timber from the field in which the mound is located, it was then 9 feet high, and surrounded by an embankment, with a deep ditch, evidently from which the material was taken to build the mound and embankment. At the present date the ditch is obliterated, and but a faint ridge marks the outline of the embankments. The remaining part of the mound is 2 feet high, with a base diameter of 45 feet. From this field a great many fine arrows, axes, celts, pestles, &c., have been picked up. In trenching the remaining portion only burnt clay, ashes, and charcoal were encountered. No bones of any description, ornaments, or fragments of pottery were seen. So far back as the time that this field was brought under cultivation, Mr. Herrall has no

recollection of ever plowing up so much as a fragment of a human skeleton, nor has the present owner ever observed anything of the kind; therefore this mound also must have been constructed for a signal station.

Number 19 is in Sec. 29, T. 10 N., R. 2 W., in the southwest corner of the southwest quarter, on the highest terrace formation, and on Mr. Wilson Jones's farm. This mound, like No. 18, has been under cultivation for a great many years, which has diminished its size considerably, so that at the present time it only measures 4 feet in height, and as to the diameter of these cultivated mounds it is impossible to obtain anything accurate. In trenching no signs of fire occurred. It is simply a heap of compact clay.

Number 20 is in Sec. 29, T. 10 N., R. 2 W., about in the center of the northeast quarter. It occupies the highest terrace formation on Mr. Jno. Kelley's farm, south of the Blooming Grove and Fairfield road, one east from Mr. Kelley's house about 30 rods, and very near the line of his and Mrs. George Miller's farm, just at the apex of the hill that juts up to the ravine running along the base of the hill on the north side. This mound, says Mr. Kelley, was originally 8 feet high, with a base diameter of 50 feet, but with the plow and scraper he leveled it down, so that he could cultivate over it, which he has continued to do for the past twenty years. At the present date it measures 2 feet and 3 inches in height. The portion levelled down was similar in the strata to the remaining portion of the mound. Around this was a ditch and circular wall or embankment, the wall originally was 2 feet high, with the ditch upon the inside. But in leveling it the ditch was filled and the circular embankment destroyed in several places. This circular wall measured 225 feet. In the process of leveling was found a fine copper gorget, which was used to mend a broken shovel-handle. The shovel was purchased and the article removed in a mutilated condition. In trenching the remaining portion of the mound the writer found one fine leaf-shaped spear-point in the *débris* of ashes and charcoal, being somewhat burnt. From this mound can be distinguished mounds 34, 36, 37, 38, 39, 40, 41, 42, 43, 46, 47, 48, 49, 50, 12, 19, 25, in the autumn when the forest is divested of its foliage. No doubt, at one time, judging from the several locations of these mounds, no forest intervened between them.

Number 21 is in Sec. 9, T. 12 N., R. 13 E., in the southeast corner of the southwest quarter of the section, second terrace formation of Duck Creek, and on Mrs. Wilson's farm. The height is 6 feet, base diameter, 36 feet, and the composition, compact clay.

Number 22 is in Sec. 4, T. 12 N., R. 13 E., in the southeast quarter of the section, 60 rods from the north line and 40 from the east line. It is located on Mr. J. Hay's farm, and on the west side of the Blooming Grove and Connersville pike, south side of Duck Creek, near where the pike bridge spans the creek. This is also in the second terrace formation of the creek. Its height is 8 feet, base diameter, 48 feet, and composition, brick clay.

Number 23 is in Sec. 34, T. 13 N., R. 13 E., in the southeast corner of the northeast quarter of the section, on Mr. Milton Trusler's farm, due west of his residence about 20 rods. This mound has been cultivated for several years, long enough almost to obliterate it. It is somewhat difficult to distinguish it from the surrounding surface.

Number 24 is in Sec. 33, T. 13 N., R. 13 E., in the southeast corner of the northeast quarter of the section, near the east line, on Mr. J. Backhouse's farm, and but a few rods from the Blooming Grove and Connersville pike, on the east side. The height is 7 feet, and base diameter 60 feet. This mound also has been under cultivation for several years; perhaps originally it was 10 feet high. It is composed of brick clay.

Number 25 is in Sec. 17, T. 10 N., R. 2 W., near the west quarter section of the southeast quarter, and north of the county line 40 rods. It stands on the second terrace formation that juts out between two small branches or creeks that empty into the river, about 15 rods southwest of the residence of Mr. Jas. Herrall. The tumulus originally was about 5 or 5½ feet high, with a base diameter of 20 feet, but at the present time it measures only 3 feet 9 inches. The diminished height is owing to annual cultivation. Upon being trenched, several fragments of calcined bone, one spear-point, a small gorget, but no pottery or fragments of pottery were found. The remaining portion is composed of four strata of ashes, charcoal, and clay. The fragments of bones, relics, were found in the base or first stratum.

Number 26 is in Sec. 16, T. 10 N., R. 2 W., in the northeast corner of the northwest quarter section, on the second terrace formation of the river, north side of Bloyd's Creek, between the creek and road, due north of Mr. Orlando Campbell's residence 2 rods. The creek during the freshet of June 14, 1882, cut into it about 4 feet. This is a low, flat mound, only 2 feet high, with a base diameter of 46 feet, and that of the apex 40. In trenching, no bones or relics of any description were seen. The mound is composed of fine sand, and covered by a very thin stratum of brick clay. This is the only mound of this description known along the valley or in the territory under investigation. If this was a residence mound, as some would term it, we should find several such mounds grouped together. If this is to be construed as a camping ground or village site, taking the location and surroundings into consideration, the selection was poor and does not correspond with the better judgment exercised by these people in the selection of the sites of their other tumuli. Some contend that these were constructed for the site of the chief's wigwam or building, so as to afford him a better view over his subjects or village, but such arguments are not convincing. The notion that a low, flat mound, only 2 feet high, afforded a much better view is preposterous, when within 40 feet of the mound we come upon the third terrace formation 5 feet higher than the mound itself, affording a far better view and over three times the amount of territory. The mound

shows no action of fire, and no remains of any description were found within it. It could not have been a resident mound, a burial mound, or a sacrificial mound. In either case fragments of some kind would have remained to tell its story.

Number 27 is in Sec. 8, T. 10 N., R. 2 W., in the northwest corner of the southeast quarter section, on the highest terrace formation, at the apex of the hill, and on the north side of Bloyd's Creek. East of the mound, about 100 yards, is a small ravine, fed by springs. The tumulus is 7 feet high, with a base diameter of 48 feet. It had been explored to some extent about a year before the work of 1880, and the parties who sunk the pit in the center found, while so doing, a part of a pendant and a small celt, also, a few bones, ulna, radius, tibia, and a portion of the spinal column, but no fragments of the cranium. They, like a great many other curiosity hunters, placed no value on these bones, but threw them out among the brush. The exploration herein described commenced with a trench on the north side, 1 foot below the base, which ran longitudinally through the mound. An unfinished gorget was found, one corner of which having lain in the fire had become calcined to some extent. This ornament and the "finds" of the other parties are made of striped slate. This mound will be fully explored in the near future as opportunity offers, being only $1\frac{1}{4}$ miles northwest of the village of Fairfield. The construction of this mound is different from that of any other of the numerous mounds explored. No distinct strata occur but patches of ashes and charcoal are interspersed throughout the mound. There have been seven hearths, and the fires kept burning there were intense, for the clay beneath each is burnt to a brick, red and hard, also giving evidence that the fires have been extinguished at different times, and covered over to be rebuilt in another place. The construction of this mound is similar to that on Shaw's Point, on Manatee River, Florida, described by Mr. S. F. Walker. In its use, however, it was entirely different, for no charred animal bones occur, nor were the bones removed by the first explorers in any way burnt. From this mound can be distinguished mounds 12, 28, 34, 36, 37, 38, 39, 40, 41, 42, 43, 46, 47, 48, 49, 50, 76, stone grave 55, workshops 57, 58, 59, 61, 62, 63, cemeteries 64, 65. From off this mound an enchanting scene is presented to the observer in whatever direction he may choose to turn, with the exception of the west. No doubt this would be as beautiful as that to the north, east, or south, were it not for a dense woods that obstructs the view. You have not only a plain view of the valley, but also of the uplands as far as the eye can reach to the east. A fire built upon this mound at any time and in any season of the year, could be plainly seen at all the mounds, &c., specified in the figures given above. We are justified, therefore, in terming this structure not only a burial mound but an observatory, or signal mound as well.

Number 28 is in Sec. 5, T. 10 N., R. 2 W., on the highest terrace for-

mation on Mr. Charles Snider's farm, about 50 yards from the apex of a very prominent hill which is on the south side of Elie's Creek, and back from the river on its west side about 80 rods from the mouth of Elie's Creek. The highest is $4\frac{1}{2}$ feet, and the base diameter, 35 feet. From the field in which this mound is located, and the one due west, many finely made perforators, arrow-points, spear-points, celts, &c., have been picked up from time to time. Mr. Milton Trusler and Mr. Elmer Sheppard have in their cabinets some very beautiful specimens from this locality. In the trenching no bones or ornaments of any description were recovered, but, as usual, the tumulus proved to be a stratified mound, which also may be classified as a signal mound. From this and only this one can be seen mounds 23, 24, 29, 30, 31, 32, 33.

Number 29 is in Sec. 5, T. 10 N., R. 2 W., in the southeast quarter of the section, about the same distance from the east and north section lines. It stands on the south side of Elie's Creek and the west side of the river, about 50 yards from the creek and river, on the second terrace formation, on Mr. Chas. Snider's farm. The height is $3\frac{1}{2}$ feet, the diameter 22 feet. It is composed of sand overlaid with a thin stratum of brick clay. Mr. Snider, in cultivating over this tumulus has at several times plowed up human bones, but they would crumble as quick as exposed to the atmosphere. In trenching, the writer met with the same trouble of crumbling to dust on exposure. So far as learned, no relics have been found in this mound by any one. Several have dug into it, thus marring the symmetry, and in the course of five or six years there will be nothing left to mark its location, which is the case with a great many of these ancient monuments along this valley.

Number 30 is in Sec. 24, in the southwest corner of the northeast quarter section, T. 13 N., R. 13 E., on Dr. A. C. Fosdick's farm, and on the east side of a small creek that empties into Elie's Creek. It occupies the highest terrace formation of Elie's Creek. The height is 8 feet and the diameter at the base, 28 feet. This mound has a pit sunk in the center about 5 feet square, concerning which nothing is known. The mound is composed of compact clay stratified.

Number 31 is in Sec. 14, T. 13 N., R. 13 E., Fayette County, in the southwest corner of the northeast quarter section, on Mr. John Dungan's farm. It stands on the north side of the same creek as No. 30, northwest of Mr. Dungan's residence about 150 yards. This mound is $7\frac{1}{2}$ feet high and 46 feet in base diameter. It has been partly explored by some one who commenced a trench on the west side 5 feet wide, and dug to the center of the mound. The sides of this trench reveal the composition throughout. The mound stratified and composed of brick clay. From the field in which this mound is located several species of aboriginal handiwork have been picked up.

Number 32 is in Sec. 14, T. 13 N., R. 13 E., in the northwest corner of the northeast quarter, about 20 yards from the north section line and 75 yards from the west quarter-section line. It stands in the center of

a fine maple grove, on Mr. Asbury Henson's farm. The height is 11 feet, and the base diameter 57 feet. This mound, like No. 30, has a pit^{*} sunk in the center. Fifty yards to the northwest of the mound is a large circular pit, from which, no doubt, the material used in the construction was taken. On the mound are three large maple trees, and on mound 31 are two maple and a beech tree. The material is compact clay.

Number 33 is in Sec. 25, T. 11 N., R. 2 W., in the southeast corner of the north west quarter section, in Union County, northwest of Roseburgh 500 yards. It stands on the east side of Hannal's Creek, about 400 yards distant, and on second terrace formation, on Mr. Hayworth's farm. This mound is 15 feet high, with a base diameter of 65 feet, and is considered the largest mound in Union County. Riding over it with a horse or pounding on the apex produces a hollow sound. The supposition among the villagers is that it is not solid. No doubt this is a sepulchral mound.

Number 34 is in Sec. 3, T. 10 N., R. 2 W., about midway, near the east section line of the northeast quarter section, on the east side of Hannal's Creek, and on the highest terrace formation. It is located on Mr. Andy Sutton's farm, northwest of Santaannahsburg a little over a half mile, and on the west side of the road that runs from the burg across to Hannal's Creek, and 300 yards a little northwest of Mr. Sutton's residence. This mound is $14\frac{1}{2}$ feet in height, with base diameter of 60 feet, unexplored.

Number 35 is in Sec. 33, T. 11 N., R. 2 W., in the southeast corner of the northeast quarter-section, on the highest terrace formation of the river, 40 rods from the east section line, and 75 or 80 yards from the south quarter-section line. It is on the north side of the road and about 150 yards north of Mrs. Hughes's residence, on Mr. Jas. Wilson's farm. The height is 4 feet, base diameter 38 feet; the material is brick clay.

Number 36 is in Sec. 34, T. 11 N., R. 2 W., on the line that divides the northwest and southwest quarters, and 60 yards from the west section line, on Mr. Israel Martin's farm. It stands on the highest terrace formation of the river, east of Mrs. Hughes's residence about 100 yards. The height is $4\frac{1}{2}$ feet, and the base diameter 38 feet. This mound has been trenched from the west side to the center, and Mr. Geo. Hughes, who lives in close proximity, states that there have been taken from this mound several nice copper and striped slate ornaments, and human remains, in a very good state of preservation. Like a great many others who destroy these ancient tumuli, however, merely to satisfy a morbid curiosity, placing no value upon these old and partly decomposed bones, "he threw aside" that which the student as well as the scientist value as highly as the relics found with them. Thus it is, in every community, a class of people exist, to place hinderances in the way of investigators.

Number 37 is in Sec. 34, T. 11 N., R. 2 W., about half way between

the east and west quarter section lines of the northwest quarter, and 10 rods from north section line. It is located on the highest terrace formation of the river, on Mrs. Lewis Pugh's farm. Its height is $4\frac{1}{2}$ feet, and base diameter 35 feet. It is unexplored.

Number 38 is in Sec. 3, T. 10 N., R. 2 W., in the northwest corner of the northwest quarter, about equal distance from the north and west section lines, on the highest terrace formation of Hannah's Creek, and on Mr. Jerry Sample's farm. The height is 4 feet, and the base diameter 28 feet. It is unexplored.

Number 39 is in Sec. 3, T. 10 N., R. 2 W., in the southwest corner of the northwest quarter, about equal distance from the west section line and south quarter-section line. It stands on a very prominent hill that juts out to Hannah's Creek, where it and Dubois Creek join. From this mound can be distinguished Nos. 36, 37, 38, 40, 41, 27, 28, workshops 60, 62.

Number 40 is in Sec. 4, T. 10 N., R. 2 W., in the northeast corner of the southeast quarter, about 10 rods from the east section line, and 12 rods from north line of the quarter, on the highest terrace formation of both the river and Hannah's Creek, and on Mrs. Scott's farm. Unexplored.

Number 41 is in Sec. 9, T. 10 N., R. 2 W., in the northeast quarter of the section, southwest of the township school-house 508 yards, on Mr. Alex. Johnson's farm, and southeast of his residence 300 yards, on the highest terrace formation of the river. The height is 5 feet, and the base diameter 40 feet. From this mound can be distinguished Nos. 27, 28, 29, 38, 39, 40, 42, 43, workshop 60. Unexplored.

Number 42 is in Sec. 9, T. 10 N., R. 2 W., in the northeast corner of the southeast quarter section, on the second terrace formation, and on the south side of a small stream called Hollingsworth's Creek. It stands only a few rods east of Mr. Henry Master's spring-house, also southeast of his residence about 400 yards. The height is $4\frac{1}{2}$ feet, and the base diameter 32 feet. It is composed of compact clay.

Number 43 is in Sec. 9, T. 10 N., R. 2 W., about midway between the south section line and the north quarter section line, and in the southeast quarter of the section, due south of residence about 500 yards, on the same farm, and on the second terraced formation. This mound is oblong, and is 3 feet high, its longest diameter being 42 feet, its shortest 20 feet. Mr. Enoch Hollingsworth, who owned this farm years ago, at his leisure moments trenched it from east to west, and in doing so removed several fragments of human bones, a few arrow-points, and one stone ax, which were thrown aside as valueless.

Number 44 is in Sec. 24, T. 10 N., R. 2 W., in the northeast corner of the northeast quarter section. The east section and township line touches the base of the mound on the east side. It is south of the north section line just 8 rods, and northwest of Mr. Thomas Flood's residence 40 yards. This mound has been under cultivation annually for the past

fifty years; therefore as to its original height there are no means of judging. From this mound have been taken a fine pipe, several arrows, spear-points, and ornamental stones, all of which were given to persons who were making a study of these prehistoric relics.

Number 45 is a stone structure in Sec. 23, T. 10 N., R. 2 W., in the northeast corner of the northwest quarter section, 10 rods south of the north county line, 20 rods west of the east quarter-section line, on the west side of a small branch or creek that empties into the north branch of Templeton's Creek. This is the most peculiar stone structure in the valley. The east half has been destroyed by the branch undermining the bank, and letting it down about 6 feet to the bed of the creek. This structure was examined very minutely. Judging from the remaining half, and allowing both sides to have been equal in width and length, we may form some idea of its character. The height of the wall and altar is the same, measuring just 2 feet. It is an easy matter to conjecture the use for which this peculiar structure was erected, but a more difficult task to establish opinions as facts. There is an altar surrounded by a wall. Whether this was a sacrificial altar or one upon which had been erected an idol cannot be known. The center is not raised above the surrounding walls. The stone covering the top was once in one solid piece, but now broken, and was perfectly smooth on its upper surface. It does not show any action of fire. Mr. Joseph Miller, who first called attention to it, and others, could not imagine for what purpose it was constructed. This was a great curiosity during the days when the noted Bath Springs were a resort of the people from a distance as well as those of the surrounding country. Crowds would visit this structure and speculate upon its probable use and constructors.*

Number 46 is in Sec. 15, T. 10 N., R. 2 W., in the southeast corner of the southeast quarter section, 4 rods from the south section and county line that separates Franklin and Union Counties, 8 rods from east section line. It stands on the south side of Bath Creek, 40 feet from the bank, at the foot of a small hill in the woods, on the third terrace formation of the river, and on Mr. Noah Newkirk's farm. On the north side and also on the east side, about midway of the apex and base, are growing two large beech trees. Mound, height, $3\frac{1}{2}$ feet; base, diameter, 30 feet; composition, compact clay.

Number 47 is in Sec. 22, T. 10 N., R. 2 W., in the northeast part of the northeast quarter section, on the south side of Bath Creek, and on third terrace formation of the river, located on Mr. Amos Cary's farm. The height is 5 feet; base diameter, 35 feet; composition, compact clay.

* Since the above was written Mr. Joseph Miller states that during the freshets of June 13, 1882, the creek, near whose bank it was situated, overflowed. The current, being swift and destructive, completely destroyed the remaining part of the structure by undermining the bank and tumbling the whole into the creek. Thus it is, one by one, these old remains are becoming removed.

Number 48 is in Sec. 22, T. 10 N., R. 2 W., in the southwest part of the northeast quarter section, on the south side of Bath Creek. It occupies the highest terrace formation of the river, about midway between the creek and the road to the south that leads from Fairfield to Colter's Corner and Oxford. It is located on Mr. Amos Cary's farm. The height was originally 6 feet and base diameter 40 feet. This mound has been under cultivation for the past half century. The author remembers very distinctly going twenty-two years ago, in company with a cousin, and gathering pockets and hats full of fine arrow-points and spear-points from this mound, carrying them to the house, after which they amused themselves by striking them together to see the sparks fly. Even recently have been secured fine specimens of arrow-points, spear-heads, two or three very good axes, several fine celts, and three discoidal stones, the largest weighing eight pounds and six ounces. In digging from west to east a trench 6 feet wide, nothing was found in the shape of ornaments or domestic implements, but a stratum of ashes, coal, and burnt clay.

Number 49 is in Sec. 16, T. 10 N., R. 2 W., in the southeast quarter section, about midway between the north quarter and south section and county lines. It is 10 rods from east section lines, on the third terrace formation, on Mr. John Sim's farm. This is an oblong mound, height, $3\frac{1}{2}$ feet; longest base diameter, 40 feet; shortest, 20 feet; composition, compact clay. From this mound can be distinguished Nos. 20, 25, 26, 27, 28, 53.

Number 50 is in Sec. 27, T. 10 N., R. 2 W., in the northeast part of the northeast quarter section, about 20 rods from the north section line, the same distance from the road on the south of the mound, and northeast of Mr. C. Master's residence, on whose farm it is located. It lies south of a small stream called Blue Liek, which empties into Bath Creek, and is in the woods about 60 rods from the creek. The height is 5 feet 9 inches; base diameter, 25 feet; composition, burnt clay, coal, and ashes. On the north side of the mound is a large beech tree, whose roots permeate the mound. This tumulus, in construction, is similar to No. 12 in being a protected mound. No. 12 is covered with flat shelly limestone; this, with cobble-stones. The strata are five in number, the protecting rock, or cobble-stone covering, varying from 5 to 12 inches in thickness. The stones were laid symmetrically from base to apex, and were all calcined; the silex and quartz by the confined heat had become vitrified. This was accomplished by overlaying the rock covering with a heavy deposit of compact clay, thereby confining the heat; but the most difficult problem is how the savages accomplished the feat of arranging these boulders so evenly while such an intense fire was burning. What was the object in thus protecting such a mound is difficult to say, unless it was for the cremation of the dead. Upon sinking a shaft in the center below the level of the mound, or in digging a trench 6 feet wide from the west to the east side, not a fragment of bone,

pottery, or any implement appeared. It was simply a pile of calcined rock, intensely burnt clay, ashes, and coal. Judging from the vast amount of broken arrow-points, spear-points, and celts, in the field near mound 51, a terrific conflict must have raged upon this spot, and it may be that the conquerors heaped up their dead or those of their enemies and cremated them upon the spot where this mound of ashes, coal, and calcined rock now stands. It was not used as a signal mound, for several reasons: First the builders would not have expended their labor in gathering these cobble-stone and protecting it as they have done for such a purpose. Second, the location is not suitable, for all signal stations or mounds are located on the most prominent points, clear of all obstructions. Nor is it a kitchen mound, there being no fragments of bone, pottery, &c. Therefore this must have been a funeral pyre.

Number 51 is in Sec. 27, T. 10 N., R. 2 W., in the northwest corner of the northeast quarter section, on the highest terrace formation, about 6 rods from west section line and almost due west of number 50. It lies a little northeast of Mr. Jon. Hugh's residence, on whose farm it is located. This mound has been under cultivation for the past half century. Under the turning process of the plow and scraping and dragging of the harrow during all this time, one finds it impossible to form any idea of its original height. At the present time this one is 2 feet 10 inches high. From the field in which this mound is located a great many arrow-points, pestles, axes, bark-pealers, scrapers, etc., have been picked up from time to time, of which a great majority were broken.

Number 52 is in Sec. 27, T. 10 N., R. 2 W., in the northwest part of the southeast quarter section, on the highest terrace formation, due south of number 51, near the woods, on Mr. Jon. Hugh's farm. The height is $4\frac{1}{2}$ feet; base diameter, 35 feet; composition, compact clay.

Number 53 is in Sec. 20, T. 10 N., R. 2 W., in the northwest part of the northwest quarter section, near the head of a stream called Herralls' Branch, on the highest terrace formation, due north of Mrs. Hayworth's residence, on whose farm it is located. The height is 4 feet; base diameter, 25 feet, and composition, compact clay.

Number 76 is in Sec. 27, T. 10 N., R. 2 W., in the northeast corner of the southwest quarter section, on the highest terrace formation, and on Mr. A. C. Carter's farm. The height is 3 feet; the base diameter, 20 feet, and composition, compact clay.

Number 77 is in Sec. 23, T. 10 N., R. 2 W., in the southwest corner of the southwest quarter section, on the highest terrace formation, on Mr. R. Wortman's farm, at the head of a small stream called Blue Lick, which empties into Bath Creek. The mound is on the east side and almost due south of the old log cabin that still stands on the south side of the farm. The height is $4\frac{1}{2}$ feet; base diameter, 28 feet; and composition, compact clay.

Number 78 is in Sec. 28, T. 11 N., R. 2 W., about the center of the southwest quarter section, on the second terrace formation. It stands

a little northwest of Quakertown, on the east side of Bond's Creek, about 80 yards distant. The present height is 3 feet, and base diameter, 60 feet. Mr. Hugh Abernathy, among the first settlers of this valley, states that, sixty years ago, this mound was about 18 feet high, and made of fine sand, which the older citizens of Quakertown and Dunlapville hauled away for building purposes. The remaining portion does not look like the remnant of a mound.

Number 79 is in Sec. 31, T. 14 N., R. 14 E., in the northeast corner of the northwest quarter section, on the third terrace formation, on Mr. Hugh Abernathy's farm. The height is 8 feet; base diameter, 45 feet, and composition, compact clay.

Number 80 is in Sec. 2, T. 11 N., R. 2 W., in the northwest part of the northeast quarter section, on the highest terrace formation, on the Leviston farm. It stands about half way between the Junction Railroad and Liberty and Brownsville pike, and about 4 rods from a never-failing spring, which is a little northwest of the mound. The mound has been under cultivation for a great many years, which has greatly diminished it in height.

Number 84 is in Sec. 5, T. 11 N., R. 2 W., in the northwest part of the southeast quarter section, and on the second terrace formation of Hannah's Creek, on Mr. Henry Ruse's farm. The height is 6 feet; base diameter, 42 feet; composition, compact clay.

The fragments of pottery which have been found in the exploration of the several mounds that are distributed along this valley (no complete vessels have been recovered) are composed of potter's clay, sand, and pounded shell. In the process of burning, a portion of the sand became vitrified and the shell calcined. By the aid of the microscope it was possible to find out the composition of each fragment, yet these would crumble with the least handling. The mysterious people who constructed these mounds must have exercised a great deal of care in removing the larger pebbles from the dirt, since those composed of clay or sand show a very few pebbles as large as a good sized marble. This fact has been often verified by the author, who ordered his helpers to notice critically every particle of dirt handled in the process of trenching or sinking a pit. Mounds from 20 to 60 feet in diameter have been trenched without finding as many as a dozen pebbles. It is not for the want of pebbles in the surface soil, for they are plentiful and can be gathered by the bushel. It is not that the material has been brought from a distance. Ninety-nine of every hundred mounds are heaped up from the surrounding soil, and seasons of rain-fall, freezing and thawing, growth and decay have filled up these places, so that the surrounding surface presents the appearance of never having been disturbed. How much higher these tumuli were originally we have no means of knowing; the same changes will diminish the height of these monuments with each succeeding year.

Number 54 is a group of stone graves in Sec. 10, T. 9 N., R. 2 W., in

the northwest corner, near the north section line of the northwest quarter section, on the third terrace formation of the river. It is situated north of a small stream that runs through Mr. James Logan's farm. Mr. James Rucker, in company with Mr. Logan, some years ago, excavated them, but in doing so only found a few fragments of decayed bones. Mr. Logan also states that the field in which these graves are located was formerly covered with arrow-points, but the process of plowing, rolling, and harrowing has broken them into fragments; yet a great many are still picked up by the children from time to time.

Number 55 is also a stone grave in Sec. 16, T. 10 N., R. 2 W., about midway between the north section line and the south quarter-section line, and in the northeast quarter section. It stands about 4 rods from the east section line, on the brow of a very high hill that is covered by heavy timber. In digging into this grave a few fragments of bone were found, a portion of the humerus, ulna, radius, and femur, the outer plates of the cranium, which was as thin as paper, the inner being entirely decayed.

Number 64 is a cemetery in part Sec. 29, T. 11 N., R. 2 W., on the highest terrace formation, and on a prominent ridge that projects out to Bond's Creek, on the west side, on Mr. Jackson Leech's farm. Five years ago, in the neighborhood in which this cemetery is located, the road supervisor, in his search for gravel, by chance stumbled upon the point of this ridge, which he commenced to remove. After digging and caving down the ridge about 8 feet from the point of commencement, the workmen came upon and removed four skeletons with a few stone-axes, one of which, 8 pounds in weight, is in the author's cabinet, and one of about the same weight is in the cabinet of the Natural Historical Society of Cincinnati. At that time also a few celts were found with these skeletons. A great portion of the skeletons crumbled to pieces upon exposure to the air. One cranium was nicely put together by Mr. Stanton, who has it yet in his cabinet. The depth of the interment was 7 feet.

Number 65 is a cemetery in Sec. 4, T. 9 N., R. 2 W., in the southwest corner of the southeast quarter section, on a ridge that projects out to a small stream which empties into the river. It is situated on the east side of the river, on the second terrace, a little southeast of the river bridge, on Mrs. K. Templeton's farm. Over it has grown a small forest, which obscured the fact that it was a resting-place of the dead. There are only four places within a range of 11 miles—these two cemeteries and the stone graves—where the dead were buried in this manner.

Number 56 is an open-air workshop in Sec. 3, T. 9 N., R. 2 W., in the southeast corner of the southwest quarter section, on the second terrace formation of the river, in a field on the north side, through which runs a small stream fed by numerous fine springs. This workshop is but a short distance southwest of the group of stone graves.

Number 57 is an open-air workshop in Sec. 4, T. 9 N., R. 2 W., near the southeast corner of the northwest quarter section, on Mr. George Templeton's farm. It is situated on the second terrace formation of the river, south of Templeton's Creek about 300 yards, and 150 yards south of his residence. The gentleman states that he has found a great many axes, pestles, celts, and arrow-points on this piece of land, and from a spot about 200 feet square has hauled at least sixty wagon-loads of chipped and unchipped cobble-stones, and yet as many loads remain. Mr. Templeton has in his possession an ax taken from this shop, the most perfect one the writer has examined.

Number 58 is a workshop in Sec. 12, T. 10 N., R. 2 W., in the northeast corner of the southwest quarter section, on the second terrace formation, and in Mr. Charles B. Hayward's farm. It stands almost opposite the noted Glidwell mound, and on the west side of the river, in plain view of No. 57. To the northwest of the field in which this shop is located are several never-failing springs, whose water forms quite a stream, which flows along the north side and empties into the river. Here can be found a vast amount of chert chips, chert balls, broken and chipped cobble-stones, and broken arrow-points. The implements that predominate are the scrapers, axes, sinkers, hammer or chipping-stones. A few ornamental pieces have been found. The author has gathered and received from Mr. Hayward at least a bushel of relics. And every year when this spot of ground is turned over hundreds are picked up by the owner and given away, yet, from among the vast number, not one pure flint-point has been found.

Number 59 is a workshop in Sec. 17, T. 10 N., R. 2 W., in the southeast part of the northeast quarter section, on the second terrace formation of the river, on Mr. James Herrall's farm, a little east of north from his residence, and close to the road, on the east side of the field in which it is located. East of the field is a fine spring of water, and near by in the field is the workshop, about 300 feet square. Here were manufactured the ornamental or ceremonial pieces, for every year that this spot is cultivated several implements are picked up in an unfinished or finished state. Some are only chipped into form, some chipped, pecked, and partly ground; others completed, with the exception of drilling, which in some cases is commenced; others are entirely finished. A few celts and chipping-stones have been found, but they do not seem to be very numerous.

Number 60 is a workshop in Sec. 9, T. 11 N., R. 2 W., on the southwest corner of the northwest quarter section, on the second terrace formation of the river, and on Mr. Alexander Johnston's farm. The spot covers about 4 or 5 acres, constituting the area of the plateau over which the work was prosecuted. The articles of manufacture were axes, celts, and pestles. From this spot have been gathered quite a number of these domestic implements, with a few ornaments, by Mr. Theodore Campbell, S. Conrad, H. Brown, James Mills, and others. Quite

a number of large axes, weighing from 10 to 16 pounds, have been found here. Mr. James Rucker has one in his cabinet with about 4 inches of the bit broken off, found by Mr. Henry Brown, that weighs, as it is, 12½ pounds. No doubt before it was broken it would have weighed 16 pounds. The author has one in his cabinet, made of striped slate, plowed up on the 26th day of August, that weighs 10 pounds. Mr. Theodore Campbell gave the author a mortar that holds very near a half gallon, the finest specimen of the kind he has ever seen. It was plowed up in 1848, by Mr. Taylor, "a former owner of this farm," who at that time picked the date on the bottom of it. Very few arrow-points are found on this farm or those joining it on the north, east, or south. Through the field in which this shop is located an old Indian trail passes to an Indian camping-ground due west, about 200 yards. Some of the older inhabitants of this and that neighborhood still recollect some of the incidents that transpired at this camp while the aborigines yet roamed at will up and down this valley.

Number 61 is a workshop in part, Sec. 29, T. 12 N., R. 2 W., on the second terrace formation of the river, and on Mr. Levi Bond's farm, just north of his residence, about 300 yards. It is about 500 yards northwest of Quakertown, on the north side of the road that leads from Quakertown to Alquina; also on the west side of Bond's Creek. A little to the south is an excellent spring of pure water running the whole year round. A little northeast of this shop was the once great sand mound spoken of. The articles of manufacture of this shop were the ax, pestle, celt, and hammer-stone. This was one of the most productive shops along the valley. There has been gathered here, from time to time, at least a half wagon load of domestic implements, and yet every year that this field is cultivated Mr. Bond or his sons pick up about two dozen implements. Almost every cabinet in this section and that of the State museum contains typical specimens taken from this notorious workshop which covers about 2½ acres. This space is covered with a mass of chipped and broken stones; but to my knowledge or that of Mr. Bond's, no ornamental piece has yet been found within the field in which these remains are located. Northwest of this, a quarter of a mile, is a cemetery which will be mentioned further on.

Number 62 is a workshop in Sec. 4, T. 11 N., R. 2 W., in the northwest part of the southeast quarter section, on the second terrace formation of the river, and on Mrs. E. Scott's farm. It stands northeast of her residence and on the north side of Hannah's Creek. The articles of manufacture have been pestles and celts, those implements predominating. But very few axes have been found here. The area of this shop is about 1 or 1½ acres. A vast amount of broken cobble-stone covers the spot. Very little of the striped slate-stone is found here. No ornaments or fragments thereof has ever been discovered on this piece of land, arrow-points also being very few in number. Occasionally one is picked up in the spring or fall of the year, when plowing is going on.

Number 63 is a workshop in Sec. 21, T. 12 N., R. 2 W., in the northwest corner of the southeast quarter section, on the second terrace formation of the river, and on Mr. Harrison Erb's farm. It stands on the west side of the river, also on the west side of the road that leads from Dunlapsville to Brownsville. A little northeast of this workshop is an excellent spring, which has never been known by the oldest settler to fail in supplying an abundance of water. The articles of manufacture at this shop were axes, pestles, celts, and hammerstones, or, as some would wish to classify them, sinkers. From this shop, which covers an area of about 2 acres, quite a goodly number of these domestic implements have been taken. Only two or three ornamental pieces have been found here, and those were broken or unfinished. A great many of the domestic implements have also been found in this condition.

Number 66 is a workshop in Sec. 36, T. 13 N., R. 13 E., in the northwest part of the southwest quarter section, on the highest terrace formation, on Mr. Jacob Master's farm, a little northwest of the residence and on the north side of Bloyd's Creek. To the south of this shop is a fine spring of water. The predominant articles of manufacture were arrow-points, scrapers, and drills. Seldom an ax, celt, or pestle is found here, but a great many arrows, with which the several local collectors have enriched their cabinets. They are principally made of chert; occasionally a specimen of chalcedony or of flint occurs.

Number 82 is a workshop in Sec. 20, T. 10 N., R. 2 W., in the southwest part of the northwest quarter section, on the highest terrace formation, and on Mrs. Agnes Miller's farm, north of her residence about 100 yards. To the south of this shop is a fine spring of water. Articles of manufacture are arrows, spear-points, and scrapers. The area of the shop is about one-half acre, which is thickly covered with fragments of chert. A great many fine arrow-points have been found here by Mrs. S. B. Johnston's sons, who make a business of collecting these relics and selling them to the several local collectors.

Number 83 is a workshop in Sec. 27, T. 13 N., R. 13 E., in the southwest part of the southeast quarter section, on the highest terrace formation, on Mr. Jacob Meyer's farm, northwest of his residence about 75 yards. East of the shop about 100 yards is a good spring of water, which flows directly along the south side of the field in which the shop is located. Articles of manufacture are arrow and spear points, although a few fragments of ornaments have been found and two "anvils." The area covered by the shop is $1\frac{1}{2}$ acres. Here we find the ground covered with chips of chert, with occasionally a few fragments of flint and chalcedony. This shop has also furnished several local collectors with a fine assortment of arrow-points. So far, not a single ax, celt, or pestle has been found on this shop or even on the farm.

Number 85 is a workshop in Sec. 10, T. 12 N., R. 13 E., in the northern part of the southeast quarter section, on the highest terrace forma-

tion, and on Mr. Jon. Webb's farm. Articles of manufacture are axes, celts, arrow and spear points. Here a profusion of articles have been found, along with some fragments of ornaments. Mr. Webb and his sons, in the process of tilling this field, have secured a vast amount of the arrow-points, some of them very fine specimens. The shop covers about 2 acres of ground. In the writer's cabinet is a sledge which Mr. E. Webb gave him in the spring of 1880, turned over in the process of plowing. This sledge weighs $22\frac{1}{2}$ pounds; the groove being complete, also the pole, the bit being chipped and pecked down ready for grinding. This is an excellent specimen. Every year when tilling the field in which this shop is located the owners secure a goodly number of relics. In the adjoining field on the north the oldest settlers say there was an Indian camping-ground, and the trail passed through the northeast corner portion of the field in which this shop is located.

The old block-houses which were erected along the valley some seventy-five years ago have nearly all been removed, and the spot where they once stood will soon be unknown. The old settlers are passing away rapidly, and they alone retain their history. Here in this valley they settled down in 1803 and 1804, in somewhat compact colonies, and erected these forts for preservation in time of danger from the then savages. Of these but two remain, one on Mr. William McClure's farm, a little northeast of Brookville, No. 89; the other on Mr. Jon. Power's farm, No. 81. This was weather-boarded and converted into a dwelling, and has been occupied as such up to the present time, but the owner contemplates its removal. Thus the last one of these forts whose rude walls had protected our first inhabitants from the deadly arrows of the red men will be gone to give place to a more commodious dwelling.

Block-house No. 67 is in Sec. 28, T. 12 N., R. 2 W., and in the southeast corner of the northwest quarter section, on the east side of the village of Dunlapville. This block-house was erected by Mr. William Nickles in 1806.

Block-house No. 68 is in Sec. 30, T. 14 N., R. 14 E., in the southwest corner of the northeast quarter section, and just opposite the mouth of Richland Creek. It was erected in 1805.

Block-house No. 81 is in Sec. 33, T. 10 N., R. 2 W., in the southwest corner of the southwest quarter section, erected by Obadiah Eustes, in 1804.

Block-house No. 87 is in Sec. 21, T. 9 N., R. 2 W., near the southwest corner of the northwest quarter section.

Camping-grounds and trails have been laid down on the map and sectional drawings as correctly as it were possible. To accomplish this has been quite a task and involved writing to a great many who are acquainted with facts, who do not now reside within the county. The greater portion of the knowledge thus gained was from the oldest inhabitants who were born and raised in this community.

No. 69 is in Sec. 31, T. 10 N., R. 1 W., in the southwest corner of the southwest quarter section.

No. 70 is in Sec. 33, T. 10 N., R. 2 W., in the northwest corner of the southwest quarter section.

No. 71 is in Sec. 10, T. 12 N., R. 13 E., near the southwest corner of the northeast quarter section.

No. 72 is in Sec. 36, T. 13 N., R. 13 E., very near center of the section.

No. 73 is in Sec. 8, T. 11 N., R. 2 W., southeast corner of the northeast quarter section.

No. 74 is in Sec. 11, T. 11 N., R. 2 W., in the northeast corner of the southwest quarter section.

No. 75 is in Sec. 7, T. 14 N., R. 14 E., in the southwest corner of the southwest quarter section.

No. 86 is in Sec. 34, T. 13 N., R. 13 E., midway between the east and west quarter-section lines, and near the north line of the northeast quarter section.

OPEN-AIR WORKSHOPS.

These shops are discovered in the valleys under the uplands by evidences as positive as those of the mounds and earthworks, and perhaps more so than those of the mounds, from the fact that a great many persons are misled in regard to these elevations, ever ready to call any symmetrical hillock a mound. Only a section will disclose the truth as to their natural or artificial formation. Not so in regard to these ancient workshops. If by chance one should, while passing over a field or piece of ground, come upon a vast amount of broken cobble-stones or chert, unable to find hardly one intact, he naturally would conclude that here some kind of industry had been carried on. A true knowledge of that branch of industry would be found out by any inquiring mind. If among these spalls or fragments we find an ax, celt, or pestle, and upon due inquiry of the owner or tenants ascertain that he at different times had gathered several of these different implements there we could surely say, this is a workshop where were manufactured only this peculiar class of implements. Wherever these fragments are found there is no difficulty in classifying the style of implement which were manufactured, whether they be the ax, celt, pestle, hammer, arrow, or ornament; the superabundance of each article tells the story. Sometimes we find a variety of implements, such as the ax, celt, arrow-points, &c. In such instances there will be found a conglomeration of fragments. But such is seldom the case, and only one shop of this character is known along this valley; this is No. 59, in Sec. 17, T. 11 N., R. 2 W. Here are found the warlike and domestic implements in conjunction with ornaments, all of which have been found in goodly numbers in their finished and unfinished state; some chipped into form, others chipped and partly pecked; others again showing three stages of advancement, chipped, partly pecked, and partly ground or polished. Such is not only the case with the ornamental finds, but also the axes and celts show the same

stages of advancement. These workshops, as a general rule, are located on the second terrace formation along the river or the larger streams that empty into the river, and in close proximity with each shop is an excellent spring of water. Also in close proximity will be found a signal mound or station, located on the highest hill or bluff along the river. Mound 12 commands an excellent view of Nos. 56, 57, and 58; mound 25 that of No. 59; mound 27 that of shop 60; mound 41, that of 62; mound 79, that of 63; mound 21, that of 85; and so on, through the whole valley. 'Tis true these signal mounds in some instances have been converted or adopted as burial mound, probably after their abandonment as signal stations. We are better able after trenching these structures through the center to determine their true character and probable use. Until this is done our theories are premature, for only a true section of their formation can establish the facts as to whether they are signal mounds or burial mounds or both. In signal mounds there is only one spot, and that in the center, that shows the action of fire, and when it has served its purpose it is built up in a cone shape and abandoned. In case it is converted into a burial mound the fire has been extinguished, the surface leveled, the dead deposited, and again another layer of clay or whatever material is used in its construction is symmetrically laid over the dead to the depth of 6 to 18 inches. Over the whole surface a fire once more is started, the object being to burn the clay or harden it, so that the water will not permeate it so readily as it does the unburnt clay. In doing this there is no fear of destroying the objects deposited below. Sometimes where a limb has not been sufficiently covered it has been charred, which accounts for that part of the subject we oftentimes find in these tumuli that are mutilated and attributed to cremation. The moisture that is contained in the body preserves the bones of these subjects from the intrinsic action of the fire.

In studying the reports of the survey of mounds in certain portions of the country, by those who have classified them as signal and burial mounds, the question often presents itself, by what criteria are they asserted to have been signal stations or otherwise? The writer has followed in their footsteps heretofore in his classification, description, surveys, &c. In the present paper the theory of their past usage is based on the appearance of their strata, after a perfect section of the mound is made, not from the strata shown in sinking a shaft in the center, for, perhaps, these strata may extend to within 6 inches of the outer edge of the structure or tumulus, and perhaps they may not; hence the advisability of a perfect section of the works so as to enable one to classify them correctly. This has been done in this present report as far as it was possible to superintend the work. These signal and burial mounds develop the fact that their builders looked to the safety of the living and to the preservation of their dead, and adopted the most rational means at that time, taking into consideration their surroundings and facilities. They could not, with all their shrewdness, have hit upon a more

preservative mode—the ashes and coal for the bed of the sleepers, and the hard burnt clay as their covering. Under such circumstances it required years for these bodies to molder away. Perhaps where these mounds stand forests have grown up, fallen, and decayed to give place to other species, and yet a goodly portion of the skeletons are exhumed from these tumuli in a good state of preservation. The people who once occupied this land have had their turn, and in the most joyous career of their vanity and splendor their strength failed, and they have again returned to dust. Therefore the whole world is but a sepulcher, and there has nothing lived on its surface but has been entombed beneath it. The mounds and obscure cemeteries all over the world are full of this loathsome dust of bodies once quickened by living souls, who perhaps occupied thrones, presided over assemblies, marshaled armies, and subdued provinces.

Mounds surrounded by circular walls are scattered along the valley and on the hill-tops that command a view of the greatest territory; those in the valley generally stand on the second terrace formation, near the greatest prominence. Why are the circular walls thus built? Is it to mark the peculiar purpose for which they were constructed, as signal, crematory, or sacrificial. Perhaps these walls were built to serve the purpose to which have been attributed the smaller circular works without any center elevation. All the lesser works of this character were probably constructed for the same purpose as mentioned heretofore. They are the remains of a primeval wigwam, it may have been of a religious character, or one in which the royal chief and family dwelt. Exploration does not develop anything positive. It is seldom that any fragment of bone is found. When such is the case it is of an animal, but the species cannot be determined. Generally fragments of pottery are found throughout the work, but domestic implements are seldom found. If such be the case it will be only a fragment. Another noticeable feature is that these structures contain no ornamental or ceremonial stones. If one is allowed to judge from the material that is found within them, of a domestic character, they would be classed as kitchen mounds, containing more fragments of plain domestic pottery than anything else. They cannot be works of defense, for they are too small, measuring only 40 to 80 feet in diameter. These circular works were simply the protection walls of a wigwam or temple, perhaps of religious character. Nothing can be more obvious than that they were built in accordance with a general plan and for a specific purpose. When, however, a conclusion is sustained by analogies of a most striking character, it is invested with double value. It is then that we proceed with some degree of confidence to inquire how far we are justified in supposing that these ancient structures were temples of worship, or palaces for the chief ruler. It is true, we have neither the light of tradition nor that of history to guide us in our inquiries. Even the name of the people by whom these works were constructed is lost. Therefore every

attempt to draw aside the curtain that separates myth from truth may fail, but if this investigation is but partially successful in casting a ray of light upon these mystical structures, the labor will not have been in vain.

SIGNAL MOUNDS OF BUTLER COUNTY, OHIO.

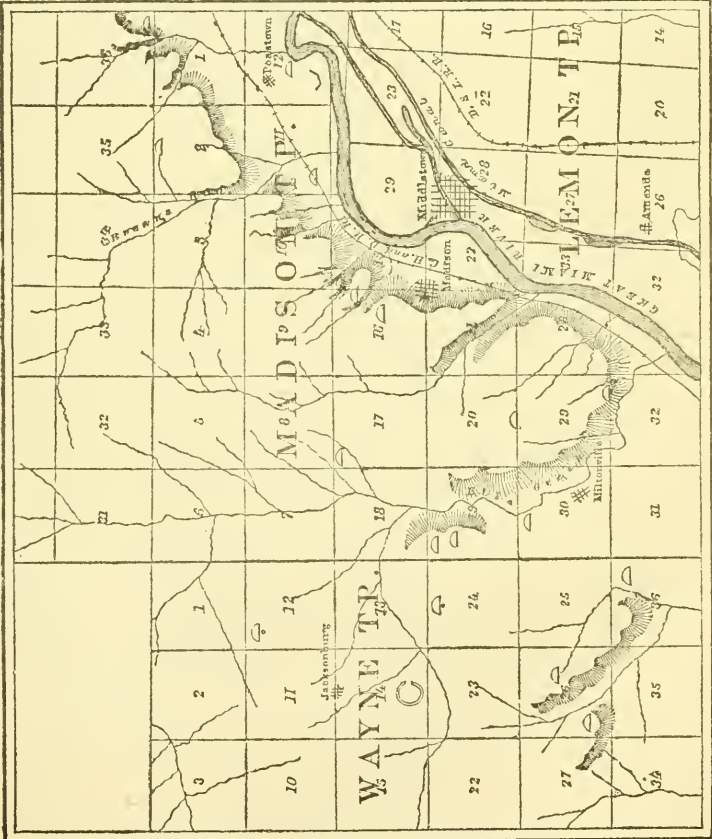
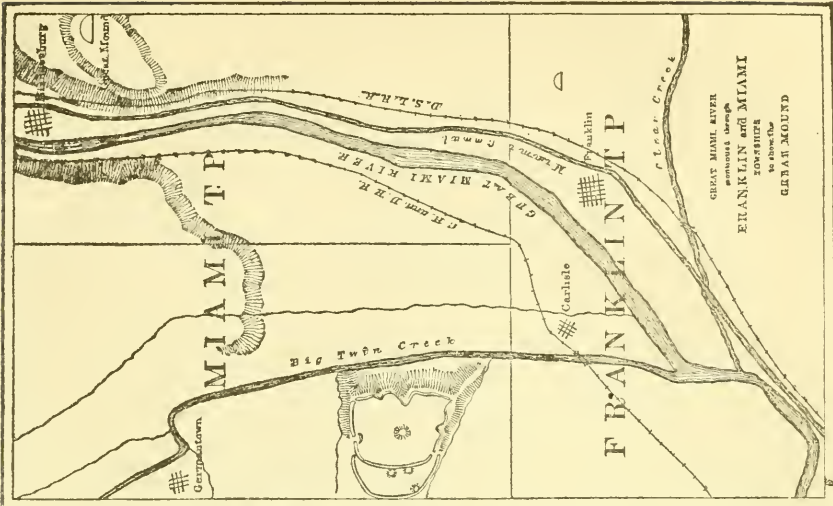
By J. P. MACLEAN, of *Hamilton, Ohio.*

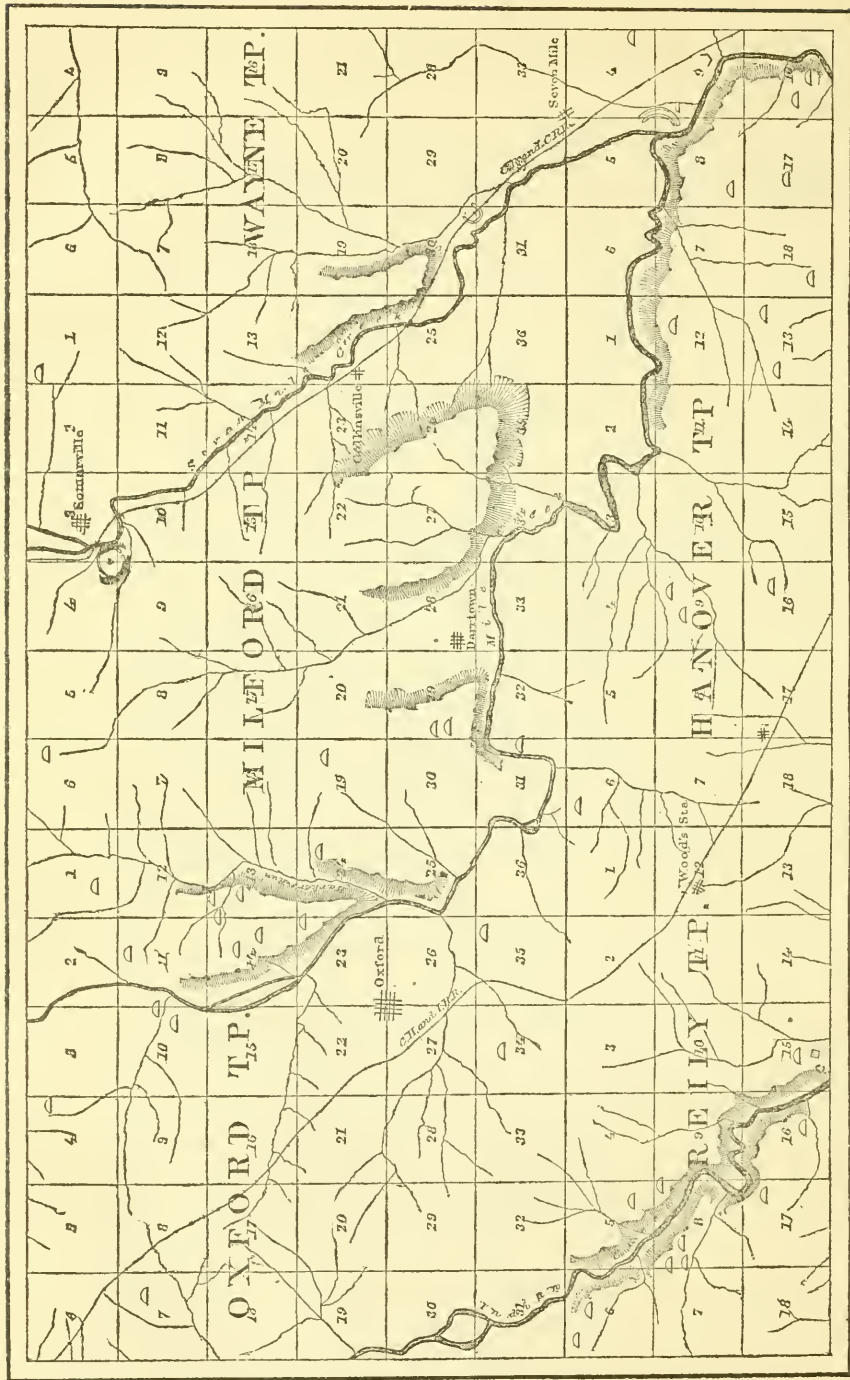
The great mound of the valley of the Great Miami River is situated on one of the highest hills in its immediate vicinity, and located about three-quarters of a mile southeast of the town of Miamisburgh, Montgomery County, Ohio, and about the same distance east of the Miami River. The hill is composed of limestone representing the geological formation known as the Hudson River epoch. Broken limestone crops out on the surface, and the soil is very thin, not adapted to agricultural purposes. The hill from the north and west is steep and may be said to be difficult of ascent. The surface of the country for a considerable distance to the east and south is very much broken. The mound is on the summit of the hill and on a natural knoll of a very noticeable declivity. The sides or various slopes of this knoll appear to be regular and of equal descent, or rather rising evenly from all directions. On the east side of the mound and penetrating it is an excavation walled with stone and probably used as a milk house. Two or three rods farther removed is a farm-house, while the same distance to the northeast is a barn. The mound is 68 feet in perpendicular height, and 852 in circumference at its base, and contains 311,353 cubic feet. The summit is level, circular in form, with a diameter of about 20 feet. It is said that from this point a view may be seen extending for 20 miles up the valley and the same distance down the river. The day I visited it was cloudy and rainy, causing the view to be limited, although one of the grandest sights within the State presented itself to my eyes. Some of the hills of Butler County, upon which I knew were located mounds, were before me.

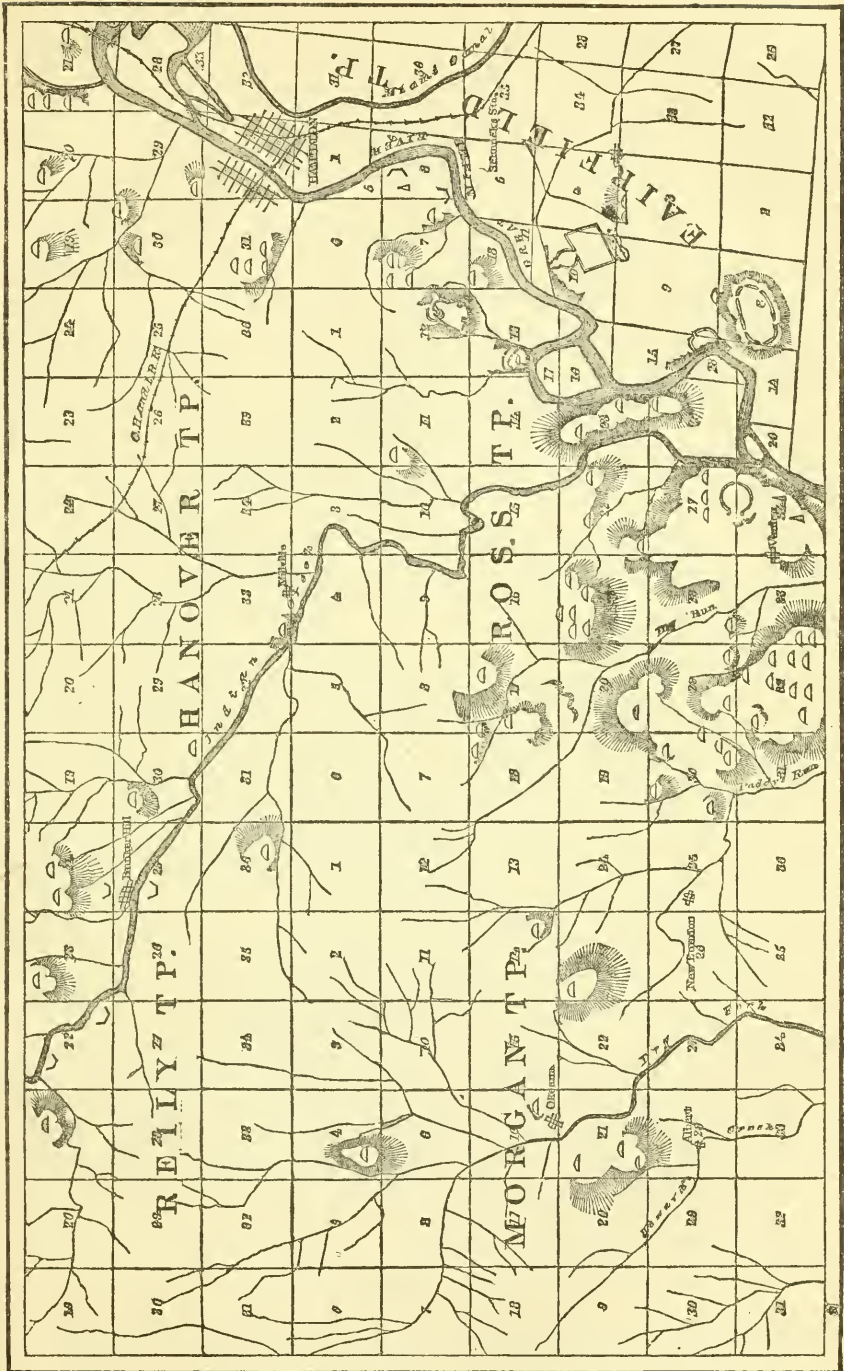
The summit of the mound overlooks some of the most important inclosures of the valley. Looking north a distance of 3 miles are the incomplete works at Alexandersville, figured and described in "Ancient Monuments of the Mississippi Valley," p. 82.

In a southwest direction and 5 miles distant from the mound is the Fort on Big Twin located on Sec. 3, German Township, Montgomery County, described in my work on "The Mound-builders," p. 25. An enlarged plan of the work is given.

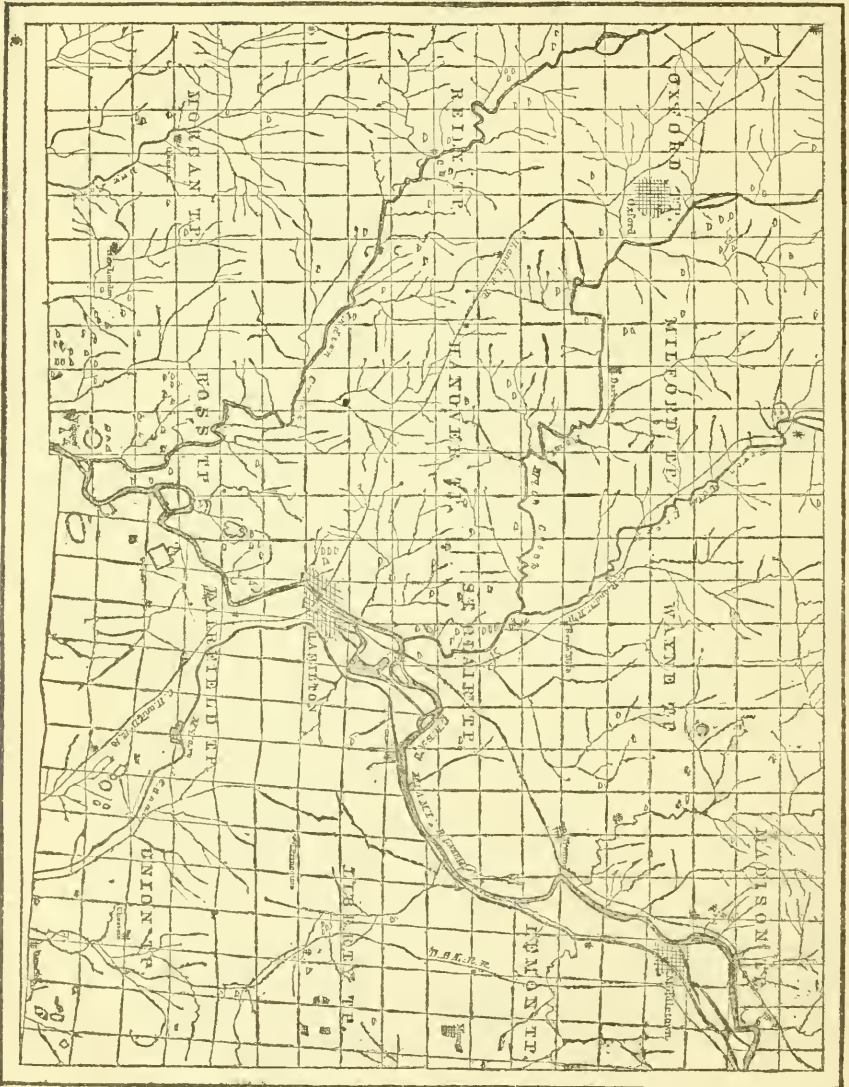
Nine miles northeast of the last-named fort, and $1\frac{1}{2}$ miles south by west of Farmersville, situated on Big Twin Creek, is another inclosure containing two irregular circles, with still another at the north gateway. The work is situated on a spur of land about 100 feet above the creek with a perpendicular declivity. Toward the north the hill slopes and the







line of embankment is carried down the slope. The entrance-ways are at the east and west sides, the inclosure at these points being covered by a double line of embankment more formidable than at other points. The circles have no gateways. A short distance east by south are the



remains of what purports to have been a very large mound. The altitude of the mound as it now stands is 20 feet. The creek encroached upon the bank and gradually undermined the mound, taking away not less than three-fourths of it. The creek then receded to its present bed, distant about 20 rods.

On the same creek, in Lanier Township, Preble County, was once the work described and figured in "Ancient Monuments."*

Five miles south of the great mound is the large mound near Franklin, in Warren County. This mound is about 35 feet high, located on



one of the high hills bordering the east bank of the river, and removed a distance of about three-fourths of a mile from it.

The best view of the Miamisburgh mound seen from any of the Butler County mounds, is that given from the summit of the mound on Sec. 32,

* *Ancient Monuments of the Mississippi Valley*, p. 33 (Plate XII, No. 2).

Madison Township. In the same township, Sec. 19, is the highest mound in the county, with an altitude of 43 feet. A fire on the Miamisburgh mound would be distinctly seen from the summit of this mound. While this mound is not situated on the highest hill in the county, yet its situation is seen to be better adapted for the purpose of a signal station than any other spot, when the various earthworks it was intended to protect are taken into consideration. All the signal mounds radiate from this one. It is located on a hill rising 400 feet above the Miami. It overlooks the inclosure on Sec. 14, Wayne Township. A fire on its summit could be seen from the mounds on Sec. 26, Wayne Township; Secs. 9 and 16, Saint Clair, and Sec. 22, Fairfield; also from the inclosure situated on Sec. 16, Fairfield. The three mounds on Sec. 9, Saint Clair, overlook the inclosure last named, also the one on Secs. 4, 5, 8, 9, Saint Clair; the one on Sec. 30, Wayne, and that near Somerville (Secs. 3, 4, 9, 10), Milford. A light on the same three mounds (Sec. 9, Saint Clair) could be seen from the mound on Sec. 31, Milford, which overlooks the inclosure on Sec. 36, Oxford Township.

The mound on Sec. 20, Liberty Township, could be signaled from the Madison, Saint Clair, or Fairfield mounds. From that point communication could be had with the mound on Sec. 24, Union Township, thence to the mound on Sec. 14. The last named overlooks the inclosures on Secs. 14 and 8, Union.

Communication is established between the mounds on Secs. 16 and 19, Saint Clair, and from the latter to Sec. 12, Ross, located within a few rods of Fortified Hill Fort. This fort commands a view of the earthworks on Secs. 16, 10, 15, and 8, Fairfield, as well as Sec. 13, Ross.

A light on the mound in Sec. 12, Ross, would be seen from the mound in Sec. 21, and this by those in Sec. 30, Hanover, and 24, Reily, while one in the last named mound would be visible from that on Sec. 22, which overlooks the works just above the village of Reily.

The mound on Sec. 21, Ross, overlooks the mound and fort on Sec. 8, Fairfield, also the Cobrain works in Hamilton County, and the circular works on Secs. 27 and 34, Ross.

On Sec. 9, Union Township, and Sec. 15, Fairfield, were a series of works overlooked by a mound on last-named section. A communication could be had with this mound from several mounds on the west bank of the river, notably such as the mounds on Sec. 12, Ross, and 3 and 16, Saint Clair.

REMAINS ON BLENNERHASSETT'S ISLAND, OHIO RIVER.

By J. P. MACLEAN, of *Hamilton, Ohio*.*

The most famous of all the islands of the Ohio River is known as Blennerhassett's Island. For more than two generations it has been an historic spot. Around it clusters one of the saddest episodes in the history of our country. The traveler anxiously seeks to have it pointed out, and having once beheld it his imagination lingers at the spot. The history of the past wells up before him, and with pity and kindness he thinks of the unfortunate man who was once its possessor.

The island received its name from Harman Blennerhassett, who, in 1798, purchased the upper portion, containing 170 acres. Previous to this purchase it was known as Backus' Island. It is supposed that the island was first located by General Washington, in the year 1770. It was first surveyed in 1784, and in 1786 Patrick Henry, then governor of Virginia, made out a patent for it to Alexander Nelson. In 1792 it was purchased of James Heron by Elijah Backus. At the present time it is divided into four farms, and owned by four different parties, none of whom resides there.

All that remains of Blennerhassett's costly mansion and tasteful improvements are the old well, whose wall is covered with moss and fern, two sand stone steps, and a piece of a stone gate-post. Where once was the cellar is now a depression, with a sycamore tree several feet in diameter growing in the center.

The island is situated 14 miles below Marietta, and $1\frac{1}{2}$ miles west of the mouth of the Little Kanawha. It extends east and west and is of peculiar form, narrow at the middle and broad at both extremities. It is over 3 miles long, although its area embraces only 297 acres. At the eastern extremity a ridge of land commences and runs through the center of the island until half the distance is reached. On either side of this ridge is a natural trough, resembling the bed of an ancient canal, with the ridge banks higher than those bordering the river. The trough or ancient channel bed on the north side of the western half of the island has been cut away by the river, thus leaving the ridge to form the river's bank. During high water the river breaks over its banks and flows through these troughs, and in its course deposits rich sediment. During the time of these explorations the river was high and had broken into the

* The writer would here express his indebtedness to Mr. F. P. Ames, of Belpre, Ohio, for the valuable assistance he rendered in the exploration of Blennerhassett's Island. It was he who called attention to its antiquities, and who took every opportunity to make the visit both profitable and pleasant. Mr. Bryant E. Johnson also deserves grateful mention. Besides furnishing relics and granting permission to dig in the principal shell heap, he generously abandoned his plow and assisted in making the excavations. The illustrations were made from photographs and negatives furnished by Mr. L. C. Overpeck, of Hamilton, Ohio, who kindly volunteered to do the work without any charge.

trough on the south side and flowed through the channel to the point where the water re-entered the river, thus forming an island of considerable size on the south. During low water the river recedes, thus reuniting the different parts of the island. The head of the island is covered with trees, which serve to protect it from erosion and also from damage by ice. Between these points is a dense covering of trees and underbrush left for the same purpose, on account of the land being low and the channel somewhat deep. Here driftwood accumulates in great quantities, making it of particular advantage to the islanders. Wisdom, however, would dictate to allow the driftwood to accumulate in order to protect this, the weakest part of the island.

The geological formation of the bluff on the Virginia side of the river was not examined, but the rocks appear to be the same as those on the opposite bank. On the Ohio side the rocks are composed of sand and take the name of sand-rock. Not far distant, and farther up the river, are located several grindstone quarries. The series of rocks belong to that age known as the upper portion of the coal measures. Through this sand-rock the Ohio has gradually cut its way until its bed is nearly 600 feet below the summit of the adjacent hills. That the bed of the river was once still lower is evident from the fact that its bottom is composed of sand and gravel. The river channel was partially filled during the glacial epoch, and since the close of that period the river has been gradually reaching its former level. During this process it has changed its bed several times. The plain of Belpre was its bed at the close of the glacial epoch. Distinct markings occur which exhibit changes that took place upon the plain. By the continued process of erosion, first on the Ohio and then on the Virginia side, shifting its channel from time to time, the river has cut its way to its present bed, leaving on the Ohio side a series of beautiful plains and on the Virginia a perpendicular bluff.

Blennerhassett's Island is not wholly an accretion of sediment formed by the river, but largely a deposit of the age of ice. The river, in the constant shifting of its bed, formed two channels at this point, which gives shape to the island. The troughs running along the sides of the ridge, thus forming three ridges (one of which is high and the other two low and bordering the river), were once additional channels, thus presenting four beds, all of which were occupied at one and the same time. When this was the condition of the river the island, in all probability, was a series of three islands running parallel, the two outer extending farther into the present river channels. The bed of the trough on the north side is higher than that on the south, and hence was the first to become dry. More than one-half of the old trough on the south side is still quite low and is soon overflowed during a rise in the river. The whole island is occasionally inundated, which generally inures to its benefit on account of the rich sediment usually deposited.

From the observations made the land seemed to be making on the

south side, but on the western half of the north side the erosion was great. The river, flowing from the north, strikes the Virginia bluffs a little below the mouth of the Little Kanawha, and, on its rebound, passes over to the north side of the island and washes the Ohio shore, which in turn forces the waters against the island. So great has been the erosion at this point that the summit of the ridge is scarcely 3 feet in width. Unless it is soon protected the river, at no distant day, will cut through, which will result in the rapid annihilation of the western half of the island.

The geological structure presents a mixture of sand, gravel, clay, and river sediment. Fine sand is the principal ingredient; the clay and gravel are not predominant. The ridge is covered with a rich vegetable mold, varying in thickness from 4 inches to 30. Fossils are occasionally picked up, among them *Spirifer mucronatus* and a variety of *Zaphrentis*. Coal is washed upon the sand-bars in the form of rolled pebbles. The coal has been lost from sunken barges and then rolled along the bottom of the river. When thus found it takes all the variety of shapes represented in the river gravel or cobble-stone.

The fact that the island was rich in its archæological remains was known only to a few. The islanders are not interested in these remains save to pick up the relics, for which they find a ready sale. Curiosity-seekers have paid high prices for relics, simply as mementoes of the famous place. Two speculators have steadily watched the island for several years, and immediately after high water they search along the north bank where they pick up quantities of ancient art. These are disposed of without revealing their true locality. Although the writer visited the islands two days after a speculator had been there, enough relics were secured to illustrate fairly the wonderful productiveness of the place. Including those purchased, the following is a list of relics obtained: Fifty-seven arrow-heads, twelve spear-heads, one drill, four hatchets, one flesher or bark-peeler, two pestles, three hematites, two bodkins, one bone needle, two bone beads, seven ornaments, five circular stones, besides numerous pieces of pottery, human and animal bones, and three pipes, one piece of the bowl of a pipe, and two pipe-stems. Some of these are now deposited in the Smithsonian Institution. Occasionally complete vessels are obtained. Some of these were found by Blennerhassett, all of which were presented to his guests as soon as they were obtained.

The first point examined was the largest shell heap on the island near the center. The deposit is 1,125 feet long by 200 in width at the west end and 3 feet in width at the eastern extremity. What was the original width of the shell heap would now be impossible to tell. Mr. Bryant Johnson, who has resided on the island during the last twenty years, and in its vicinity all his life stated that, in his recollection the width had been reduced 70 feet, and the whole distance was covered with shells. Save along the margin of the bank the shell heap has been

plowed over for the last forty years or more. The plow has displaced innumerable shells from their bed and thrown them upon the surface. The ground is almost covered with the shells of the *Unio*. Intermingled with these shells are numerous pieces of pottery, chert chips, the bones of the deer, &c. The jaw-bone of the deer is found in great numbers. The remains of two human skeletons had been recently turned out by the plow, but in a fragmentary state. This location is a little below the brow of the ridge. Lying on the beach human and animal bones occur with the shells of the land tortoise.

The point presenting the most satisfactory view for examination was the brow of the bank, for along this line the deposit of shells had not been disturbed by the plow. The bank presented first, a layer of vegetable mold varying in thickness from 6 inches to 30. Then a layer of shells (*Unio*) ranging from 4 to 6 inches, containing pieces of pottery, bone and stone implements, and the bones of various animals. Under this, at different points, varying in depth from 12 inches to 25 were ash pits. Then came a sandy formation lying over a stratum composed of sand, gravel, and clay.

Along this bank were made seven excavations; the first was at the eastern extremity. As the ridge here is so extremely narrow the face of the bank was slightly cut away in order to discover whether the shells occurred farther east along the neck. The shells here presented a fair compactness of deposit, but on being handled their sharp edges crumbled. This is also true of the other places examined. Farther westward, immediately under the mold, and 4 inches below the surface were found in conjunction, intermingled with the shells, several pieces of pottery and an implement made of the antler of a deer. It had been ground to a point and was probably highly polished. It does not come to a point evenly, but presents two fiat sides. Numerous split bones occurred and the jaw, axis, and other bones belonging to the deer (*Cariacus virginianus*); a little west of the middle, 2 feet below the surface was found a human skull, and with it a shell bead of the *Oliva*. It was lying on its left side, with its base toward the north and within the bank a distance of 4 inches. Under it and partly around it was an ash heap. All the bones of the face were in place when discovered, but rapidly crumbled on exposure to the air. By great care the cranium was saved almost entire. It is now in the Smithsonian Institution. The entire skull was filled with vegetable mold, very compact, and full of rootlets, some of which still adhere to the sutures. On the removal of the mold, within the skull and lying against the sagittal suture were a pebble, a piece of charcoal, two finger bones, three sections of the vertebral column, a piece of the atlas, a part of the sphenoid bone, and pieces of the ribs, also one of the teeth (bicuspid of the upper jaw) in the right orbit. It may be a matter of interest to know how these bones came to be displaced. The skull bore no traces of having been rolled or even displaced since inhumation, save a twist in the lower jaw. If the skull had

been displaced then the body or rest of the skeleton was displaced with it. The probability is that some small animal burrowing into the earth found the body before decomposition had destroyed all the fleshy parts, and entering the skull through the *foramen magnum* used the cranium for a home. This must have taken place prior to the accumulation of vegetable mold within the cranium. But this will not account satisfactorily for the gravel stone and charcoal within the cranium nor the tooth within the orbital cavity. The following are the measurements of the cranium:

	Inches.
Longitudinal diameter.....	6
Parietal diameter.....	5½
Vertical diameter.....	5
Intermastoid arch.....	12
Horizontal circumference.....	18¾

The cranium nowhere bears any traces of artificial flattening. On placing it side by side with a skull taken from a mound in Liberty Township, Butler County, Ohio, a great difference presents itself in every feature. Compared with an Indian skull from the west bank of the Great Miami, same county, still another difference is seen besides its noticeable smallness. The only feature in common is the raised line along the sagittal suture. But between it and a skull from a mound near Belpre, Ohio (noticed farther along), a great similarity is readily seen in every characteristic feature. The skull was found where it had been placed by the burial party. Had it not been for the few bones protruding from the bank it would have been missed. The remainder of the skeleton had been washed away by the encroachments of the river. The fire-heap had gone out and was partly buried before the interment, and vegetable mold had commenced to form over it. In covering up the body some of this mold was thrown immediately over it. The probability also is, that some shells had been deposited prior to the inhumation. The mold above the skull gave no evidence of having been disturbed.

Within 3 inches of the skull, and on the same level with it, an atlas of the deer was found; on the west of the skull, and removed about 2 feet, yet on the same level, were excavated a chert chip and one of the bones of the foot of the deer; immediately below the skull, and lying on the beach, were pieces of the lower and upper jaw of the deer; also the scapula and one of the bones of the foot of the same animal, besides many fragments of pottery. This pottery, like all the rest found, was made of clay mixed with crushed river shells.

The next examination was made a little farther west. The vegetable mold was over a foot in thickness, and the remains of the shells and works of art also a foot in depth, including ornamented pottery and fragmentary bones in abundance, together with a human atlas. A broken implement was obtained here. It is composed of porphyry, and

was finely polished. It presents four sides, showing breakage. In all probability it was originally a bark-peeler.

At the last point examined the shell deposit is from 6 to 10 inches below the surface. Under the shells is a charcoal layer. In this deposit were found ornamented pottery, an implement from antler, the lower jaws of the deer, both young and old, the split bones of same animals, the breast bone of some large fowl, probably the turkey, and other objects of interest.

It is evident that if one should excavate at any given point within this shell-heap works of art would be revealed.

It should be remarked that the above excavations did not partake of the true character which that word necessarily implies. Only a few inches along the face of the bank were removed, a further exposure being unnecessary. Another consideration also had weight, that to cut much away would endanger the bank, and hence would have been disadvantageous to the land.

It is along this bank where most of the implements which have been thrown upon the market have been taken. All the implements mentioned in the paper either came from this shell-heap or else from one on the southeastern part of the island.

Other shell-heaps inspected are small and composed of the *unio*. They were not explored, as they appeared to belong to the same age as the one fully described above. The shell-heap at the southeastern part of the island covers about one-half acre, extending to the south bank of the ridge. When first discovered it was inclosed by a low wall, nearly square, composed of surface material. Pipes, ornaments, circular stones, and, some other implements were found in this heap.

A little below the shell-heap, and over the brow of the bank, five human skeletons were dug up. Two of these were very large. They were placed in a straight line, heads near together, but divided by a small pile of shells.

These heaps face the Virginia shore, with the exception of one. It is probable that the large one faced both shores originally. The general surface of the land presents no reason why the heaps should be so located. It is not probable that the Virginia side contained more of the *unio*, and even if it did the supply would not have held out long enough to have continually maintained a residence on the south. The reason must be looked for in another direction. The Virginia bluffs do not present a favorable point of attack by marauding bands, and, hence, it may be concluded that the south side was deemed safer in case of an assault by an enemy.

Fifteen different forms of arrow-heads are common on the island. They are composed of gray, black, and brown chert, chalcedony, jasper, and hornstone. As the implements occur in abundance it is probable they were fastened to arrows and used for shooting fish. Implements of the form commonly called a drill, composed of jasper, were probably

used in fishing. The general opinion that these so-called drills were used for perforating stone or other implements may be true. So far as my own observation extends this view is not sustained. Hundreds of them have been examined by the writer, and many are in his cabinet, yet out of all these not a half dozen would indicate that they had been used for drills. If so used their edges would be more or less broken. In Butler County, Ohio, they are almost wholly found along our larger streams. It is probable that sometimes they were used for drilling, but usually in fishing or in the chase.

The forms of spear-heads made from chert and other stone are various. One with a sagittate base is composed of a very pure and clear chalcodony. Only the stem or base is left; the shaft lost. This form is rare in the latitude of Ohio.

Other forms of implements were secured; a drilled ornament composed of the columella of the *Pyrula perversa*; another composed of the same, not perforated, resembling a handle, but with no appearance of ever having been so used; the tips of the horn of the deer, already referred to; pendants composed of cannel-coal, in one the eyelet is broken, but in the other it is perfect; beads made from bones of the bird; a bone awl; one cup-shaped form is called an "eagle-stone." It is a natural formation, and must have been picked up from the gravel. It is partly drilled, and perhaps intended for a suspended ornament.

Three forms of pipes occur in the collection. One is composed of baked clay, and is as hard as stone. It somewhat resembles catlinite. Near it was found the stem, composed of the same material. As this stem makes a complete fit in the orifice or stem end of the pipe there can be no question that it was intended for this identical pipe. The workmen did not complete it, for the perforation is still unfinished. At one end its depth is one inch, and at the other one-fourth inch. A second pipe is composed of a fine-grained sandstone, blackened by use and age. At the top and opposite from the stem is a lip made for adornment. The third is an incomplete pipe, composed of calcite, and intended to represent the head, neck, and breast of some bird. A tube composed of steatite found with it was, in all probability, a pipe-stem.

Among the pottery fragments are ears; one is perfect and the other broken. One stone celt might be classed between hatchet and bark-peeler. It is somewhat rude, never was finished, and is composed of greenstone. A polished hatchet composed of greenstone and a tool of the same material, probably used as a polisher, are types of stone implements.

Circular discs occur. Some of them are perforated; one is discoidal, and all of them are composed of fine micaceous sandstone, excepting one, of cannel-coal. Its face is smooth, and near the center is a countersink. The perforation is regular, but not smooth. The opposite side is roundish, with a slight depression at the center. It is scratched by the coarse grains of sand.

Another implement is composed of a very hard quality of baked clay, and probably used in polishing. Chert flakes are everywhere picked up in the two principal shell-heaps. Nodules of red hematite are common here, but do not belong to the island.

Some of the coarser implements found are a broken flesher or bark-peeler, polished and made from sandstone, a pestle, made of quartz and finely polished, another unpolished and composed of a compact sandstone, a double mortar, composed of sand-rock. The obverse bowl is 6 inches long, 5 wide, and $1\frac{1}{2}$ in depth. The reverse bowl is of the same depth and $5\frac{1}{2}$ inches in diameter at the top.

Double mortars are seldom met with in the Ohio region. The collection contains also a so-called spindle-rest, with three perfect circular depressions. On the opposite side is one similar depression. The material is a fine sandstone. It was found in Highland County, Ohio. The mortar is from the alluvial deposit on the Ohio side of the river, immediately opposite Blennerhassett's Island.

The implements above described do not represent all that are found on the island, but only those obtained. Some very fine hatchets, composed of brown hematite, and grooved stone axes were seen, but they could not be purchased. Doubtless other classes of implements are picked up from time to time.

After a careful study of what was observed at Blennerhassett's Island the following conclusions were reached:

(1.) The shell-heaps were all deposited by the same race of people and at the same period of time.

(2.) The deposits were formed by that race commonly known as the American Indians.

(3.) The evidence appears to lead to the conclusion that the Indians who formed these heaps belonged to the earlier tribes; for (*a*) time must be allowed for the formation of the vegetable mold, and (*b*) also a period must elapse for the growth of the forest trees. When the island was first known to the Caucasian it was covered with forest trees, which extended over the shell-heaps.

(4.) The island was a permanent home for the savages, and chosen on account of its natural advantages. The savage races of North America chose their abodes, whenever practicable, along the margin of streams, partially because it afforded them protection against a sudden attack. The high bank near the point of the confluence of two streams was always chosen either for villages or camping parties, for the reason that only one side needed to be guarded. Blennerhassett's Island was protected on all sides, thus giving natural advantages not afforded on the main land. The deer and other animals were hunted on both sides of the river and brought over in their canoes.

(5.) The evidence that the island formed a permanent habitation is further shown by the vast amount of chert chips scattered throughout the heaps. The chert was brought from "Flint Ridge," in Licking and

Muskingum Counties, Ohio, and then worked into such forms as the "arrow-maker" had designed. The cannel-coal was brought from a distance, and then shaped into such forms as was desired. Two good-sized pieces of cannel-coal were exhibited, which had been plowed up.

(6.) That this people either bartered or undertook long excursions is shown by the chert and cannel-coal implements, and the ornaments made from the columella of the *Pyrula*, which shell-fish lived in the Gulf of Mexico.

(7.) The numerous skeletons turned up by the plow probably belong to a later age. It is hardly susceptible of proof that the people who deposited the shells would bury their dead in shallow graves before their huts. That intrusive burials occurred on the island as late as the time of the white man is proven by the evidence of a lead pipe found among the shells. The stem of this pipe is 3 inches long, and the bowl $1\frac{1}{4}$ inches in height. It shows the traces of the molds.

On the Ohio side of the river, and immediately opposite Blennerhassett's Island, and on the second river terrace (plain of Belpre), are numerous evidences of the mound-builders, consisting chiefly of mounds. One of these mounds is a miniature representation of the truncated mound in the cemetery at Marietta. Like the above, it is surrounded by a wall, with the ditch on the interior, the elevated pathway leading from the mound to the gateway. In front of the gateway (parallel still kept up) is a straight embankment several feet in length. The only difference in the design of the two mounds is that the gateway in the Belpre mound faces the north.

About one year ago a mound near the above was removed. It measured 14 feet in height. In it were found several human skeletons and numerous tubes and pipes. It is composed of some kind of mottled stone resembling steatite. One of the steatite tubes measures 11 inches in length, and it is 1 inch in diameter across the mouth. The bore is perfectly smooth and even until it reaches within one-eighth of an inch of the opposite end, where it suddenly contracts and the remaining part of the aperture becomes quite small. This end of the tube (some call it a pipe) is surrounded by a flange $1\frac{1}{2}$ inches in diameter. The tube is finely wrought, and exhibits much skill on the part of the workman.

Near the top of this tumulus was found a human skull, which is now in the Smithsonian Institution. In form it is similar to the one obtained on the island. The wormian bones in the right lambdoidal suture and at the junction between the lambdoidal and sagittal sutures are the largest the author has observed. These bones do not occur in the skull from the island. The following are the measurements :

	Inches.
Longitudinal diameter.....	$6\frac{1}{2}$
Parietal diameter.....	$5\frac{1}{2}$
Vertical diameter.....	$5\frac{1}{4}$
Inter-mastoid arch.....	$13\frac{1}{2}$
Horizontal circumference.....	$19\frac{1}{4}$

Over the left orbital cavity, and just above the superciliary arch, is a perforation one-half inch in diameter. Another perforation occurs in the right parietal bone, near the sagittal suture.

On the farm of Cyrus Ames, and on the alluvial terrace, several years ago, the river washed out a hollow structure, composed of stone carefully laid up in the form of a well or cistern. This subterranean vault had no visible outlet. Near it was found a rude mortar.

It is probable that other remains occur on the plain of Belpre and on the Virginia side, but as attention was not called to any other ancient works, this account must here come to a close.

ABORIGINAL STRUCTURES IN CARROLL COUNTY, TENNESSEE.

By JAMES M. NULL, *of McKenzie, Tenn.*

The aboriginal structures in this county are four mounds, situated in the southwest corner of civil district No. 22, three of them on Clear Creek, and one on Crooked Creek, 4 miles south of McKenzie, Tenn. Crooked Creek and Clear Creek are small, ever-running streams, with swampy bottoms and miry banks, without any fords except where they are crossed by the old Indian trails. Mound No. 1 is 8 feet high and 30 feet in diameter, being situated in a front yard. The owner will not allow it to be explored. It is on a ridge running down to a point on the creek, half way between a spring 300 feet distant on the west and a bluff 20 feet high on the east. On it were standing, when first occupied 35 years ago, a chestnut and a sweet gum tree, each $2\frac{1}{2}$ or 3 feet in diameter.

Mound No. 2 is on the south bank of Clear Creek, three-fourths of a mile from mound No. 1, in a northwest direction, 350 feet from a bluff 15 feet high, and 200 feet from a spring. It was originally not more than 3 feet high and 30 feet in diameter, was in a horse lot twenty-five years or more, and has been plowed over for 10 years, so as to be nearly obliterated. During the plowing nothing in the way of relics has been discovered.

Mound No. 3, one-half mile northeast of No. 2, is on the east side of a bluff 20 feet high, and 200 feet distant, and about the same distance from a spring. It was 6 feet high and 25 feet in diameter when explored a few years ago. A man dug a cellar in it, knowing it to be an "Indian mound," hoping to find valuables. He sunk a pit 12 by 14 feet, 2 feet below the original surface, and found nothing but "red dirt," as he expressed it.

Mound No. 4, 6 feet high and 20 feet in diameter, is one-half a mile northeast of No. 3, and $1\frac{1}{2}$ miles north of No. 1, with a spring 300 feet and a bluff 600 feet distant on the east. It is situated in the woods,

out has no growth on it. There is no depression of the earth near by. It was explored by an old gentleman 30 years ago for treasures. He sunk a pit 3 feet in diameter from the center of the summit to the level of the surrounding earth. A gentleman who was present gives the following account: The mound was composed of red clay, and extending from the apex to the bottom was a circular space, 6 inches in diameter, consisting of black mold, apparently the remains of a pole, around which the mound had been built; nothing else was discovered.

At the head of the bluff, east of mound No. 1, is a good ford, with hard, sandy bottom, the only one known on Crooked Creek. On the north bank, which is 10 feet high, is a deep worn trail, plainly visible, although it has not been used as a crossing since the settlement of this country, as long ago as 1820. The old settlers call it the "buffalo trail." A ridge runs from this ford to the lower end of the bluff near mound No. 2, where there is another ford and the only one on Clear Creek for a number of miles. Like No. 1, it shows a deep trail worn down the bluff on the east side. From the bottom runs a ridge near mounds No. 3 and 4.

When this country was first explored by white men, all the land west and north of Clear Creek for a great distance was open barrens, almost devoid of timber, and, consequently, a vast grazing place for buffalo, elk, deer, etc. These fords gave them the only means of crossing in their migrations, and the absence of any remains or relics in the two explored mounds leads me to the opinion that they were designed for observation. Each one is within sight of another, from No. 1 to No. 4. Mr. Edward Gwin, who settled this place, collected quite a number of relics in the vicinity of mounds Nos. 1 and 2, consisting mostly of spear and arrow heads and obsidian axes. They were sent to the Smithsonian Institution by Prof. E. H. Randle a few years ago.

The other indications of the former occupation of this region by the aborigines are the remains of a great number of workshops. There are a great many springs in this country, and wherever a spring occurs, on the nearest elevation will be found quantities of flint chippings, broken pottery, incomplete arrow-points, blocks of flint, smooth, rounded stones, some with a small cavity worn on one or on both sides. These places occupy an area of from $\frac{1}{2}$ to 2 acres. The material used must have been brought from a great distance, as there is no stone in this country except soft sandstone, and very little of that.

In 1863 the author assisted in exploring a mound 3 miles west of Tupelo, Miss. It was 8 feet high, 30 feet in diameter, and composed of white sand. It was situated on a ridge 400 feet west of a bluff, at the base of which is a spring. A shaft about 6 feet in diameter was sunk from the summit to the level of the surrounding soil, and a circular space filled with dark mold was reached. It was not more than 2 inches in diameter. The ridge on which it was situated was composed of loose sand covered with small growth of scrub oak.

MOUNDS IN PUTNAM COUNTY, GEORGIA.

By BENJ. W. KENT, of *Eatonton, Putnam Co., Ga.*

The most remarkable mounds in Putnam County were visited and measured by Charles C. Jones, jr., and the writer, and reported by Mr. Jones, namely, the Eagle Mounds, of which no description is needed in this communication. Since the last report the stone tumuli on the plantation of Dr. J. T. de Jorrette, east of Eatonton, have been disturbed, and besides human bones taken therefrom, a pottery pipe of the ordinary size, and shaped like the head of an eagle, was found. No description is necessary of the other pipes in the series excepting the one made to imitate a human foot, which is remarkable for the hardness of the stone. From the stone tumulus on the plantation of Robert M. Grimes was taken a soapstone finger-ring, not in the writer's collection, which is without ornamentation. Another finger-ring, found near the Eagle Mound, on Scott's plantation, is made like a seal ring, with a head or top. None of the pottery collected is remarkable; one vessel is about 14 inches high, and a bowl measures 13 inches across the top; all the remaining vessels are about the usual shapes.

There is in this place a chungkee stone of white quartz or limestone about 6 inches in diameter, owned by Thomas B. Harwell. It is beautifully smooth, hollowed out on either side, and more smoothly finished than any other implements ever seen by the writer except those of Mexico or Peru. It has no hole through the center like the one drawn in Foster's *Prehistoric Races* (p. 218).

The human bones picked up from time to time reveal nothing unusual. It is impossible, however, to get any whole skulls. Attention is drawn to the fact of the existence of human remains under every conical-shaped stone tumulus so far as examined; but whether such will prove true of the bird-shaped mound is not known, as the stones are too large to be removed. Regarding the three mounds on Shoulder Bone Creek, near Sparta County, pipes and pottery have been obtained from the largest mound, but no human bones; whereas from the middle mound, which is the smallest, and but little above the level of the bottom lands, having been plowed over for 7 years, many human bones and teeth and beads were taken. Ashes and shells are often found, showing where the aborigines lived. There existed hereabouts, so far as I know, no cave dwellings, and neither masonry nor sculptured slabs. While an isolated skeleton is sometimes found, many exist in the tumuli. No skeleton in a cyst or other receptacle has been found, except one of an infant, probably in Mellepueli. All the stone tumuli are on high hills, usually on the highest portion; all the earth tumuli are in the bottom lands.

There are various other mounds and shell-heaps in this and adjacent counties. There is an earth mound on the lands of Mr. C. Purifoy, in Jasper County, once probably 6 feet high, but now much leveled by

plowing. Near Murder Creek, in this county, and not over half a mile from the Clinton road, exists a stone tumulus said to be of immense size, but never visited by the author. Near Little River, and below Pierson's mill, and on the opposite side, are several stone tumuli, and another group east of these. They are within a few feet of the conical group, and not more than 100 yards apart. There is a mound near Dr. Jorrette's dwelling, near the opposite bank of the Oconee River, from which was dug a bird-shaped calumet, and human bones also were found. There is a rock mound on the plantation of Robert M. Grimes, near the line of Hancock and Greene counties, also an earth mound about 8 feet high and 30 feet in diameter, west of the rock tumulus, and near the Oconee River, in Greene County, situated in the bottom land. Near Lawrence's Ferry, and between Little's Ferry road and Oconee River, is a mound supposed to be bird-shaped, inclosed in a circle. Upon the plantation of Dr. White, Hancock County, are mounds of earth, near which runs a ditch.* Various other small mounds and shell-heaps are scattered over this county.

PREHISTORIC REMAINS IN FLORIDA.

By J. FRANCIS LE BARON, *U. S. Engineer.*

I arrived in Fernandina, Fla., February 26, 1877, accompanied by an assistant. This place seemed to have been a camping or living place of prehistoric man, for there was to be seen here the remains of a somewhat extended kjökkenmödding, on the north side of the town.

I next went to Jacksonville, and remained there until July 14. While there I made the acquaintance of the principal archæologists of the place, and from them obtained many valuable notes and suggestions.

Mr. A. A. Knight, esq., informed me of the location of the mound in T. 2 S., R. 27 E., and the shell-heaps or kjökkenmöddings at the mouth of the Saint John's River, in T. 1 S., R. 29 E., which I have since visited. Those on the north side of the river on Fort George Island are mentioned by S. P. Mayberry in the Smithsonian Annual Report for 1877, p. 305, and by a writer in Harper's Monthly for November, 1878, in an article entitled the "Sea Islands."

W. W. Dewhurst, C. E., postmaster at Saint Augustine, referred me to the mounds in T. 3 S., R. 26 E., and T. 4 S., R. 26 E., two miles east of Mandarin.

Leaving Jacksonville on the 14th of July, 1877, we sailed up the river in a two-masted sail-boat and discovered our first mound one mile south of Picolata, on the east bank, in a high hammock. It is of sand, about 25 feet in diameter at the base, and 8 feet high, and situated about 50 feet from the river. We did not open it, and it showed no signs of ever hav-

* *Antiquities of Southern Tribes*, C. C. Jones, jr., p. 144.

ing been explored. Leaving this place and continuing up the river, we passed a mound on the east bank, 5 miles south of Tocoï, without knowing it. The next mound that we found was situated on the west bank of the river, about 2 miles north of Pilatka. It was a shell-heap about 12 feet high, the eastern edge abraded by the waters of the river into a steep bluff. A large part of this shell-heap had been carried away in boats to form walks and drive-ways in Pilatka and for fertilizing purposes.

This practice is very common throughout the State, and is working the speedy destruction of these interesting remains.

The shells in this mound were mostly fresh-water species. The bottom of the mound is washed by the river, and the part that has been exposed to the continued action of the water has formed a kind of calcareous conglomerate, which is thickly interspersed with human and other bones, broken in all cases that came under my notice. The conglomerate forms a very hard, apparently durable, stone, upon which extreme age would produce but little effect.

I am informed by Mr. James H. Fry, of Pilatka, that there is a mound in the swamp half a mile west of the shell-heap. Arriving at Pilatka I found the remains of a small mound, filled with broken pottery, in the southeast part of the town. The fire-bell tower stands upon it, and it is partially demolished. There seem to be kjökkenmödding remains all along the shore here. I was fortunate to meet Mr. J. H. Fry in this place, and I found him well versed in the archaeology of the region, and disposed to give me all the information in his possession. To him I am indebted for the location of a large number of stations, including the following:

1. A shell mound nearly opposite Pilatka, a little to the north, on the land of Mr. Thew. There is a wind-mill on the top.
2. A large shell mound, about 9 miles east of Pilatka, on the land of Mr. Rollinson.
3. A large number of mounds, 20 to 30 miles west of Pilatka, from one of which shells and arrow-heads have been taken.

Mr. Fry had a large collection of relics from different mounds; among them was an earthen bowl holding about a quart, in perfect preservation, which was taken from a mound in Lake Worth, on the east coast. Mr. Fry also informed me that there was a well-defined chip-yard, or aboriginal neolithic workshop, with an abundance of rejected fragments of flint, on the east bank of the Saint John's where it leaves Lake Monroe.

At Pilatka I also met Col. H. L. Hart, to whom I am indebted for the locations of two mounds on Murphy's Island, in the Saint John's River, 10 miles south of Pilatka, on his land.

Leaving Pilatka, the next mound on the river, going south, is 4 miles south southeast up a creek. We stopped next at San Mateo, a landing on the east side.

From Mr. P. B. Bishop there I learned of a mound about 15 feet high, 30 feet in diameter, on the southeastern shore of Orange Lake, Marion County.

The next place of interest on our route was a shell bluff near Buffalo Bluff, on the east side of the river. Here we found human and other bones and pottery in abundance. The bluff was about 6 feet high, and the locality gave evidence of having been a residing station of an ancient people. This place is only a short distance south of the mouth of Dunn's Creek. A little further on we came to Mr. White's, on the same side of the river. From him I obtained the following data: There are three mounds here on Mr. White's land, and three shell-heaps partly on his land and partly on that of his neighbor, Mr. McDean. There is also a shell-heap on the opposite or west side of the river, about a quarter of a mile from the bank, claimed by Mr. White to be the largest in the State; and a shell-heap and mound three-quarters of a mile south of Mr. White's, on the east bank, on land known as the Hernandez grant. There are, besides these, one on the west bank, 2 miles south of Mr. White's, which is very large; one opposite this, on the east bank; a very large one on the east bank, 4 miles south of Mr. White's; a very large one on the east bank, 6 miles south, on land of Mr. Wells; another very large one on the east bank, 13 miles south of Mr. White's, at a place now called Beecher, at the entrance of Little Lake George; and, finally, one on the east shore and one on the west shore, 2 miles south of Beecher.

On the east side of Dunn's Creek is a mound with earthworks and fosse. There is another mound on the same side of the creek, at its junction with the Saint John's, on land of Mr. Wells, or very near his line; and one on the other side of the creek, on Mr. John Wells's land.

On Bear Island, in Dunn's Lake, there are mounds, and others on both sides of the lake. Mr. Wells's house, at Nashua, Putnam County, east bank of the Saint John's, is situated upon a large shell heap. There is another about half a mile north of Mr. Wells's, on the same side; and still another west of Mr. Wells's, about a quarter of a mile from the river, on the first island in the swamp. There is also a shell-heap on the west side of the Saint John's, half a mile north of the mouth of the Ocklawaha River and half a mile from the Saint John's River. We passed the celebrated Mount Royal, but did not go ashore to examine it, as it has been so fully described by Bartram and Professor Wyman. There was a large shell heap (kjökkenmödding) at Fort Gates, on the opposite side of the river from Mount Royal and a little to the south. Here Dr. Lente found an arched fire-place or oven, with numerous bones of turtle, deer, and other animals, together with human bones, on land belonging to himself, about 30 feet from the wharf. The arch, he stated, was perfect, and was found several feet below the surface of the kjökkenmödding as it was being leveled. He informed me that it exhibited the true principle of the arch.

Five miles south of Fort Gates we came to the outlet of Lake George. Here on the east side, on land of Martin Hyas, are two mounds and two shell heaps, in Range 26, Township 13, East and South. These were pointed out to me by Judge Bartlett, of Georgetown, whom I found very kind and obliging, and who left his office and took me through the hummock to the locality. On Lake George are additional remains, as follows:

1. On the west shore, commencing at the northern end, there is a shell mound directly west of Hog Island.

2. One on Salt Run, 1 mile up the run.

3. One at the mouth of Silver Run.

4. A very large shell-bluff on land of Damon Greenleaf, at the mouth of Silver Spring. The shell mounds noticed near Silver Lake, and one 2 miles up Juniper Creek, are given on the authority of Professor Jeffrey Wyman.*

Passing around the southern extremity of the lake to the east shore, at the influx of the Saint John's, at a place called Lake View, we find a very large mound on land of Mr. Rapes.

Next on the Acosta grant, Range 27 S., Township 13 E., on Dr. Lente's place, called Seville, there are several small mounds.

We now leave Lake George, and passing up the river to Volusia find there a large cone-shaped mound at the landing on the east side of the river. This mound appears to be nearly 20 feet high, and at least 300 feet in diameter at the base. There is a house and orange grove upon it. It is irregular in shape, and was probably built on lilly ground. Professor Wyman speaks of a shell deposit there and a mound at Fort Butler, opposite, but we saw nothing of them. The next shell mounds observed by us are those called Orange Bluff and Bartram's mound, near the outlet of Lake Dexter. These are also mentioned by Professor Wyman.† He also speaks of two between these and the last mentioned, which we did not see.

The next shell mound visited is at Saint Joseph's, 7 miles north of Osceola, on the west bank of the river. There is a house on it. We did not stop again until we arrived at Blue Springs. There are several shell-heaps shown on the map in this distance which had been examined by Professor Wyman, so we did not stop for them, but contented ourselves with a view of them as we sailed along. The one on the west bank at the outlet of Lake Beresford appeared very large. The other one is half a mile south of Palm Landing, and one a mile south, both on the east side. At Blue Springs I was fortunate in meeting Mr. L. P. Thursby, to whom I am indebted for valuable information, as was Professor Wyman on his visit. We found there the shell heaps mentioned by the latter on both sides of the Blue Spring outlet.

The next shell mound is at Mr. Scott's, called Barker's Landing, on

* *Fresh-water shell mounds of the Saint John's River, Florida*, p. 38.

† *Ibid.*, pp. 35, 37.

the east bank, about 2 miles north of the mouth of the Wekiwa. There is a house upon it. At the mouth of the Wekiwa there are two mounds on the east bank of the Saint John's. They are 1 mile south of Emanuel Landing. One is about 100 feet from the river, on the edge of the hummock, and the other is about 250 yards, and in the hummock. There is another about 7 miles by river, 4 in a straight line, near or on land of Colonel Thrasher, about a quarter of a mile from the Saint John's River, across a marsh. This mound is 1 mile north of Lake Monroe, on the east side of the river.

Professor Wyman mentions extensive shell deposits, 6 or 7 miles up the Wekiwa, but we did not visit them. There is a shell mound on the Sanford grant, at the north end of Lake Monroe. About Lake Monroe are other mounds, as follows:

The celebrated shell mound at Old Enterprise; this was being carted off when I visited the spot, August 15, 1877, for the purpose of fertilizing a neighboring orange grove. I collected several specimens there, of which mention will be made further on. The mound was apparently about half gone. It was composed of fresh-water shells, similar to those now found in the lake, but very much larger than any now living that I have seen.

There were occasional fragments of large sea conchs, many human and other bones, and much pottery with ashes, &c. Very many of the delicate shells were uninjured, although very fragile, showing that they must have been piled up in very large quantities at a time, and not have been simply the remains of a feast left on the ground, for in this case the shells would have been exposed to breakage by the trampling of feet and movements of the family. Throughout the mound the shells were deposited very loosely. There was not sand enough to bind them together, and remarkably little humus or black soil. This heap cannot then be classed as a *kjökkenmödding*. It must have been raised for a purpose, and not as the incidental accumulations of kitchen refuse. If the shell fish were used as food it would seem that they must have been boiled whole and then the shells thrown on the pile after the extraction of the tenant.

I am informed by Mr. Scott, of Barker's Landing, that 2 or 3 miles from this mound and from the lake is a shell heap, composed entirely of oyster shells.

Leaving Lake Monroe, the first station of interest was Ginn's Grove. Here are two sand burial-mounds and near by is a shell heap, or rather a kitchen refuse heap (*kjökkenmödding*). One of the mounds is high and conical, the other low and flat, and spread out over a large extent of ground. The conical high mound had been opened previously and we found several fragments of pottery and human bones thrown out of the excavation.

Continuing on our voyage we passed Lake Jessup by a cut-off, and so did not see the mounds referred to by Professor Wyman, and shown on

the map at outlet of Lake Jessup. Lemon Bluff was the next place where we found prehistoric remains. This about 10 miles from Lake Harney. The bluff is about 30 feet high and on the top is a cultivated field, and here are found indistinct remains, broken pottery and shells. It was evidently a place of residence.

At Cook's Ferry, on the west bank of the Saint John's, at the outlet of Lake Harney, is a very large shell heap, on which is an orange grove and house. I found several pieces of pottery there and some bones of animals and human beings. This is described under the name of King Philip's Town by Professor Wyman. Back about 200 yards is a small but steep conical sand mound. In this mound Mr. Coue, sheriff of Volusia County, found two flakes of silver about as large as a 25-cent piece; they were smooth and without marks, and he thought were poor silver.

On the west side of Lake Harney, just north of Fort Lane, is a mound. I am also informed that there is a large earth-mound at Fort Christmas, above Lake Harney and west side of Saint John's, in pine woods.

The next that we visited was the so-called Orange mound, about half a mile south of Salt Creek outlet, and on the west side of the Saint John's. This has the appearance of an island in the boundless marshes surrounding it, and is visible from a long distance. It was then covered with trees, which have since been cut away, sugar-cane and other crops being planted in their place. It is conical in shape, rising on all sides to the center. It is colossal in dimensions, being over 600 feet in diameter at the base, and about 40 feet high. The ground appears everywhere to be composed of black earth and shells and ashes. It does not seem possible that it should have been artificially formed, for the nearest dry land is as much as 3 or 4 miles off, and communication can only be made by boats. It appears to me probable that it was a retreat for the women and children in time of war, and that there was originally a small hill there, which was increased in size by the accumulations of shell-fish and kitchen refuse, incident to a prolonged camp. A small excavation made by some alligator hunters, which I examined, yielded the usual pottery and broken bones. I think this place deserves a careful exploration.

There is a small mound of like nature about 2 miles south of Lake Harney, on the west side of the Saint John's River, and about a quarter of a mile off in the wet prairie. It is covered with cabbage palms, and is but 3 or 4 feet high.

The next mound, as I have been informed, is situated at the northeast end of Lake Poinsett, on the east bank. Going further south, there is an earth mound at Fort Taylor, on the west side of Lake Winder, on the margin of the lake. There is now a country store on it. There is a mound 10 or 15 miles south of Lake Washington, at the head of Big Cypress Swamp, west side of river, and north of the swamp. For the last three I am indebted to Mr. Osteen, tax collector of Volusia County.

Professor Wyman mentions two shell heaps on the east bank of the Saint John's and the right bank of Salt or Moccasin Creek (facing down stream), near the union of the creek with the river. One of these he calls Possum Bluff, but wrongly, as Possum Bluff is situated about 15 miles south of Orange mound, in a straight line on the east side of the Saint John's.

There is a mound near the mouth of Snake Creek, which connects Salt Lake and Lufman's Lake. It is about one-half to three-quarters of a mile up the creek. Mr. Coue informed me that he had made a cursory examination of it, and found a lot of beads and a human skull with a bullet-hole in the back.

This completes the locations on the Saint John's and its tributaries as far as my examinations extend. The Ocklawaha River, I am informed, contains a great many on its banks. Crystal River, on the Gulf coast, is mentioned by Col. F. L. Dancy, formerly State engineer and geologist of Florida, as having a remarkable mound on its bank, 4 miles from its mouth.*

Several mounds are reported 20 miles south of Saint Augustine, on Peltier's Creek, on land of David Carter, and shell-fields on Anastasia Island, opposite Saint Augustine.

I am also informed by a "Cow-boy," who had seen them, that there are two or three mounds on the east bank of Reedy Creek, in the north-east corner of Polk County, between the creek and Lake Tohopekaliga, and also remains of extensive earthworks, believed to be fortifications, near the bay on the east side.

I am informed there are mounds on two large islands in Lake Kissimee, southerly from the last.

Mr. A. W. Conklin mentions in *Forest and Stream* of December 30, 1875, pp. 330 and 331, the following mounds and earthworks:

One near the south bank of Boggy Creek, a stream which flows to the southeast and empties into the northwestern bend of Little Tohopekaliga, and another about 4 miles further south, near the edge of Fennel Prairie. These mounds, he says, are very much alike, being about 50 feet in diameter and not over 10 feet high. Also a greater number on Barton's or Parton's Island than in any other place. One in particular, which he calls Parton's mound, seems to be a fortification, with a fosse, enciente, graded approaches, &c.

A mile to the northwest of the above-described works, in the edge of the hummock overlooking Pleasant Lake, are the remains of a very large fortification, with walks nearly 20 feet in thickness and from 3 to 8 feet high.

Other and somewhat indefinite remains are found on a hill, about a mile to the southwest, across Pleasant Lake. One mile further west, on Pine Island, he says, there is another work, consisting of a mound surrounded with a wall, and having what he thinks an artificial boat

* *Smithsonian Report*, 1866, p. 357.

harbor. In the interior of the island, which is 2 or 3 miles in diameter, other mounds are found which do not differ materially from the one at Boggy Creek. In addition to these larger remains, the main island has on its surface some two or three hundred smaller mounds, usually about 30 feet in diameter, and 2 or 3 feet in height. He considers these dwelling places.

Four miles south of Pine Island is a work similar to the one at Pleasant Lake. Along the eastern side of Lake Tohopekaliga are a number of small mounds, and at the place of Charles McQuaid, on Lake Cypress, are two of the ordinary round-topped mounds. Twenty miles southeast of Lake Kissimee is another large mound. It is about 35 feet high, 40 yards in diameter, built of sand, with a graded approach, and covert way. About a dozen miles southeast of this mound, which is called the Hope mound, in the neighborhood of old Fort Drum, are two other mounds similar to it.

All down the Kissimee River mounds are to be found, of which the largest and most important is at Daughtery's, on the west side of the river, 4 miles northwest of Fort Bassenger, on Istokpoga Island, at the northeastern extremity. Here we have again the graded approach, a covert way, and circular bastion. One hundred yards to the west is an earthwork resembling a redoubt. Eighteen miles to the southwest of this mound, in the marsh which bounds the island, is a part of a wall, which is a mile in length. At the southeastern extremity of Little Tohopekaliga Lake is a work similar to the Parton mound already described.

Along the Kissimee River are embankments apparently raised by the hand of man, running for long distances in a straight line. He says they were apparently constructed for dikes. In the Parton mound, on the Little Tohopekaliga Lake, John Evans, ex-sheriff of Queen's County, exhumed fifty-four skulls which had been buried close together, forming a circle.

At McQuaid's, mound on Lake Cypress, a piece of gold, inscribed with characters in some unknown tongue, was found. It was hammered, not coined, and sold for \$16.

The "Hope mound," near old Fort Drum, has not been disturbed, and offers with others near it a fine field for the antiquarian. The articles taken from the Daughtery mound are all modern, consisting of an immense variety of beads, some small as a pin's head and others an inch in length, of various colors, and some of them gilded—glass ear-drops, and a piece of silver about 3 inches in diameter and about equal in thickness to a silver half dollar; two steel axes, each over 10 inches in length, one $4\frac{1}{2}$ and the other $5\frac{1}{2}$ inches on the blade. On the sides of the ax are several markings made with a cold chisel. All these articles were found near the surface.

Mention is also made of a remarkable work on the Caloosahatchee River, which appears to be a canal. On the west side of Lake Okeechobee, near Fort Center, just above the mouth of the Trathlopopka-

hatchee River, in Townships 40 and 41, Range 31 south and east, are mounds, as I am informed by Dr. Kenworthy, of Jacksonville, and others who have visited them. There are fortifications south of them in T. 42 S., R. 30 E. Dr. Kenworthy also locates a mound south of the Caloosahatchee River in T. 45 S., R. 26 E. Mention is made of shell banks at the mouth of Manatee River, Tampa Bay, in Smithsonian Report for 1866, page 357. Mr. James M. Kremer, chief engineer of the Atlantic and Gulf Coast Canal and Okeechobee Drainage Company, who has lately visited the remarkable canal on the north side of the Caloosahatchee River, describes it as a canal 4 feet deep by 10 feet wide, clearly cut through the low flat pine woods, and the excavated sand and earth thrown up on the sides. It starts from the upper end of Lake Flirt, and runs in a northeasterly direction, in a perfectly straight line, as if laid out by an engineer, to a group of large mounds situated in the pine woods about 3 miles from the Caloosahatchee River, and then returns to the river in a southeasterly direction between Coffee Mill Island and Lake Hiakpochee, inclosing a triangular area, and having a total length of nearly 6 miles. Large pine trees were growing in the bottom, in places where there was no water. Many of these trees were as large as any growing in the surrounding forest.

Returning to my own discoveries, while chief engineer of the Saint John's and Indian River Railroad in Florida, and engaged in locating the line from Titusville to Lake Harney, I found the following mounds: About half a mile from Titusville, and a quarter of a mile north of the track, on the south side of the wagon-road to Salt Lake, is a small sand mound in the pine woods. It is only about 5 feet high, and perhaps 15 feet in diameter at the base, and is overgrown with bushes and saw palmetto. Four miles and fifty-four hundredths from the terminus in Titusville, at the junction of the Salt Lake branch of the railroad, is a large sand mound. The Saint John's and Indian River Railroad comes round near the west side. It is about 200 feet in diameter and 30 feet high, almost a perfect cone. The pits from which the sand was taken are plainly discernible at its base. This mound is mentioned by Professor Wyman,* who opened it on the top, and found a "skeleton and piece of coquina cut in the form of a turtle." Subsequent explorers found two silver coins in it, which were in the possession of S. J. Fox, then general manager of the Saint John & Indian River Railroad.

The next mound is about a mile from the railroad, to the east of station 160 (100 feet stations starting from "Indian Mound Station" on the Salt Lake Branch Railroad), or about 3 miles from the junction.

At station 284, about $5\frac{1}{3}$ miles from the junction, is a small mound on Turtle Island at the head of the Salt Lake Prairie. It is situated on the immediate east bank of Boggy Branch, and only about 60 feet northeast from the center line of the railroad. It is a sand mound about 25 feet in diameter, and 5 or 6 feet high.

* *Fresh Water Shell-Mounds of the Saint John's River, Florida*, p. 16.

Commencing now at Mosquito Inlet, on the east coast, and going south, I will mention the mounds on the Hillsboro' River, Mosquito Lagoon, Indian and Banana Rivers, and Lake Worth, as far as I have been able to discover and locate them or learn of them. But first I will mention a mound on the farm of Mr. Andrew Bostrom, on the Halifax River, north of the inlet and nearly opposite Ormond. This mound is just south of the house and close to the bank of the river. It was originally about 50 feet through at the base and 6 feet high, but has since been cut through on the western side to form a road.

There is also a high sand mound a few rods south of Smith's place, about a mile south of Bostrom's, on the same side of the river.

South of Mosquito Inlet the first mound is at "the extreme north end of Block Hummock, 3 miles west of Mosquito Inlet." This is described by A. M. Harrison, assistant United States Coast Survey,* who found in it human skulls and several peculiar beads.

We come next to the large shell heap at New Smyrna. This is a *kjökkenmödding*, about 20 or 25 feet high, 300 feet long by 150 wide. It contains broken pottery. There is a country store upon it. There is a shell mound opposite, not a *kjökkenmödding*, at Captain Briggs's, formerly Alden's place, which is mentioned by D. G. Brinton, M. D., in Smithsonian Report, 1866, p. 357. Half a mile south of New Smyrna, on the west side, is another large shell heap near the river, with a house upon it.

One mile and nearly three-quarters south of New Smyrna, on the same side, is a large shell heap upon which are the ruins of Turnbull's Castle, and just north of it Turnbull's Canal. The canal and castle were built by the English during their occupancy of this region.

South of the post-office in New Smyrna, at a distance of $5\frac{3}{4}$ miles, is a mound on the west side, near the river and Mr. R. Burdick's place, which is known as the Fox mound.

Six and a half miles south of New Smyrna and on the same side is a very large shell mound, with a house upon it. The place is known as Childs's, but is now owned by Mr. F. J. Lockwood. It is about 30 feet high and 400 feet long on the river. Directly opposite this, and half way to the ocean, in the middle of the large mangrove marsh, is a shell heap on a branch of Cedar Creek. It is about 15 feet high and 60 feet in diameter at the base, which has been partly washed away by the waters of the narrow creek. If this place was chosen for concealment, the builders were eminently successful, as it is very difficult of access and effectually hidden by the thick mangrove trees. It seems incredible that human beings would ever have chosen such a place for a habitation, unless to escape discovery from an enemy. The island upon which the mound stands is all mangrove marsh.

One mile south of Childs's, by the west passage, is a large mound on a small island near the west bank, known as "Brick-house Mound."

* *Smithsonian Report*, 1877, p. 305.

The Coast Survey have a trigonometrical station and a stone post on top. This mound is high and steep, and composed of oyster shells and conchs. It is about 100 feet in diameter, and 20 or 25 feet high, with a steep bluff on the eastern side, where it fronts on a small cove. This cove contains the best oysters on the east coast. A wagon road has been built around the eastern face and a causeway across the marsh in the rear to the main land, about 100 yards, where there is a large wild orange grove which has been budded with sweet stock.

Nearly due east from this shell heap, on the ocean beach ridge, is the celebrated Turtle mound, $8\frac{1}{2}$ miles south of New Smyrna. It is composed mostly of oyster shells, with occasional conchs. The western side, next to the Hillsboro' River, is now abraded by the water to a precipitous bluff. It appears to have two summits, with quite a valley between, and the sides are covered with thick bushes. This mound is described by the same writer in Smithsonian Report, 1866, p. 357, and by myself in Rod and Gun, November 4, 1876.

We come next to a very large mound at Bissett's Hill, on the west side of Hillsboro' River, about a mile south of Turtle mound. It is as much as forty feet high, with steep sides, composed of shells and black earth, and covered with a wild orange grove. It was also used by the Coast Survey as a triangulation station, and its position is well shown on their published chart, No. 4, of the Inside Passage, East Coast of Florida, Hillsboro' River. Several of the mounds on the Hillsboro' River and Mosquito Lagoon are shown on these charts.

Directly east of Bissett's Hill, on the beach ridge or peninsula, close to the East Channel, is a small shell-bank at a place called Pumpkin Point.

Just a mile and a half below Bissett's Hill is a small shell mound, called "Live Oak Mound," on land of Mr. Lafayette Allen, and a few rods north of his house. This I did not examine.

A little more than 2 miles south of Bissett's Hill, on the west side, is a shell heap known as Oak Hill. It is about 18 or 20 feet high, nearly 800 feet long and 500 feet wide, the longest side fronting on the lagoon. It is composed of shells, mostly oyster, and is very irregular on the top, with many small hillocks of shells, with depressions between them, as if the hill had been the abode of several families, each one making its own heap. The east side is washed by the waters of the lagoon, and the west is backed by a marsh and creek about 800 feet wide altogether. Human bones and pottery are found in it. There is a post-office called Oak Hill upon it and several houses. Mr. Rideout, formerly a county commissioner of Volusia County, once lived here, and two of his family are buried on the top, just south of his house. This is a true kjökkenmödding. It is situated on a point, partially protected in the rear by a creek and marsh, as is the one at Bissett's Hill. This kind of location was a favorite one with these people. It served to protect them from the stealthy approach of an enemy or from the dangerous

attack of wild beasts and reptiles, of which the black bear and panther, and poisonous snakes were the most dangerous. It also gave them greater immunity from the mosquitoes, and enabled them to enjoy the cooling sea breezes in summer. For the same reasons the first settlers have generally chosen these places for their own residence.

A little less than half a mile southerly, on the lagoon shore, same side, is another large kjökkenmödding, and there is a house upon this also, belonging to Mr. Frank Sam's, of New Smyrna. This heap is nearly as large as the one at Oak Hill.

Continuing south just a mile, by the west shore of the Mosquito Lagoon, we come to Swift's wharf, built several years ago for the purpose of shipping live-oak lumber. On the shore, at the north side of this wharf, is a large mound and shell heap. Captain Swift's headquarters and office is located upon it. This place is in sec. 9, T. 19 S., R. 35 E., and the two previously described are situated in Sec. 5, same township and range.

Continuing south now, we come to the "Ross Hummock," on same side of lagoon and near Mr. McCarty. Here we find a large sand burial mound, about 50 yards from the west bank of the lagoon, in what was a wild orange grove, but had been grafted and cleared up at the time of my visit in February, 1878. There is a small brook between it and the shore, close to the mound and a deep artificial ditch with running water about 100 feet to the south. This last is believed to be the work of Dr. Turnbull's colonists at the time of the English possession of Florida. The mound, as I have stated, is of sand, with very precipitous sides. This has apparently never been opened.

Two and a half miles north of the Haulover Canal, near Butler Campbell's, there is said to be a burial mound in the scrub, about 200 or 300 yards from the west shore of the lagoon.

Passing through the aforesaid canal and going south about half a mile we come to a small sand burial mound on land of Charles H. Nauman, formerly Lisbon Futch. It is about 155 yards from the east bank of the Indian River. I made a partial examination of this mound in 1869, and described it in Rod and Gun, November 4, 1876. We found there only portions of skeletons and broken pottery. Subsequent explorers have opened a trench through the mound down to the original surface of the ground. They found nothing worthy of note except a large oval coquina stone, about $2\frac{1}{2}$ feet in transverse and 14 inches in conjugate diameter. Around the shortest medial circumference a groove was cut about 2 inches deep, as if for the fastening of a rope. There were no other marks upon it, but it had evidently been rounded and brought to shape by the hand of man. This stone was left lying at the base of the mound by the discoverers, where I saw it in 1878. I am informed by Mr. Nauman, whose house is only about 200 feet east of the mound, that the stone was found in the exact center of the mound at the bottom. It is difficult to determine its use. It could have been used as an anchor for a large canoe or for fastening a guy-rope.

We pass next to the shell-banks, or kjökkenmöddings, at Dummett's, $1\frac{1}{2}$ miles from the last. These are low fields, with shells and pottery, and are found on the lagoon and Indian River sides of the isthmus. One of the largest orange groves in the State is growing at each of those places. They were originally wild groves.

Passing then to the head of Indian River, on the east side of which we find a mound in the hummock near Mr. Griffith's, and descending to Titusville I learn that there was a small sand mound about 6 or 7 feet high on land of P. E. Wager, who removed it and excavated a cellar for a house on its site. It was about 300 feet from the west bank of Indian River.

East southeast from Titusville, on the east side of Indian River, on Merritt's Island, there is a large mound on land of Dr. Moore, as I was informed by J. W. Joyner, since deceased, who also stated that he picked up several earthen vessels on it, which he used in the house until broken by the children.

On the Banana River there is a large shell-bank containing broken pottery, at the De Soto Grove, on the east side of the river, on the line between Townships 22 and 23 South. South of this about 5 miles is a burial mound in the orange grove of M. O. Burnham, keeper of the Cape Canaveral light-house. It is about 8 feet high and 50 feet diameter. There was a wild orange grove there.

South of Titusville, 12.3 miles by the new Titusville and City Point road, as I located it, is a large sand mound in the hummock now belonging to Charles R. Carlin, but formerly to Albert Faber. It is on the west side of the river, about 500 feet from the bank, in T. 23 S., R. 35 E. It is about 25 feet high.

A very large mound or shell heap is reported directly east of the head of Banana River, near the ocean beach, but I have never visited it.

In T. 24 S., R. 36 E., are two sand mounds on Merritt's Island. The most northern one is about half a mile west of New Found Harbor, and the other is only about 100 feet from the east bank of Indian River, in Section 27, near the house of Aaron Cleveland, C. E. They are both small.

The next mounds of which I have any knowledge are situated on the peninsula, between Indian River and the Atlantic Ocean, at the mouth of Banana River. There is at that point a very large shell mound, which was used by the Coast Survey for a triangulation station. Its western face is abraded by the waters of the river into a steep bluff, the river having encroached nearly to the center. It is composed of small shells and ashes, mixed with human, animal, and fish bones. It is not far from 50 feet high and 300 or 400 feet in diameter on the river.* The back of it is covered with a wild orange grove, and it is covered with large India-rubber, torch-wood, and other trees. There is broken pottery mixed through it, but I could find but one stone implement, al-

* Detailed survey and plan of this locality was made.

though the broken river face presented a fine opportunity for viewing the interior. I am informed that near this to the north are two burial sand mounds in the scrub, although I was able, after a close and long-continued search with two assistants, to find but one, and this had been opened. What appears indistinctly like a wide level road or way leads due east from the shell heap, between two ponds, which possibly were once one.

Less than a mile south of this mound is a small kjökkenmödding on the immediate east bank of the river, on land of J. M. Hopkins, whose house and garden are situated on it. There are somewhat indistinct remains at the mouth of Crane Creek, at Melbourne, on the north side, on land of Thomas Fish, deceased, and on the south side on land of Peter Wright. On the opposite side of the river in Sec. 6, T. 28 S., R. 37 E., is an Indian mound. South of this not quite 2 miles is another, both on the east side of the river, and the last opposite the mouth of Turtle or Turkey Creek. I am told that shell fields exist on the banks of this creek but have not examined them.

Cape Malabar is an insignificant point of land on the west bank of Indian River. South of the cape, on the same side, about four-fifths of a mile, is a shell mound on land of E. Arnold, and adjoining this, to the south, is a shell bank. About a mile and a half south of the Arnold mound there is a sand mound, on land of Mr. Damon, in Sec. 8, T. 29 S., R. 38 E.

The next mound is of shell, situated on the beach ridge due east from the island called Grant's farm, and near the northeast corner to T. 30 S., R. 38 E. It is called "Wild Boar Mound," and is situated in a deep bay of the river at a very narrow place in the peninsula. The waters of the river come to the foot of this mound, which is about 20 feet high and 200 feet long on the river, with steep sides, and composed of broken pottery, shells, and ashes.

In T. 31 S., R. 39 E. is a high long bluff of shells on the west side of Indian River. I have not examined this except from the river, but it is probably an extended kjökkenmödding.

Opposite Jupiter Inlet on the west bank at Stone's Point are several large oyster-shell heaps, as I am informed by numerous observers, one of which is said to be *very* large. In the southern end of Lake Worth, in T. 45 S., I am told there is a large mound on the west side of the lake, about 100 yards from the beach, and across the lake on the sea beach there are two large shell heaps composed of oyster shells. No oysters exist now within 10 miles of these heaps. There is also a mound in the hummock opposite the old inlet to the lake.

On the Delesfine grant, on the east boundary of Sec. 32, in T. 22 S., R. 35 E., is a very small and insignificant kjökkenmödding. It is very probable that this place is of much more recent age than the remains previously described herein, it having the appearance of a camping place of some of the Seminole tribe of Indians.

I will now briefly speak of some prehistoric remains in the southwestern part of the State that I have lately visited.

In March, 1881, I started from Orlando, Orange County, Florida, with an ox-wagon, in charge of a Government party, to make certain surveys and examinations for a steamboat route from Saint John's River to Charlotte Harbor, on the Gulf of Mexico.

We passed down by Forts Gatlin, Davenport, and Clinch, and thence down the valley of the Big Choctaw River to Peace Creek; thence to Charlotte Harbor, and from there to the mouth of Caloosahatchee River and up the river nearly to Lake Okechobee. Before making Fort Clinch, and near Lake Pierce, we passed near the Indian village of Chipco, named after the old Seminole chief, since deceased. We visited the village, which consisted of less than a dozen cabins built of logs and fan palmetto. It is situated on a small hill. Numerous sweet orange trees in bearing were growing among the houses, and a sugar-cane field was being cultivated near by. The Indians had been living on this spot for many years, but there was no indication of a *kjökkenmödding* forming. This is accounted for by the fact that these Indians live principally on venison and fish. No shell-fish of any kind were observed about the place, and so the principal agent in the building of the heaps was wanting. This may account in some measure for the absence of heaps in the country traversed from Orlando to Charlotte Harbor, as no shell-fish are attainable in that region.

In all this distance from Orlando to Charlotte Harbor, about 120 miles, I found only one prehistoric mound that I could confidently assert to be of human origin. This was a small *kjökkenmödding* on the west bank of "Stake Ford" prairie, just north of the entrance of the south prong of the Big Choctaw River. It was situated in a grove of live oaks and was small and uninteresting.

On the west bank of Lake Livingston, about 12 miles north of the last-named locality, we found about one-fourth of a mile from the lake what appeared to be an earthwork, about 5 feet high, and perhaps 800 feet long, shaped like a crescent broken in the middle. It was in flat pine woods, the convex side facing the lake, and the interior was at that time a grass pond with three small islets, the water about a foot deep. It is very doubtful whether it is the work of man, but it struck us as singular to find such an embankment in the flat pine woods, whose monotonous level is often unbroken for many miles.

At the town of Myers, on the site of Fort Myers, I found a small sand mound in the western part of the town. Second street is laid out over it.

Captain Peter Nelson, of Myers, told me that a canal existed clear through Pine Island in Charlotte Harbor. This is a long, narrow island about $1\frac{1}{2}$ to 2 miles wide. He said public opinion was divided as to the builders, some attributing it to the mound builders and some to the Spaniards, or early pirates. I was unfortunately unable to visit it. There is quite a large mound below Myers on the same side of the river, about a mile from the town.

In the summer of 1880 I was appointed county surveyor of Brevard County, Florida, and surveyed the south line of the county, starting in near the mouth of the Saint Lucie River, and going west about 22 miles. On the way to the starting-point, at the mouth of the Saint Lucie River I stopped at Fort Capron, opposite Indian River outlet. Here I found a large deposit of oyster-shells resembling a *kjökkenmödding*, but saw no mound. I stopped also at Fort Pierce, about 4 miles south of Fort Capron, and here I found a large sand mound on the west bank of the Indian River or Saint Lucie Sound, and just south of the old fort, the embankments of which are plainly discernible. I stopped also and examined Mount Elithabeth, which is shown on nearly all maps of Florida. I found this to be a large, high, and symmetrical mound of black earth and shells, which would probably be classed as a *kjökkenmödding*. It is an immense work, probably 60 feet high, and with the exception perhaps of Turtle mound, the largest prehistoric monument that I have seen in the State.

I found also, on the north bank of the Saint Lucie River, about 3 miles from the mouth, in a large bay of the river, another immense mound called Mount Pisgah, truly gigantic, and of the same character as Mount Elithabeth. Near its base is the remains of a stone house, built of coquina stone, and believed to be the remains of the abode of some of the pirates that are known to have infested this locality in the early days of the present century. I saw no other mounds on the whole trip.

This completes my present knowledge of the prehistoric remains of Florida. As the object of this paper has been to simply state facts, I will not enter into any lengthy discussion as to the objects or uses of the shell mounds.

Different persons with whom I have conversed in Florida have suggested that some were built for lookouts, others as sites for residences, to enable the dwellers on them to obtain the benefit of the breeze, so desirable in this climate, while others have thought they were used as dwelling-places to avoid the mosquitos, which are so troublesome in the woods near the ground, and others still that they were used as dwelling-places, to enable the occupants to escape the floods which even now in certain seasons often surround their bases during great storms. This last hypothesis receives more credence from the fact that numerous instances have occurred of white settlers resorting to them in such emergencies. It may perhaps be safe to say that incidentally they have served all these purposes. Not a few persons whom I have met contend strongly against this artificial origin, believing them to have been cast up by the sea, but they totally fail to account for the presence of broken pottery and bones which almost invariably forms part of their composition. The great shell banks on Fort George Island, at the mouth of the Saint John's River, have the appearance of oyster banks in which the shellfish were killed by some geological catastrophe, such as elevation above the water, but the remains of man appear distinct, superimposed upon them. This place deserves more careful study. I have endeavored to

fix the location of all the mounds and remains in the State of which I could learn, in the hope that others with more leisure at their disposal and better fitted by anatomical knowledge might be aided in their search by these descriptions. If in this I have succeeded, I shall feel that my labor has not been in vain. There are numerous mounds and shell heaps on the western coast of the State that I have been unable to visit. Many of them will be found described in the recent Reports of the Smithsonian Institution. In regard to the race or tribe who have left these monuments, it appears to me most probable the *kjökkenmöddings* were the work of successive races or generations of Indians, and incidentally formed by the slow process of accumulation naturally coincident to prolonged residence on one particular spot, and the bulky and imperishable nature of the remains of the shell-fish upon which they principally subsisted, this residence being chosen and maintained as most eligible, and in many places the only dry location available throughout the year. These *kjökkenmöddings* are now generally the most desirable places of residence to be found in the adjoining country, and they and the immediate vicinity are commonly occupied by the present settlers. The reason for the formation of the shell heaps is more obscure. Some intelligent persons, however, with whom I have conversed are of the opinion that they both have been modified by the action of water since their formation, the stratified appearance of some of them and their immense extent lending a shadow of plausibility to this supposition. If this should be the case it would define an age for these remains far earlier than has generally been supposed. The general absence of stone or flint implements would seem at first sight to favor this hypothesis and carry the age of these remains back to the earliest advent of man in the Palæolithic age. I think, however, from my somewhat extended observations in this and other States that the theory of a submergence since the original formation of the shell heaps cannot be maintained.

We find the same appearance of stratification in the small shell heaps in Ipswich, Mass., examined and mapped by me in 1873 for the Peabody Museum, which are of comparatively modern date, and it is easy to see that this stratification could have been formed in the gradual accumulation of the heaps, occupied probably, at irregular intervals, by the wandering tribes. It is known that the Ipswich shell heaps have never been covered by flood. In all the remains that I examined in Florida I could find no evidence of a superimposed stratum of material foreign to the heap, except such as resulted from an accumulation of vegetable humus, or was caused by the action of the wind transporting loose sand, and by the action of the river waters at their several stages or such higher stages as periodically occur. I have, then, unhesitatingly assumed the remains to belong to the Neolithic age, and account, in a great measure, for the absence of flint and stone implements by the almost entire absence of material from which to construct them in the regions examined. The natives undoubtedly possessed some of these

things, but they must have been brought from a great distance, and were therefore held in great esteem and corresponding care taken of them. Their tools and weapons were probably mostly of wood, and have, of course, long ago decayed. Very many of the flints found were probably the implements of the later Indian tribes.

Regarding the remains in the Kissimmee Valley and about Lake Okechobee there is little doubt that they were constructed by a race anterior to the Seminoles, and for purposes of worship or war; possibly, also, in some places for internal improvements. These remains deserve careful and systematic search and study. I am informed by Dr. Kenworthy, of Jacksonville, that he has found on the Gulf coast other evidences of attempts at improvements by canals on a large scale.

The amount of pottery that is found in Florida is truly astonishing. In the *kjökkenmöddings* it forms a large percentage of the material. It is found also in the sand mounds, generally in larger pieces, and sometimes in whole vessels. It has never been my fortune, however, to find any of the latter. There is scarcely a hummock or piece of rich arable land which does not yield numerous specimens upon being cleared and dug up. It seems as if the ancient people who used it had an eye to fertility in choosing their residences, and goes to prove that they practiced agriculture. They certainly made a very judicious selection of lands for cultivation, if we are to believe that these places had been in actual cultivation where such broken pottery is found in the soil. It is very seldom that it is found scattered in like manner in the poor, light, sandy soil. *Kjökkenmödding* heaps are found on all kinds of soil, but it is very seldom, in fact never to my knowledge, that the poor, white, sandy soil yields, upon being turned up, any broken pottery, as is the case in the rich lands. *Per contra*, the residence of a large community for a great length of time on poor, white, sandy soil would necessarily enrich the land and give it a darker color; but it would also tend to an increased elevation and so form a *kjökkenmödding*, which simple cultivation would not do. Allowing that these rich fields where broken pottery is found had been under cultivation and been cleared of trees, we must go back for the age of these agricultural operations beyond the age of the trees now growing upon them, which, in many situations that have come under my observation, would exceed four or five hundred years. There are now growing upon these fields dense tropical forests, almost impenetrable jungles, with trees of immense size and age.

It is known that the Seminoles were agriculturists. In the Seminole war our armies found flourishing fields of corn and other crops, and the settlers often point out clearings in hummocks, with the great dead bodies of live oaks girdled and killed many years ago, as old Indian fields. These old giant live-oaks will last two or three generations when girdled and left standing. Broken pottery is also found in these places in profusion, but these fields are but small clearings in immense forests, whose soil, wherever opened, is found filled with pottery.

On Indian River, at the large shell mound situated at the mouth of the Banana River, on the beach, at the foot of the mound, an unfinished arrow-head of flint was found. It is the crudest article of flint manufacture that I have found, but it has evidently been worked by the hand of man. It has been smoothed by the action of the waves. Most of the pottery found is very rough and shows no marks. There is a great difference, however, in the composition of different pieces, some being made of very fine clay, and very compact and smooth, while others are very porous and disintegrating. One piece picked up is extremely hard, almost flinty, with a smooth polish on the inside. It is almost impossible to cut it with a knife. In color, some are black when cut and some light brown. One piece is a bright brick red on the outside third, showing evidently strong action of fire. A large piece, found in the large shell heap at the mouth of the Banana River, previously referred to, has still upon the outside the soot or crock from the fire. This was found buried nearly 8 feet from the top. None of the fragments found appear to contain any pounded shells and very little sand.

I am informed by Mr. White, of Buffalo Bluff, a very intelligent settler, that a large iron ax was found imbedded in the heart of a dead live-oak upon his place, and that this oak had been dead as long as any of the settlers could remember. He also informed me that a stone phallus was found upon his place and is in the possession of a gentleman of Savannah. Dr. Joseph Jones, in *Antiquities of Tennessee*, mentions the occurrence there of similar specimens. At the large shell mound known as the "Wild-Boar Mound," in T. 30 S., R. 38 E., I found a perforated shell similar to the one described by Professor Wyman, on page 58, *Fresh-water Shell Mounds of Florida*, and figured in same Plate VIII, Fig. 2. It is a *Busycon carica*, $4\frac{1}{4}$ inches in length, at present, the beak being chipped and broken off. The hole in my specimen is round or nearly so, about eleven-sixteenths of an inch in diameter, made in the last turn, the nearest part of the circumference being 2 inches from the mouth. The spines are all broken or ground off, and the shell, at the mouth, is chipped. It looks as if it had been used as a mallet by inserting a stick in the hole for a handle.

I am informed by the Hon. Columbus Drew, ex-governor of Florida, that a golden spear-head was found in a mound in Orange County, Florida, along with an oval disk of silver. The spear-head was about $2\frac{1}{4}$ inches in length and $1\frac{1}{2}$ in width in the widest point. He stated that it appeared as if hammered out or formed by a somewhat unskillful workman. Its bullion value, as given by a jeweller, was \$18. No marks of any kind appear on it. This interesting relic is still in his possession. The silver disk found with it appeared to have some marks or scratches upon it, but they could not be deciphered and the governor was not sure that they were intended for anything. This silver disk had unfortunately been cut in two by the ignorant discoverer, and, it is believed, a piece taken out for the purpose of ornamenting the stock of his gun.

It is highly desirable that these interesting relics be analyzed at the mint to discover, if possible, the kind of bullion of which they are made, and in this way show if they were made from Spanish or American coins, by the amount of alloy they contained. If from neither, but if composed of pure gold it would tend to show a much more ancient age for them.

In concluding this imperfect account of the prehistoric remains found in East Florida, it is proper to state that without doubt other mounds and remains exist undiscovered by me in the districts traversed. The almost impassable nature of a great part of the county, owing to the innumerable ponds, sloughs, brooks, and rivers, the cane-brakes, and impenetrable jungles filled with bamboo, grape, and numerous other vines, and tall palmetto, renders travel on foot, or in any conveyance except a boat, almost impossible. The density and luxuriance of the growth of these tropical forests hedges one in with an impenetrable wall, through which a bird can hardly fly, and in which vision is limited to a few feet around the explorer.

Of course, in these places it is only by chance the unguided explorer stumbles upon a mound. I am therefore very greatly indebted to the gentlemen I have named for information and for having left their occupation in many cases to act as guides.

Especially would I mention Mr. James H. Fry, of Pilatka; Frederick Lente, of Lake George; Mr. White, of Buffalo Bluff; Judge Bartlett, of Georgetown; Doctor Kenworthy, of Jacksonville; Mr. Wells, of Nashua; Mr. Scott, of Barker's Landing; Aaron Cleveland, C. E., of Merritt's Island; and Mr. Bradley, of Lake Worth. All evinced great interest in the objects of the expedition.

In summing up the results of the expedition, the paucity of relics will be remarked. It must, however, be remembered that the object was simply a reconnoissance and not a thorough examination. It was my desire to accurately determine and map the locations of as many stations as possible. It should be observed that between a point about 2 miles north of Pilatka and Lake George these remains are exceedingly numerous, a mound or shell heap occurring at about every half mile of the river. This portion of the State seems to have been much more thickly populated than any other examined. This region is a very fertile one, and is now more thickly populated by white settlers than almost any other. The wonderful accounts from the valley of the Kissimmee, and almost equally wonderful from the Ocklawaha, make an exploration or reconnoissance of these regions desirable. The geographical range and distribution of these people will go far towards clearing up the mystery of their origin and disappearance. Florida has undoubtedly in past ages sustained an immense population, and it is appropriate that the ruins of their cities and their imperishable monuments should be preserved, and their locations mapped, as a record of the march of nations.

GOLD, SILVER, AND OTHER ORNAMENTS FOUND IN FLORIDA.

BY J. FRANCIS LE BARON, *U. S. Engineer.*

The articles described in this paper were first brought to the notice of the writer by the Hon. Columbus Drew, sr., of Jacksonville, Fla., in the fall of 1882, who has kindly furnished the following account of the locality where they were found and their surroundings. The pieces belong to his son.

"The gold arrow-head and other pieces were found near the line dividing Polk and Orange Counties, Florida, about the year 1875. They were dug from a small mound in which they lay 3 or 4 feet deep, among many stone battle-clubs and hatchets (weighing altogether, perhaps, 100 or 200 pounds) with clay pots or pot-ware. The clubs and hatchets were given away to different parties soon after the relics were discovered. The remaining half of what seems to have been a triangular silver ornament, to be suspended by the small hole on the top, was cut off by a hunter to ornament his gun with. The half of the scissors was found with the other pieces. I feel quite certain as to the genuineness of the relics and the facts stated about them."

It was found to be impossible to obtain a regular assay of the pieces in Jacksonville. They were, however, referred to two jewelers in the city for examination.

Tests were made by Mr. J. Gumbinger, jeweler, of specimens No. 2 and 3 with acid and touchstone. He reported the spearhead No. 2 to be composed of 14-karat gold, having a bullion value of \$19.04, and the miniature ax No. 3 to be of 20-karat gold and worth \$6.

The other specimens, except the fragment of scissors No. 6, he considered to be silver, except possibly No. 9, which has somewhat the appearance of brittania-ware.

Mr. ——— Crosby, of Greenleaf & Co., jewelers, on the contrary, stated quite positively that Nos. 1, 5, and 9 were lead or pewter. No tests were made of any besides the gold pieces, except with a graver, as neither of the jewelers had proper appliances for testing silver.

My own examinations and conclusions as to the metallic character of the specimens I present in tabular form below :

No.	Metal.	Character.	Troy weight.	Specific gravity.	Remarks.
1	Alloy of silver..	Cast.....	oz. pwt. gr. 1 12 16	10.051	Apparently an alloy of silver or britania-ware.
2	Gold.....	.....	1 14 05	12.439	Dark red gold; apparently alloyed with copper.
3	do.....	Hammered..	0 7 15	14.077	Bright yellow gold.
4	Silver.....	Cast.....	0 2 20	8.500	Undoubtedly silver.
5	Alloy of silver..	do.....	0 7 12	8.574	An alloy of silver or britania; much oxidized fragment of iron.
6	Iron.....	.....	.....	.....	.....
7	Silver.....	Hammered..	0 0 05	.....	Undoubtedly silver.
8	do.....	do.....	0 0 15	.....	Do.
9	Alloy of silver..	Cast.....	0 14 20	9.594	Doubtful silver; probably britania or other alloy.
10	Silver.....	Hammered..	0 0 04	.....	Undoubtedly silver.

The specimens were carefully weighed. The specific gravity was determined by weighing in distilled water at a temperature of 65° Fah. Numbers 7, 8, and 10 are very thin, about the thickness of a wafer. No. 4 is about three one-hundredths of an inch in thickness. No. 1 is about five one-hundredths of an inch thick on the edge and about eight one-hundredths near the middle. The hole in the center has been beveled on one face of the specimen with some sharp cutting tool, the marks of which are discernible. It was evidently first cast, and has been rubbed down on the back, as presented in the drawing and photograph, apparently by the use of sand, the striæ being plainly discernible. The face presented in the photograph does not appear to have been treated in this way, but has the appearance of a casting. It is very much harder than lead, and a fresh cut does not tarnish. It is apparently brittle, having a crack nearly across its face. No. 8 is also cracked in much the same manner, and has no markings. No. 7 is unmarked in any way. No. 10 is pierced with a small hole near one apex, and there are numerous punctures on the edges, which do not, however, pass through. No. 4 is marked on the face with lines which were evidently made with a sharp pointed instrument, like a graver. The back shows the impress of a mold. It is perhaps the most interesting of the collection.

No. 5 is evidently a bullet, much harder than lead, which has been perforated with some sharp pointed tool, making a hole of large diameter at the two ends and smaller in the center, such as would naturally be made by a small penknife. The hole in this and also the two holes in the end of No. 9, are filled with a substance resembling rosin, which gives to the lizard-shaped specimen, No. 9, the effect of two brilliant eyes. This No. 9 has been broken in two places. It has been suggested that this singular shaped specimen served as a spoon or other instrument for eating, an idea suggested by its trough-shaped underside, which resembles a cheese-knife, such as is used by grocers. The material is hard and brittle, and there is a trace of gold in the tail end. Its thickness is eight one-hundredths of an inch in the center, one edge being considerably thicker than the other. This piece resembles the head of a cat-fish. No. 2 is eighteen one-hundredths of an inch thick in the center, and the edges have been rubbed down to about from six one-hundredths to eight-one-hundredths of an inch in thickness. The point is sharp. This is evidently cast, the indentations of a rather smooth mold, such as appears on the surface of smooth castings, being very plain, especially on one side. This appears also to have been rubbed down as with sand and water, and the edges beveled.

No. 3 is about three one-hundredths of an inch thick, somewhat thinner on the edge of the axe, and thicker at the top. It is evidently hammered, and is very smooth. Examining the specimens on the basis of their relative specific gravities, the low values found for the gold specimens is most noticeable. This shows them to be largely alloyed with much lighter metals, such as copper or brass, silver, &c. The alloys of the

silver specimens are shown to be a lighter material than lead, as all the specimens proved to be lighter than silver; cast-silver being 10.474 (Ganat) and cast-lead 11.352 (Ganat). This shows them to be probably alloys of silver and zinc or tin, or both, or possibly nickel. These specimens were all probably used as amulets.

No. 9 has the only totemic resemblance. This may have been intended as an imperfect representation of a cat-fish or a lizard. Nos. 2 and 3 were probably of a class known as "ceremonial weapons," being too small and valuable for actual use in war or the chase, especially No. 3, but were used by the "medicine men" in their ceremonies.

On page 61 of the *Archæological Collections of the United States National Museum* * there is figured (Fig. 224) a copper celt from a mound near Lexington, Ky., which has a resemblance to our No. 3, although more than double the size.

On page 282 of the *Eleventh Annual Report of the Peabody Museum of Archæology and Ethnology of Harvard University*, there is shown (Fig. 6) a round silver ornament, taken from a mummy in the ancient cemetery at the bay of Chacota, Peru, and described by Mr. John H. Blake. This article has a close general resemblance to our No. 1, and is, as described, of the same material, although $1\frac{1}{4}$ inches larger in diameter. Like this specimen, ours is brittle, and the hole in the center is larger, but is countersunk in much the same manner. This Peruvian specimen appears to have been worn as an ornament around the neck. Unlike the Peruvian, ours has no marked indentations on the edge, and, judging from the description, the Peruvian was much thinner.

Discoidal ornaments of shell, stone, etc., are very numerous, and appear to have been universally popular with the aborigines. Many are figured in the volume on *Archæology of Lieutenant Wheeler, United States Engineers, surveys west of the one hundredth meridian*.

Judging of these specimens by their specific gravity, it appears certain that the gold ones at least, cannot have been made from coins unless a large amount of alloy has been added.

On page 298 of the *Annual Report of the Smithsonian Institution for 1877* there is a description by Professor Rau of a gold ornament found in Florida. In his observations on this ornament Professor Rau states that there is no ground for supposing that the Indians north of Mexico possessed the art of casting gold. This would apparently point to Mexico as the probable origin of the gold specimen No. 2, which I think is undoubtedly cast, as I have stated in the table, for we would not suppose the whites to have manufactured a gold ornament of this shape; and, moreover, a close examination of the specimen will show a want of perfect symmetry, indicating it, with still greater probability, to be the work of the aborigines or Aztecs.

* The *Archæological Collection of the United States National Museum*, in charge of the Smithsonian Institution, Washington, D. C. By CHARLES RAU. (No. 257.) *Smithsonian Contributions to Knowledge*, Vol. XXII.

SHELL-HEAPS OF CHARLOTTE HARBOR, FLORIDA.

BY DR. M. H. SIMONS, U. S. N.

Charlotte Harbor, on the Gulf coast of the Florida peninsula, is roughly estimated to be 30 miles long and 8 miles wide. It is separated from the open waters of the Gulf by a series of islands, which the constant surf is steadily washing away throughout their whole extent. Into the northern extremity of the harbor, Pease Creek empties, and near the southern end the Caloosahatchie River.

Charlotte Harbor is divided by Boca Grande Pass, and its channel into a northern and southern portion of nearly equal extent. The northern half has two channels, an outer between Boca Grande and Gasparilla, and an inner between Pease Creek mouth and Boca Grande. Between these are a tongue of the mainland and several small keys. There are several extensive mud-flats, dry at low water, which afford feeding grounds for countless numbers of Grallatores, among which the roseate spoonbills are numerous, and the flamingo is not uncommon. On the tongue of land there are many marshy or swampy spots where *G. wilsonii* abound from December to March. I saw no mounds in the northern half of the harbor. The southern half contains more than sixty-five distinct keys. Pine Key, the largest, is some 12 miles long and 1 mile wide; Bird Key, the smallest, contains less than an acre. There are many reefs and shoals exposed at low water, and just awash at high; but the keys counted are from 4 to 6 feet above tide level naturally in the center, and fringed with a heavy mangrove growth. I have visited twenty-five shell-heaps in this half of the harbor and feel perfectly secure in stating that there are as many more hidden by the mangrove growth on Pine Key and the keys in the inner channel.

In the southern part of the harbor there are also two channels. The inner, or Mattacha, runs between Pine Key and the mainland down to the mouth of the Caloosahatchie, and looks as if it might once have been the bed of Pease Creek; the outer or main channel runs between Pine Key and the outer or barrier keys. On the islands in the Mattacha Channel, and on that side of Pine Key, there are many accumulations of shells, some of large extent and several feet in thickness, but no conical mounds or ridges were seen. There are works of some description, however, on nearly every key in the outer or main channel, and these I shall now describe, beginning near Boca Grande and working south.

On the Gulf side of the outer keys there are no shell heaps, but along the inner channel there are six known to me. Their average height is about 6 feet above mean water, the upper 3 feet of which are of shells and fish-bones; the surface is irregular and varies from one to several acres in extent; they have been cut away extensively by shiftings of the channel. Mondongo Key, about two miles southeast of Boca Grande, is covered to a depth of 6 to 8 feet for half a mile in length and 100

yards in width; below the shells there is probably an equal depth of sand and clay; on its northeastern end there is a conical mound about 10 feet in height, which commands an extensive view.

Southeast of Mondongo is Patricio Key, which has a layer of shells over its surface for half a mile or more, but it is apparently a clay bank fifteen or more feet in height, precipitous on one side and sloping rapidly down to water-level on the other.

Less than a mile south is Useppa Key, whose northern extremity is a mud-bank 6 feet in height topped by shells to an equal amount; this widens out into a plateau about 100 yards wide, sloping to the westward. The island is over half a mile in length, and about half way down from the northern end the plateau forks, the eastern arm forming a ridge about 18 feet high facing the channel, the western forming a narrow flat ridge not over 10 feet high. Between and protected by these there is about an acre which is not over 6 feet above mean water, and at the southern extremity of this there is a space about 20 feet square, which is not over 2 feet above water-level, and was probably used by the Indians, as it is now by the Spanish fisherman, as a location for a well. It is protected east and west by a continuation of the ridge and plateau and on the south by a conical mound 15 feet or so in height. Abreast of this mound a boat channel, which runs down from Pease Creek channel between Pine and Patricio Keys to join the main one, comes close inshore, and probably has always been the landing place, for the ridge, plateau, and mound form a gentle slope to the water's edge; south of this there is another large irregular mound and a high plateau, quite flat, and about 2 acres in extent.

South of Useppa, about 3 miles, is Garden Key, which has a plateau in front rising gradually to an irregular oblong embankment on the north side, and to one of equal height, but greater length, on the south. The latter runs east for about 50 yards, then south about the same distance, and west for a little greater distance. Between the north and south ridges there is a spring hole, or garden, half an acre in extent. Farther back, and protected by the ridges in front and on the sides, is a plateau of shells about an acre in extent and about 8 feet above mean water. South of Garden Key there is a key about 5 acres in extent, which has been raised throughout to a height of 8 or 10 feet.

Due east of Useppa, a little more than a mile, there is a group of mounds and ridges very similar to those on Garden Key, but much greater in extent—a plateau in front, then mounds or ridges flanking a spring-hole. One ridge runs parallel to the present beach but is crossed by another at right angles, the two protecting a plateau several acres in extent. These heaps are on Pine Key, and, from them, straight across the island to Mattacha Channel, there runs a canal or ditch which passes two ponds and another mound in the center of the island. This canal may have been a feeder to the ponds, as described by De Soto, but it also shortened the distance to Mattacha Channel fully 10 miles for canoes.

The shell mounds were formed by piling up the beach sand and then putting the shells on top as they accumulated. They were evidently the accumulations of ages, and were shaped as seen (conical mounds, ridges, and plateaus) to afford protection to the inhabitants during the high waters of hurricanes. In 1870 the water at Punta Rassa stood 8 feet deep over the beach on which the cable station is built. The beach is fully 4 feet above mean tide, so that the water rose 12 feet in less than twenty-four hours. The mounds also make splendid gardens, and, by giving sweep to the wind, afford the best of protection against mosquitoes and flies. The fact that the mounds and ridges do not form an inclosure shows that they were not intended as fortifications; they simply afforded places of safety from the flood and prevented the washing away of gardens and crops by it.

Many of the mounds have large trees growing on them, and the shells and bones in the center have been ground to dust, but others are made of shells, always broken, as hard as if gathered yesterday. There is an old trader among the Florida Indians, settled now at Key West, who told me that the Indians say that their ancestors built the mounds along the coast. He said, moreover, that the Florida Indians exactly resemble physically those of Cuba, but neither look at all like those of Mexico. A Charlotte Harbor settler told me that the present Florida Indians were, until the last few years, in the habit of coming down to the coast every fall and camping on the mounds to fish and to escape the sickly season on the mainland. He further said that these Indians are not Seminoles, but remnants of a tribe which occupied the country before the Seminoles moved down from farther north and conquered them. They are sun worshippers.

I went up the Caloosahatchie River 25 miles, and the Manatee 12, and neither saw nor heard of any fresh-water shell-mounds. There are shell heaps at Manatee and on the east coast at Mosquito Inlet, but they are oblong mounds with flat tops and are solitary. In a small one in Manatee village I was told that human bones were found, and with them some stone implements.

ANTIQUITIES IN WASHINGTON COUNTY, MARYLAND.

BY JOHN P. SMITH, *of Sharpsburg, Md.*

In the vicinity of Sharpsburg there were mounds and earthworks, some of which have been destroyed, and others have been excavated and found to contain numerous archaeological specimens. Tradition informs us that a most bloody affair occurred on the Antietam Creek, near its mouth, which is distant 3 miles south of Sharpsburg, more than a century ago, between those warlike tribes of savages, the Catawbias and Delawares. These tribes, it is said, were engaged in strife when this

section of the country was first known, between 1730 and 1736, and they so continued for a long period subsequent. The evidences of this conflict are still apparent in the skeletons which from time to time are exhumed.

On the farm of Mr. William Hebb, distant 2 miles west of Sharpsburg, and near the Potomac River, vast quantities of arrow-heads, pestles, skinning-knives, and tomahawks of exquisite workmanship have been found. Mr. Hebb, one of the oldest inhabitants, remembers distinctly numerous earth mounds formerly on his farm; but the constant tilling of the land has obliterated all traces of them, so much so that it would be impossible for him to determine their exact location.

On the farm of Mr. Lafayette Miller, distant $1\frac{1}{2}$ miles west of Sharpsburg, and adjoining the lands of Mr. Hebb, an abundance of stone implements have been brought to light. Mr. Miller has a number of them in his cabinet. These implements were found in the fields, and in some places they were particularly numerous. Some curiously wrought stones, perfectly round in shape, varying from 6 inches to 4 and 3 inches in diameter, and about 2 inches in thickness, have been found from time to time on this farm. The stones are perfectly flat on both sides and are polished.

A short distance from this farm, and bordering on the Potomac River, is the farm of Mr. Samuel Beeler. On this farm were two small stone mounds, one of them about 12 feet in length and 6 in width. They were composed of very small stones. One had been opened years ago; the other was excavated by the writer of this paper. The removal of the loose stone revealed a grave, which was very ingeniously constructed. The bottom of the grave was laid with large flat stone; the sides and ends also composed of the same. The covering was of large, flat stones, built in the form of the comb roof of a house. In this mound were found some bones, broken pieces of pottery, and a stone knife, now in the National Museum.

On the farm of the heirs of the late Jacob Miller, 2 miles south of Sharpsburg, on a high bluff bordering on the Potomac River, are two extensive stone mounds, which had been partly explored twenty years ago, and on a recent examination revealed bones, pottery, flints, etc. These mounds, as near as I can judge, were about 12 feet in length and 6 feet in height, and were entirely of stone. The interior was constructed in the same manner as those on the farm of Mr. Beeler above mentioned. The bones in these mounds were so much decayed that they crumbled on being handled. A few years ago some workmen were quarrying limestone near this mound when they came upon a skeleton which was buried in an upright position. At the head was a small vessel of pottery, holding about a quart, which fell to pieces on being handled.

About half a mile from this point, on the farm of Mr. William Blackford, several articles of pottery have been unearthed. Traces of some

earth mounds are still to be seen, and beautifully finished arrow-heads are occasionally found.

On the lands of Mr. James Marker, 3 miles southeast of Sharpsburg, is a cave, which tradition says was used both as a dwelling and as a burial place. This cave is about 20 feet in diameter and 6 feet in height, and contains two rooms. The outer room has been partially explored. The opening to the inner room is so small as to be difficult of access. An examination of the cave last spring disclosed some flat stones, which were removed; and underneath them a large quantity of ashes, burnt bones, bead ornaments, arrow-heads, and flints were encountered. A few years ago a pipe of exquisite workmanship was found in this cave. It is situated on the banks of Antietam Creek, on a rocky bluff, and possesses every advantage for defense, accessibility to water, game, and other means of living. Several years ago a skeleton was found under a ledge of a rock near this place in a good state of preservation. I have also in my possession a pipe found on the banks of the Antietam near this cave.

Numerous changes have taken place in the streams and forests where once roamed the aborigines. The construction of the Chesapeake and Ohio Canal, which borders on the Potomac, destroyed a great many of the mounds and earth-works. Along the canal, at a place called Mercerville, 3 miles north of Sharpsburg, is an old, aboriginal burial ground containing half an acre. Last winter the writer visited this spot and found numerous pieces of pottery, bones, a few ornaments, and several stems of pipes. The bodies were buried about 2 feet below the surface. On an examination of the graves were found ashes and burnt bones, which led to the belief that cremation was practised by these people. Large trees were growing on the spot, which indicates plainly that this was an ancient burial site. The canal passes through a large part of it.

On the farm of Mr. Jacob McQuilkin, near Martinsburg, W. Va., are two large mounds, one of stone, which is about 12 feet in height and 20 feet in diameter; this one had been explored. The other mound is of earth, and is about 6 feet in height and 12 feet in diameter. Several large oak trees are growing in this mound, probably 40 feet in height and 2 feet in diameter. In the mound were found arrow-heads, fragments of pottery, some of which were very beautiful, also bones, and a large pestle formed of sandstone, 18 inches in length. These remains are located on a high cliff overhanging the Potomac River, commanding a fine view of the surrounding country. Around them occur an abundance of broken pottery and flint chippings. In one place twenty arrow-heads, all differently formed, were picked up. There can hardly be a doubt that this point was the lapidary of the aborigines. The arrow-heads found were of different colored stone as well as of different shapes and sizes.

On the farm of Dr. Whiting, in what is commonly known as "Whiting's Neck," a short distance from the farm of Mr. McQuilkin, are sev-

eral large mounds. On the same farm is a large cave, which has been explored about 50 feet; it contains several rooms. In one of the rooms there were discovered bones and some arrow-heads. Tradition informs us that this was one of the dwellings of the aborigines, which seems plausible, from the numerous flint chippings which are scattered around.

On the farm of Mr. B. F. Harrison, adjoining the farm of Mr. McQuilkin, are numerous stone mounds and some earth-works, which have all been opened. These mounds, like all the rest described, are located on the high cliff land overlooking the Potomac River.

The dead were all buried with their heads towards the east, on a high point of land, and, in almost every instance, near a stream of water. Their burial places were in some romantic spot commanding a fine view of the surrounding country. All the mounds excavated by the writer have been found in just such spots.

SHELL HEAPS NEAR PROVINCETOWN, MASS.

BY H. E. CHASE, *of Brookline, Mass.*

In the report of the Smithsonian Institution for 1880, p. 441, it is stated that it is the desire of those engaged in collecting material for publishing a permanent work on archæology to learn the location and characteristics of all shell heaps, mounds, pueblos, etc., in the country.

Thinking it possible that some of the shell heaps which were visited by the author last summer may not be known to these persons, the following description is given of the Indian shell heaps, burying grounds, etc., in a stretch of country about 50 miles long, from Provincetown, Cape Cod, to Hyannis Port.

If attention had been solely given to shell heaps and the collection of Indian implements, no doubt a much better account could be given, for only a small portion of the route lay along the shore where Indian encampments were usually made. On the return from Provincetown, short excursions were made by small boats east and west from Hyannis Port along the southern shore, and later, a trip to Martha's Vineyard, where a few more places were located about Buzzard's Bay station. After leaving Provincetown, in crossing the fields about a mile and a half northwest of the Highland light, in North Truro, a chipped piece of quartz, the size of one's fist, was picked up with a half dozen splinters of the quartz lying near it. These were the first Indian chippings the writer had ever found, but the keeper of the signal station stated that not far from the spot where the chips were found, close by High Head, at the east end of East Harbor, there were large Indian shell heaps.

This spot, mentioned by Thoreau, is well known to collectors, and many implements of stone have been found there. In the railroad cuts,

a short distance south of the North Truro station, there was reported to be an Indian burying ground. These railroad cuts are through little hills of modified drift, close to the shore, near two little ponds, and only a little way from the 113th milestone from Boston. In both these cuts were many traces of Indian settlements, such as broken and unfinished arrow and spear heads, scattered shells, chips of quartz, porphyry cores, and unworked pebbles of the same stone, together with bones, some of which were split lengthwise. The layer of earth in which these occurred varied from 1 to 2½ feet below the surface, the drift containing none except where the bank had washed down and mixed with the lower soil.

Although there were obtained no human bones here, yet the next day, at South Truro, the railroad section man in charge at the time the banks were cut through produced a fine arrow-head, and said that while digging in one place they found the bones of about three Indians, and got one good skull, besides a great number of stone chips and arrow-heads.

The next place where shells and arrow-heads occurred was at Wellfleet, at a cut a little north of the railroad bridge. In the rich black soil, about 6 inches below the upper edge of the cut, on both sides of the track, and in the earth thrown out of a trench in which railroad sleepers were placed on end to prevent snow drifting in, were found at least 2 quarts of stone chips and arrow-heads. With a few hours to give to the search and with one or two shovels to turn over the surface soil, this spot would very likely prove richer in implements than the North Truro locality. The latter place is much better known, and nearly everything has been picked up as fast as it washes out.

A little further on, close by the shore of Wellfleet Harbor, which puts in here, was found an arrow-head that had probably been shot at something, as the point was splintered by a direct blow on the tip.

On the bluffs along Wellfleet Harbor and on the plains at Orleans, off the road which runs south of the Brewster road, many arrow-heads have been found.

In parts of Brewster and on a little island near the source of Red River and upon its banks further down many old camps, arrow-making spots, and shell heaps have also been discovered.

The next day, at Harwich Port, was spent in hunting arrow-heads near the mouth and in the fields about Allen's River. No attempt was made to cross to Trous, the bluffs which lie just across on the west side of the stream, as it was not then known to be a good place for Indian relics. There were found here one hatchet-head, one spear-head, several arrow-heads, a shell heap containing charcoal and bones broken in lengths, besides a few scattered shells near the mouth of the stream. A letter from a person who accompanied this search states that, in the shell heap found that day, he has recently dug up ten more arrow-heads, some pieces of stone pots, and bones that look like deer antlers. He

visited Trouse also and found thirteen arrow-heads, a stone gouge, and a broken pipe. It is probable that Mr. Josiah Paive, of Harwich Port, has the best collection of Indian implements on Cape Cod, as many persons have spoken of his collection.

On the return to Hyannis Port, a methodical search was made for Indian relics in the vicinity of Barnstable and Yarmouth, all along the south shore of the cape, from Centreville River to Bass River. With the addition of a few places learned on the trip to Martha's Vineyard, the following list includes all the places seen this summer, where Indian camps have been pitched: Two railroad cuts at West Truro, described; one place at Wellfleet; at Harwich Port; along Swan Pond River; along Bass River; at Port Gammon; along a stream from mill pond in West Yarmouth; around Hall's Creek, at Squaw Island; at Centreville camp-meeting ground; along Centreville River; around Buttermilk Bay, the head of Buzzard's; on shore, just south of the two stations of Cataumet and Monument.

The west end of Martha's Vineyard proved to be another good field, for, near the base of Prospect Hill, in Chilmark, on the northeast slope, close by a small stream, were found, in a spot where the surface soil had been removed by floods or by the wind, great numbers of stone chippings, cores, and partly finished or broken arrow and spear heads, besides several well-defined circles of stones, blackened on the inside, which had undoubtedly served as fire-places.

Northeast of Menemsha Pond was one scattered shell-heap, and a few stone chips. Proceeding across Menemsha Bight to the Gay Head clay cliffs, Mr. Flanders, the boatman, stated that one day, some years ago, he found over eighty perfect arrow-heads in a bare spot over Squibucket beach, close by the club-house. A boy named Tilton, living near Prospect Hill, showed a collection of over a quart of perfect arrow-heads which he had picked up mostly on the plowed fields.

On Cape Cod shells and black earth seem to be found wherever Indians have halted long or frequently. This layer of black is usually from 6 inches to 1 foot below the surface, but in one or two places it was fully 2 feet deep. Bass River, Centreville River, and Buttermilk Bay have the greatest shell heaps, and seem to have been settlements or regular stopping-places. The shells in the heaps are usually broken fine, and are often spread out thin, although, in one or two places, heaps occur 1 or 2 feet thick, and covering many square yards.

They are mostly quohoags, conchs, winkles, and clams, with very few or no scallops. Camps were almost always within easy reach of shoal salt water furnishing shell-fish, or between a fresh-water pond and the shore, or along the widest portions of the streams. Mixed with the stone chips and shells have never been found any substances of metal, except two small pieces cut in the shape of arrow-heads, which Professor Putnam, of the Peabody Museum, has determined to be of brass. These were found at Centreville and Buttermilk Bay. The fol-

lowing is a list of utensils, &c., that were found on the cape, either by the writer, or by his friends; arrow-heads and spear-heads; quiver and arrows that crumbled on exposure; axes, hatchets, and tomahawks of stone; leaf-shaped implements and skin scrapers; needles; graphite for marking; stone pestles and mortars; sinkers; stone-borers, gouges, and sharpening stones; stone pipes and pipe-stem (or bead); stone knives, broken stone pots of steatite and pots of clay; a sort of copper or brass breastplate, found on Captain Crawford's farm (Centreville), buried with a skeleton.

At Bass River, where the arrows were found in the quiver, while sinking a barrel-well, a man found Indian skeletons in two places, buried in a sitting or crouching position. With one of these were buried a stone knife, a spear-point, and arrows, which afterwards were purchased by a storekeeper of the place for a trifling sum. The position of these buried Indians is the same as that of others described as found on Cape Cod, Nantucket, and at Mattapoissett, and it seems to have been the general method before the whites came to these places. The skull of an Indian girl, probably sixteen to twenty years old, in the opinion of Professor Putnam, was given to us by some one who found it buried in a lying position, in an Indian burying-ground at Chilmark. The position, and presence of nails, very much decayed, but suggestive of a coffin, lead to the supposition that the burial must have taken place after the coming of the whites.

At Mashpee and Gay Head are to be seen the mixed descendants of the Indians, but here you can seldom see a strongly Indian face, for the negro features predominate, and many of the men when warmed up by whisky will break out into a real plantation song, thus showing a talent which their red ancestors are said never to have possessed.

The "History of Massachusetts" by John Warner Barber, contains more information about Indians on Cape Cod and Martha's Vineyard than is to be found in any other book, and a reference to it may be useful in determining the distribution of Indians in these places after settlement by the whites.

REPORT ON EXPLORATIONS IN CENTRAL AMERICA, IN 1881.

BY DR. J. F. BRANSFORD, U. S. N.

VISIT TO COPAN.

SIR: I have the honor to make the following report of work done in Central America in 1881, in obedience to my instructions; first, to determine whether the Rio Copan could be used in the transportation of the monoliths from the ruins of Copan; second, to find if possible the source of the jadeite of Costa Rica.

Sailing from New York on December 24, 1881, I arrived at Aspinwall January 1, and San José, Guatemala, on the 8th. Next day the trip was made by rail from San José to Escuintla. The road runs through low land, almost perfectly level, for 18 miles, then rises by rather a sharp grade some 8 or 10 miles more to Escuintla. This town is about the same distance from the sea as Santa Lucia de Cotzumalquapa, just where the foot-hills begin, and the whole of this piedmont belt seems to be rich in antiquities. The ancient inhabitants of Central America were apparently fond of good scenery, especially when there might at the same time be enjoyed the advantages of a fertile soil. And these two conditions are nowhere more happily combined than in the foot-hills of the Pacific slope of Guatemala. From every coigne of vantage the eye may glance over the rich forests to the placid waters of the Pacific, while on the other hand the hills slope up towards the superb volcanoes de Agua and Fuego, which seem facing each other, each grand monarch mountain followed by a long line of retainers.

The soil, which is extremely rich, is, in the neighborhood of Escuintla, devoted principally to sugar, the coffee plantations appearing at a greater elevation. The road from Escuintla to Palen, always rising, winds its way among these plantations, at every turn unfolding a new beauty in landscape. At one point we were on the edge of a cliff, deep down below in a ravine—a sort of Watkins Glen on a grand scale—the river from Lake Amatitlan rushed and tumbled. It was near sunset, the light green of the fields of sugar-cane in the foreground were given fine effect by the dark forest beyond. The tops of the volcanoes were clear cut, but lower; ghost-like white clouds in silent succession loomed, and breaking away floated off seaward. Some fires had been burning in the lowland woods all day, and the smoke-laden atmosphere took on purple tints as the red sun slowly sank in the Pacific.

The volcan de Fuego, which was in active eruption in 1880, is rugged toward the peak, with ravines and patches of bare rock. The volcan

de Agua is apparently wooded to the summit. The latter is easy of ascent; the former very difficult; but while I was in the country it was ascended by an English gentleman, Mr. Alfred P. Maudsley.

The valley of Amatitlan, between Palen and Guatemala City, is a garden spot of exquisite beauty. Beyond that another long hill took us up to the table-land of Guatemala, a parched and windy plateau, uninteresting, at least during the dry season, except for the mountains in the distance. One day had changed the climate from tropical to temperate. The direct rays of the sun were hot, but at night, or in the shade during the day, the temperature was cool and bracing.

The old village of Mixco was in sight before we reached the city; and on the left of the road, just before entering the gate, we found the plain covered with mounds for a square mile or more. One learned writer on Guatemala has described these as ant-hills.

On my presentation by the American minister to President Barrios, I was kindly received and promptly furnished with letters to the officials along the route of travel to Copan. These letters were signed by the President, and secured me every assistance possible on the trip. Under the strong administration of Barrios I journeyed in perfect security along the road where annoyance and danger so beset Mr. Stephens in the olden time.

On the 18th of January I left Guatemala for Copan at midday with an *arriero*, and rode as far as San José, on the Zacapa road. The way was through a barren hill country, some 5,000 feet above the sea. Evergreen scrub-oaks and pines were the predominating trees. The geological formation was volcanic, with tufa and lava showing in the cuts. Just before reaching the stream at Navajo, 3 miles short of San José, a vein of obsidian was seen crossing the road-bed, and the sharp-edged fragments of the bright and cutting *iztli* scattered around doubtless gave its name to the neighboring village. The road up the steep hill beyond was paved with blocks of stone, probably the work of colonial times. At several points along the road are standing in good preservation staunch monuments of Spanish work in the shape of stone bridges, high over ravines whose insignificant streams suggest no idea of the furious torrents of the wet season.

Mr. Stephens* gives a beautiful description of the park-like appearance of the environs of San José. Alas, the glory has departed, and left rather barren-looking hills surrounding a wretched hamlet, whose inhabitants live on the travelling public and the trains of mules and muleteers. I dismounted at the door of mine inn, every bone racking with fever, tumbled into a hammock, and took a drink of brandy and twenty grains of quinine. Two stalwart and rather fine-looking young ladies kept the establishment, but one was married and the other was pock-marked. Later a young bride and groom stretched their bed, consisting of a raw-hide, on the ground. The dogs and hogs shoved

* I. L. Stephens: Incidents of Travel in Central America, Chiapas, and Yucatan.

my hammock from side to side in querulous search for a comfortable resting-place, finally leaving me to the fever and the fleas.

At 5 o'clock next morning we sallied out on a most pleasant road, following the crest of a ridge with valleys falling away on either side. Near the road the *milpas* or patches of Indian corn flourished. Far away on the right were the mountains toward Honduras, and on the left beyond the valley of the Motagua rose the giant range of the Vera Paz. About 8 miles from San José we came to the edge of the plateau, and descended by a zigzag trail, among masses of limestone and blocks from the overlying basalt, to a tributary of the Motagua. Beyond this *Puente del Monte* for many miles the hills were barren. Then the desolation was varied by valleys at intervals, each with its small and miserable village. At one of these we stopped and had a good breakfast of corn-cakes (*tortillas*), beans, and eggs. After breakfast took a lazy swing in a hammock until 12 M., and then five hours to Guastatoya, where Mr. Stephens had his first experience in robber hunting. That night brought the luxury of a raw-hide bed, until 4 A. M., when we started again. About 2 miles more and we descended into the *callejou* of Guastatoya, a pass for 5 miles through a dismal gorge with steep hills or ravines on each side, where in the olden time the robber could attack with impunity and retreat with security, laughing at any attempted pursuit. It is when riding along such a road in the hour before daybreak, with an old *arriero* who at each dark thicket, or sharp turn, or silent cross, recalls a deed of blood enacted here in other days, that one feels inclined to pardon certain little irregularities so long as a strong government keeps its hand at the throat of the robber.

At half past 9 we reached Casaguastlan, and, riding up to the best-looking house in the village, were politely received by a *mestizo* lady. A few minutes later, hearing the appellation doctor from my *arriero*, she marched me right in to see her *hidalgo* who was suffering with liver and spleen. Result, a superb breakfast of beans, eggs, chicken, rice, and *tortillas*.

At dark we entered the miserable village of Eiole, and were directed to a stopping-place where, in answer to inquiries, we were assured that there was no bed, no supper, no feed for the mules, but there was a shed where my hammock might be swung among pigs and dogs and squalling brats. The *arriero* then started out to find a bundle of fodder at one house, an egg at another, and, strange to say, some coffee at a third. Before day next morning a girl started a fire and made coffee. Her beau crawled out from somewhere looking disgusted and miserable, and stood around rubbing his eyes to see that there was no flirting with the stranger.

At 9.30 a. m. on this the 21st of January we arrived at Zacapa. The road during the morning had been along the valley of the Motagua, past more frequent and larger villages. Just before entering the town we crossed the Rio Zacapa, a stream of interest to me, as it has the Rio

Copan for a tributary. The river at that time was some 40 yards wide and 6 inches deep, where it goes in rapids over a bar at the ford. Above and below, the width and depth are greater. After passing some strong rapids it empties into the Motagua, about 3 miles lower. Some 10 or 12 miles from Zacapa, Gualan is situated on the Motagua, at the head of navigation for boats of large size.

At Zacapa I was kindly received by Mr. Thomas Payne, an English merchant, who assisted me in securing mules and a guide for Copan. We started early next morning and kept up the river, leaving the road to Chiquimula, and following a trail which gradually ascended some 1,500 feet to a peak overlooking the valley of Zacapa on one hand, and on the other giving a fine view of the more distant Chiquimula. At the foot of this hill, toward the latter town, was the junction of the rivers Chiquimula and Jocotan, forming the Rio Zacapa. Turning and following the ridge in a northeasterly direction for awhile we changed our course again, and, descending, came to the bank of the Rio Jocotan at the foot of the rapids opposite the Peligro Negro. The latter, a cliff, is the end of the mountain which separates the valleys of Jocotan and Chiquimula. It is a sheer wall of rock between 2,000 and 3,000 feet high, and well deserves the name Black Danger. At this point my hope of utilizing the river for transportation of the Copan statues was at once dispelled. For 2 miles it rushes through a narrow and tortuous channel which it has cut in the rock, and the lightest canoe could not have passed at the time of my visit.

It is reported that occasionally during the wet season canoes pass successfully, but I doubt whether even then they can make the passage loaded. The rugged character of the hills forces the trail down to the bank here, and we had to follow the river some 4 or 5 miles until clear of the pass, then began to ascend again. These old Indian trails were famous for following the crest of the ridge, and frequently there was barely room for our sure-footed mules, the ground sometimes falling away abruptly on both sides. At midday we were well above the clouds. At lower points the gusts of wind would occasionally bring up a light cloud, and for a few minutes we would be enveloped in fog and misty rain. We were some 5,000 feet above the village and valley of Jocotan on the opposite side of the river. From that point of view it was the loveliest valley I had ever seen—a garden of *milpas* or patches of Indian corn and sugar-cane, and in some places coffee, on the hills. Cultivated land could be seen to the very mountain top wherever a bit of ground had been found not too steep for an Indian to stand on. This region gets much of the moisture borne on the winds which are turned away from Zacapa by the mountains northeast of that town. During the dry season the people of Zacapa, stifling in heat and dust, can look up and see the crest of the ridge veiled in mist, while cool showers occasionally come part of the way down the hills and then fade away in the face of the brazen valley.

On the hills we were crossing there were scattered superb, tall pines, apparently the yellow pine of the United States, and a great portion of the land was clothed in fine grass, which was supporting good cattle. Winding our way down again we came, at dusk, to a village of ten or fifteen houses perched half way up the mountain-side and rejoicing in the name of Mataxano. An Indian dialect was spoken by the inhabitants, but a man was found who understood Spanish. After visiting half the houses and considerable negotiation permission was obtained to swing my hammock under a shed, where I shivered in the raw, north-east wind all night. We had three eggs and a *tortilla* for supper and the same for breakfast next morning. Early in the morning we descended by a steep and dangerous trail to the river at the pass between Jocotan and Copan. Here again was a wild rush of water for 2 or 3 miles through a narrow and tortuous channel with immense boulders strewn along its course. The river, here known as the Copan, flows through a narrow valley of more fertile land. Vegetation was richer; in some places irrigation was practised, and some fine cattle were noticed. In the afternoon we crossed a slight ridge clothed in pines and descended to the village of Copan.

The night was spent in the village, and next morning, January 24, the ruins one mile east were visited. My instructions to determine whether the Copan River could be used for transportation had been carried out, and then it was my duty to return to San José and catch the steamer of the 4th of February for Costa Rica, if possible. I therefore concluded to spend only one day here walking around the ruins, and by an occasional critical comparison of some object with the representation given in incidents of travel in Central America, Chiapas, and Yucatan, testing the work done by Stephens and Catherwood.

Along the road from the village to the ruins, antiquities are scattered and the dense forest on either side is without doubt the keeper of great archæological treasure. Once at the village of Copan any native will give the locality of the ruins, and once there, no guide is needed but Stephens. The thoroughness of the work done by Stephens and Catherwood has been confirmed by subsequent visitors and is a lasting rebuke to the imperfect methods of most investigators. There is one curious mistake, made, probably in copying notes—Stephens' plan of the ruins is turned around, and the north side is marked south. With the exception of these two errors the work of description and illustration is admirable.

Passing the statue O we struck the temple at the northwest corner. Where we ascended, near D, the steps were 16 inches high and 17 wide, in blocks of stone. We descended into the court at U. In the northwest corner were two vases in the shape of human heads, ornamented fantastically, and with bowls 9 inches in diameter and 6 inches deep. These are probably the heads which Stephens says were turned over and partially buried. The colossal head, figured on page 143, was in the

same position leaning against a tree, and after thirty-two years there was very little change in the relative size of tree and head. After examining the *ventana* and ascending the wall overlooking the river, we pursued the passage V and returned by A. The drawing of the altar is excellent. I made a close examination of the hieroglyph in the upper right-hand corner of the side represented at page 141, and found the drawing exact except that there are thirteen knobs instead of the twelve given by Catherwood. Again, the characteristic prominence of the glabella, whence the nose and forehead sloped, forming an obtuse angle, is not sufficiently marked in the drawings. In other instances the minor details were hardly worked out with sufficient minuteness, a defect which was probably unavoidable in dealing with such a mass of minute and intricate ornamentation. The bold freedom of the sculpture is its most striking feature, and in some cases the undercutting leaves the ornamentation free, and several inches from the mass. The legs of some of the large figures are nearly free. I was prepared to see good work because of my faith in Stephens, but the boldness of it was beyond my expectation, and had to be seen to be appreciated. The figures in some places had been mutilated. The lip of that shown on page 136 had been broken and the chin broken off. The face looks out from a snake's mouth. About 60 feet northwest of B was the head of a large serpent, lying with other fragments at the foot of the slanting wall. In front of it, lying on the ground, was a tablet in four sections. The figure on it is looking over the right shoulder towards the head of the serpent. In the right hand is something spherical, possibly a head, which is apparently offered to the serpent. There were two other tablets similar to this, the three with the serpent head forming a square. The figure on the tablet is seated cross-legged, with a plumed turban, a mask, a necklace suspending a gorget, and a belt fastened in front with a circular gorget.

The statue C is 12 feet high, 4 across the front and 3 feet thick. Back of E, half way up the side of the pyramid—if it may so be called—the stones were in position and cut to form a smooth incline, the surface of which is covered with hieroglyphs.

We readily found all the large statues mentioned by Stephens except that at S, shown opposite page 151. In 1839 it was buried nearly out of sight, and I had no time to make a thorough search. In the deep cuttings on some of the statues were still remains of red paint. This was in positions protected from sun and rain, and in such a climate will probably last indefinitely.

About a mile west of the temple, in the village of Copan, is a mound some 40 feet high, at the west base of which are two altars with glyphs, &c. One of them has figures similar to those on the altar at A. On the south side is a double row of glyphs in the middle, with two human figures on each side facing in. On both east and west sides are four figures in profile sitting cross-legged and facing south, apparently

followers of those first described. The north side has a perpendicular row of glyphs, on each side of which is one figure sitting facing in and offering something having the appearance of a head, just as on the tablets in front of the serpent's head at the temple. These figures had the characteristic large noses and retreating foreheads, with prominent glabellæ. Their ornaments are necklaces, cuff-like bracelets and anklets, and profuse plumes in the turban-like headdresses. Those on the sides have each in his hand something like a sheaf of wheat. On the top of the altar are other figures and hieroglyphs.

The ruins were visited by Mr. Alfred P. Maudsley in 1881. After photographing many of the objects, he testified to the excellence of the work of Stephens and Catherwood. I am sure that work will not be improved on until a party with apparatus for photographing and taking casts goes there to stay at least two months. Such a party, by intelligent exploration of the neighboring forest as well as the ground already known, might secure an enormous amount of material in a shape to be forever safe. If the hieroglyphs of Central America are ever to be deciphered it is of the utmost importance that every available specimen should be photographed and cast before the hand of ignorance or time renders their correct representation impossible. Here are the walls of a pyramid covered with inscriptions, altars, and statues with human figures and hieroglyphs, illustration and text, and the study of the one must assist in unraveling the mysteries of the other. Some of the monoliths have fallen in the last thirty years; others have been mutilated by the ignorant native, who, with a careless swing of his *machete*, knocks the nose off a statue to see if it breaks easily.

The road can be made sufficiently good for carts to Jocotán, thence to Chiquimula, Zacapa, and Gualan. At the last place we meet large *bonyos* and transportation to the sea.

According to Mr. McGee, of San José, who has been for years engaged in hauling in this country, a cart will carry one ton, a wagon two. Therefore one of the large statues 12 by 4 by 3 feet cut into two pieces might be transported on wagons, and cut into four, on carts. Two of the finest statues are fallen, one of which is broken just in half.

From Copan to Izabal \$3 is the hire of a pack-mule carrying 200 pounds. From Izabal there is a small steamer which connects with the New Orleans line at Livingstone. Again, at less expense the objects might be transported by pack-mules to Gualan, and there embarked for the sea. Thus might be removed a large number of small objects, blocks on which are hieroglyphs, &c.

By using some discretion a camp might be selected near Copan, where a party could safely, if not comfortably, spend the months of February, March, and April.

The land in the valley seemed fertile, and a field of fine tobacco extended up to the west wall of the temple. Fruit was scarce, and pines grew close down to the valley. The last night of my stay I awoke in

the wee small hours, chilled through. The northeast wind bore a cold mist, almost a drizzling rain. After dressing I wrapped myself in a blanket and again turned into my thick canvas hammock, only to shiver until daybreak. We left Copan early, and ascending the ridge, looked back to see the valley a lake of fog, above the surface of which the temple and the mound in the village rose like islands. This ridge is of the same rock as the statues, a soft, whitish trachyte, which hardens on exposure to air and sun. It may have been worked easily with flint implements.

After passing the Honduras line we left the valley, and turned to the right, ascending by a zig-zag trail. Near the crest of the ridge we struck the road, so-called, between Jocotan and Gualan, and kept it through the pass and down the other side. The pines on the south side became more lofty and scattered until near the top they were almost as thin as on a lawn, the shade not being dense enough to interfere with a rich growth of grass. Suddenly this vegetation gave way to dense forest matted with creepers. In place of the pines were innumerable varieties of tropical and semi-tropical trees, their leaves dripping with water from the mist. The road was miry, and the banks were graced with ferns. We had crossed the crest, and were seeing the effects of the moisture-laden northeast "trades."

Along the road at short intervals we met parties of Indians carrying heavy loads of corn or other merchandise on their backs, with hands across their foreheads, the loads resting on their hips. Down hill or on the level they go in a shambling trot, and make better time over the mountain roads than the mules do. Over a great part of the republic the mail is carried by Indians on foot. I was assured that by following more difficult but shorter trails, they made the trip from Copan to Zacapa in a day. It took me a day and a half and Mr. Stephens three and a half.

About 10 o'clock the morning after leaving Copan we reached the crest of the ridge east of Zacapa. As usual it was enveloped in thick mist, almost a rain. The trees were giant pines, draped in gray moss, and ferns were abundant. Descending a little we came to the lower edge of the canopy of mist, and looking out from under this curtain, we had the valleys of the Motagua and Zacapa in full view. Beyond was the great range of the Vera Paz in blue with strata of white clouds along the sides. Around us, all save the moss was green, and the ferns were dripping with moisture, while we looked through the vistas of the pines, with their festoons and streamers, at the scorched and glittering valley below. We were standing under the edge of the clouds, and less than 5 miles away the vegetation was parched and the leaves were gray with dust.

I was in the City of Guatemala on the evening of the 29th, and spent next day there. The collection of antiquities in the Museo Nacional was insignificant. I noticed the two tripods of the Luna ware described

in Archæological Researches in Nicaragua;* there was no indication of their origin.

Mr. Edwin Rockstroh, professor in the Institute Nacional, was working in Indian philology with Berendt at the time of his death, and is prosecuting studies from which much may be expected by anthropologists. In 1881 he made a trip through the Peten and into the hitherto unexplored country of the Lacandones. He found them speaking a dialect of the Maya, and his Maya interpreter from Peten had no difficulty in understanding their language. Mr. Rockstroh discovered some ruins which he called Menché, which were afterward visited by Mr. Maudsley. M. Charnay found the latter there. The ecstatic Frenchman was in raptures, and dubbed poor Menché "Lorillard City."

Mr. Rockstroh told me the Lacandones, or rather more than half of them, had the peculiar profile of Copan and Palenque—large nose, prominent glabella, and retreating forehead. This gentleman presented for the Smithsonian a fine specimen of *pavo real*, whose habitat he informed me is between the Motagua and Zucatan, in the Vera Paz and Peten.

The afternoon of February 1 I rode 30 miles, from the Escuintla to the princely estate of Don Manuel Herrera, Pantaleone, and next morning, in company with my host, proceeded some 3 miles farther, to Santa Lucia. It is northwest of Escuintla, about the same distance from the sea, and in a region of similar topography. We found that the best of the objects mentioned by Habel had been removed to Berlin. Still several remained on and around a low mound. At one point were yet to be seen, *in situ*, blocks of stone forming steps up the side of the mound. These were 6 inches high and 18 inches wide. Most of the sculptures were in hard black lava. No. 9† was in granite, as were two or three blocks in the steps. I was informed that there was no granitic formation in this neighborhood.

The drawings of Habel were found to be good representations of the objects remaining. The drawing of No. 7 was excellent. Nos. 10 and 11 were good; 16 and 17 well drawn, except that details were not sufficiently worked out. No. 18 was not well drawn. These sculptures are in very low relief.

Returning to Pantaleone, I examined the figures which are mounted on the wall around the fountain. Facing the house on the opposite side of the fountain is one in hard, black basalt, 50 inches high, 43 inches wide, and 9 thick. It is a head with turban and plumes, the whole overtopped by a crest, which arches over to the front and ends in a fringe of tassels. There were large earrings; a gorget was suspended under the chin by a necklace. A fillet was on the brow at the edge of the turban. On the turban was a ribbon knotted in front, and above this a mask or ornament in shape of a face. Above were broad

*Archæological Researches in Nicaragua; Smithsonian Contributions to Knowledge, No. 383, page 20.

† Habel.

plumes, which looked like leaves. The face was the best work of art that I have seen by the ancient Americans, nor have I met with any specimen represented in the books to equal it. There was nothing conventional; the features were regular and well cut; the expression grave, dignified, regal.

One of the figures on the left had the beardlike ornament discussed by Habel.* It seemed not a beard, but a strap passed under the chin to hold on the head-dress. Next was the head of a woman, with the eyeball hanging out of the socket on the cheek. The forehead was wrinkled and the face expressed acute pain. Next a man with both eyes hanging out. Here the expression was of sadness mixed with pain, as of one recently blind. Each face was distinctively individual, but all with high cheek bones, wrinkled brow, and stern expression. The woman had a small cap on one side of the head; the men wore turbans. They all originally had trunnions behind the neck for insertion into a wall. They were found by the *mayor domo* in some of his agricultural operations.

As remarked before, this belt of territory, at the foot of the western slope of the Guatemala Mountains, is extremely fertile; is almost covered with forest, and the objects at Santa Lucia, Pantaleone, and many other places reported near Escuintla indicate a rich field, awaiting the investigations of the archæologist.

The day after my arrival in Guatemala, Colonel Stewart, the American consul, presented some specimens of pottery, which were obtained from a mound about a mile and a half from San José, that was cut by the railroad. The specimens consist of No. 59380, a vase nearly complete, and the fragments numbered 59381, 59382, 59383, 59384, 59385, 59386, 59387. There is similarity in the biscuit and the degree of burning of the objects, and in certain features of ornamentation. The vase is 12 inches high and 13 across the top. The bowl only occupies about two-thirds of its depth. On each side is an ear, or handle, on the lower part of which is a button or flower-like form with a depression in the center. On the front of the vase is a rosette or bow in relief, the ends of which are free. This also has the button, the central depression in this case being filled by a flattened ball. The color is buff, with red bands and circles, and on each side is a crescent in red.

No. 59382 is a head, originally an ornament on a large vessel. The collector probably broke this off and saved it as curious. The face is of the type of many of the pottery figures here in the collection from Mexico. The head-dress is a coronet, with plumes above; the earrings of a flower form, shaped like the curved corolla of certain lilies; a banded necklace suspending a flower-shaped gorget, and an ornament suspended in the nose or upper lip graced this belle. The fragments are ornaments, probably of the same vessel; they are evidently representations of flowers.

The discovery of this Mexican pottery makes one more link in the cor-

* Habel.

roborative evidence furnished by archæology in support of the traditions of a migration along this coast from the valley of Mexico toward Nicaragua—a migration which was so clearly traced by Dr. C. H. Berendt in his philological investigations.

VISIT TO COSTA RICA.

We reached Punta Arenas, Costa Rica, February 16, and on the morning of the 19th embarked on a steam-launch bound up the Gulf of Nicoya. We got to the head of the gulf at 3 p. m., and our destination, Bolson, at 6.30 p. m. This place, the port of Santa Cruz, is on a creek which empties into the Tempisque. The little steamer arrived at high tide, and had a comfortable bed of mud in which to lie while waiting for the next rise.

From Bolson, with a man and three horses, the journey to Nicoya was made in seven hours. Found it the same dead Spanish town seen in 1877. A long church at one side of the *plaza* and rectangular streets, with eight or nine hundred inhabitants of all grades, from the pure Spaniard to the pure Indian. It is a fertile valley, with hills 500 to 800 feet high around it. Here was one of the most important towns found in Central America by the conquerors, and if we may judge by the relics with which the ground is sown in every direction we are inclined to credit the stories related by the old chroniclers of dense masses of population that owed allegiance to the cazique of Nicoya.

Riding up to the house at which I stopped in 1877, everything seemed as though I had left it but yesterday. The same old blacksmith-shop, and apparently the same old gray horse waiting to be shod. I had the good fortune to secure a room and a raw-hide bed, and madame engaged to feed me. Hernandez reports that no strangers have been here hunting for antiquities since my visit. And as the neighbors drop in one by one I have accounts of *huacas* enough to keep me at work for years. At Bolson similar reports were made, and subsequent investigations proved that there was no exaggeration in the accounts.

After two days spent in looking around and settling down, I rode with the padre, the alcalde, and jefe politico to some *huacas* at Pipal and Ochote, some 4 or 5 miles from Nicoya. There were several slightly raised mounds of loose stones, below which were the relics in shape of human bones, shards, and celts. The padre had made excavations in one or two places, but had not met with conspicuous success in obtaining entire vessels. The ground was of tough clay, and during the dry season was almost like brick; it was, therefore, rare luck for an object to escape the violence of the blows necessary in digging.

That night, headache and fever; next day, quinine and rest.

The 27th, with the padre and jefe, rode to Las Huacas, where rich fields were reported. The road lay along the valley as far as Matina, whence it began to rise, crossing one or two slight ridges and finally mounting by a steep zigzag some 2,000 feet to the plateau of Las

Huacas. From near Matina to and beyond Las Huacas are cuts and other remains of an old road supposed to antedate the conquest. Along its route cane and *pita* grows, marking its trail through forests, up and down hill, in straight lines, instead of the zigzag for easier grades, as would have been the case with Spanish roads. This road was like those in the mountains of Guatemala in their propensity to follow the crest of the ridge.

The next morning three men were set to work excavating at a point on the road to Matina, about 200 yards from the house of Angela Carrillo, where irregular piles of stones, forming elevations of 2 feet in height indicated *huacas*. Near the surface there were many fragments of *metates* of great variety and rollers. At this point hundreds of *metates* appeared to have been broken, and it seemed incredible that they should have been the results of accidental breakage, but rather as if in time of war sudden flight had become necessary and articles too heavy for easy transportation had here been rendered unfit for the enemy's use. Near the surface, and mixed with the stones, were fragments of the class attributed to the Chorategas in a paper on Nicaragua.* Lower were fragments of red painted pottery. At 51 inches depth the handsome argillite gorget No. 59849 was found, in the mouth of a red vase, No. 59811. The body of the vase was in fragments; it was apparently a water jar. The end of the gorget showed above the mouth. About 2 feet away and 19 inches lower was found No. 59850, which unfortunately was badly broken by the Macana. On a level with that and within 2 feet was the celt No. —. The small vessels Nos. 59827, 59828, 59829 were found in the earth above the gorgets, and were probably associated with them in origin.

Among a great number of shards there were none of Luna ware.†

About a mile from Carrillo's, near the house of Mayorga, were many large huacas on the border of the old roadway.

That evening we returned to Nicoya, and the next few days were spent in hunting and interviewing old Indians, always with eyes and ears open for the green stone mine. There was an old man named Espiritu, living near Nicoya, of much shrewdness and native intellect. He took a great deal of interest in antiquities and questions concerning the old Indians. He reported that many of the old graves were seven or eight *varas* deep. A Frenchman who had spent several years in Chiriqui told me that the *huacas* were similar to those observed near Nicoya. Of course, the only possible way of discovering the source of the jadeite was by searching the ravines and cuts while hunting or riding, or by questioning the old Indian hunters and rubber-men. Many of these men become interested in what they saw I considered so important, and some later traveler may reap the reward in finding a guide to the jadeite mine.

*Archæological Researches in Nicaragua, Smithsonian Contributions to Knowledge, No. 383, p. 80.

†Archæological Researches in Nicaragua, p. 80.

The padre and I made a trip to Santa Cruz on the 3d of March, returning next day. We heard great accounts of antiquities on the Pacific coast, and one small figure No. — was obtained by purchase. One of the men who worked for me at Las Huacas brought Nos. — —, which he reported that he obtained working at the same place. Nos. — — were lying together beside a skull, and were, presumably, worn as a necklace.

With a party of about a dozen men the padre and I left Nicoya on the morning of the 6th, and following the road to Matina for awhile, turned to the right to Matambu, thence over a ridge into the valley of the Nosara, and camped on that stream at a place called Las Canillas, about a mile beyond the *castia* of Blas Lopez. This man Lopez had a great reputation for knowledge of the antiquities of the region, but was a very suspicious and surly Indian, and managed to keep to himself all that he knew of the *huacas*. Close by a mango tree, near our camp, some partial excavations had been made, and in one of them we commenced work. The first plateau, above the low grounds of the river, was some 25 feet above low water. In the edge of this the burials had been made, and the top of the grave covered to a depth of 3 feet with stones from the river-bed, the pile forming a slight mound now, after ages of settling, about 2 feet above the surface of the plateau. These resembled some graves seen on the Madera end of Ometepec.* The clay here was tough, but not so hard as at Las Huacas, as it contained more vegetable matter and was protected in the shade of the forest. In the surface soil and among the stones were fragments of pottery. Celt No. 59875 was 3 feet below the top of the mound, with the little vessel, No. 59883, near it. In a neighboring excavation was found a human skeleton and a celt, No. 59880. A mound larger than the others was some distance back of the edge of the plateau.

Discouraged by such poor results for two days of work, we transferred our camp some 3 miles further up the stream. Here in a higher plateau on the left side of the river similar piles of stones, hardly deserving the name of mounds, were seen on all sides. We were in the finest forest I had ever seen. Apparently not one of the magnificent trees in this valley had been cut since the conquest, except where for an acre or so in two places clearings had been made. The undergrowth was scanty, while high overhead there was a dense canopy supported by superb columns. The rays of the sun touched the ground at rare intervals, while at night a star here and there peeped through the foliage. Along the river innumerable frogs made night hideous with their croaking. Then owls and many night-birds of discordant note, reenforcing the howling monkeys, joined forces in the early night to convince the trembling greenhorn that all the ferocious beasts of the earth were assembled to sup on him. The mosquitoes, which were vicious the first two hours, suddenly disappeared, and the forest quieted down. The

*Archæological Researches in Nicaragua, p. 44.

padre led off, and was followed by first one Indian and then another, with *cuentas* tales, after the style of those of the Arabian Nights, to amuse children. Wrapped in their blankets, one by one they fell asleep as the words of the last yarn died away in drowsy tones. Don Antonio freshened the fire and peered into the darkness to see whether a tiger were lurking around, then hugging close his gun and machete, sought repose. About midnight I awoke. The fire had died out, but it was not entirely safe to stir around for wood; there was the possibility of a tiger and the probability of a shot from Don Antonio. So I kept quiet, and began to feel the awful stillness of a tropical night in the forest; then from far away came the sound of a solemn moan, nearer and nearer, till with a sigh and a rustling of leaves a breath of wind passed overhead, and left the night as silent as before.

Again we were doomed to bad luck. We worked two days at this place carrying the excavation to a depth of 6 feet with miserable results so far as securing specimens was concerned, and as there seemed nothing peculiar in the style of burial, as there was nothing more to eat less than half a day's journey away, we gave up the job as unprofitable.

A few days later I made a trip to Punta Arenas, via Bolson, and on the 15th took passage in a canoe from Punta Arenas for Puerto Jesus. Among the many delightful modes of traveling in Central America, the voyage in the dug-out deserves remembrance. There is no room to stretch one's legs under the most favorable circumstances, while on this occasion the boat was loaded, and I had to eat, sleep, and be as comfortable as I might for two days and a night on the top of two boxes that were not even. The second day we were becalmed at midday in the middle of the gulf, with not even a fleecy cloud between us and the sun. Then in the afternoon a stormy breeze sprang up and we were driven in on the rocky coast of Chira and had to drop our anchor, a large stone, to keep from going ashore. There we lay within 20 feet of the rocks bobbing and bouncing around so we could hardly sit up, for six or eight hours, till the weather moderated. About midnight, the second night we reached Puerto Jesus, the port of Nicoya, at the head of an *estero*, which can only be navigated by canoes at high tide. The rest of the night was spent on a raw-hide stretched on the ground, with musquitoes for company. Next morning on a hired mule some 12 or 15 miles to Nicoya.

The neighborhood of Santana was visited on the 18th. There was no lack of *huacas* as indicated by the low mounds scattered over the country. On the northern slope of the ridge between Nicoya and Santana there is a round top-hill, from which is a fine view over towards the Temisque and the head of the gulf to the line of volcanoes in the distance. On this hill-top the *huacas* were marked by large stones, under which the relics were found at a depth of 3 to 5 feet. The burials in the valley seemed similar to those at Las Huacas and Las Carrillos.

Sunday, the 19th, was the feast day of the patron saint of the *barrio*

of Las Huacas, and I visited it, arriving before sunset. There were sixty or seventy natives present, the guests of the family of Carrillo, who fed them well and furnished wine of the coyal palm as a beverage. Dancing and singing were kept up to a late hour, the padre as usual contributing his share towards the merry-making.

Next morning the padre and I with two men started on the trail used by rubber-men between Las Huacas and the Rio Oro. A horse had never been over this trail, and it required an expert guide to follow it. The padre and I were mounted, and were preceded by the men who trimmed a way for us with their machetes. For the first two hours we were on the plateau of Las Huacas between 2,000 and 3,000 feet above the sea. In the bed of a stream called Salto de los Perros, where it was crossed by the trail, there was a boulder of hard basalt nearly 2 feet in diameter, on one side of which there were eight parallel grooves up and down, the widest and deepest of which was just of the width of an ordinary celt. The incline of this side was about 75° . I repeatedly noticed celts which had apparently been sharpened after use, and believe that this was a grindstone for that purpose.

From the edge of the plateau there was a steep break to the small Rio Medio, some 1,500 or more feet below. Off to the right there was a sheer wall over the edge of which poured a small stream. The Indians claim 3,000 feet for this fall, and it apparently was several hundred, the water breaking into mist towards the bottom. We descended along the edge of ridge, dismounted, and the poor horses slid a good part of the way on their haunches, one man leading and another driving. After reaching the stream we kept the bed of it; most of the way the horses were led, and slipped and stumbled over the boulders as best they might. Occasionally short cuts were taken across bends, which were particularly enjoyed by me. In the morning while trying to ascend a steep bank my horse fell back and rolled over into the stream below. The stirrups were narrow and I could not free one foot, and in the struggle my foot was hurt so that I could not wear a shoe; so when in the afternoon I had to walk through these woods without a shoe, traveling was anything but pleasant. At last, late in the afternoon, the guide stopped at a camping ground after the most terrible trip in my experience. In the bed of this river Medio, a tributary of the Oro, black basalt formed the rock with veins of quartz. Right in our camp were killed an otter, a *pavon*, and two *pavos*. There were tracks of deer, tapir, and tigers. Below the camp green quartz appeared in the rock of the bed of the stream. During the day fragments of pottery were noticed several times where slight washes had occurred, or in the banks of ravines. My couch was of palm branches on the solid rock. About 1 a. m. next morning I was awakened by the swaying or horizontal motion of what I supposed a solid bedstead; the trees were waving in that not unusual occurrence, an earthquake. An hour and a half later there was another shock.

At 6.30 A. M. we started again, and in two hours of more pleasant travel reached the Rio Oro at the mouth of the Rio Medio, where we breakfasted in style on *pavo* and *camerones*. Between noon and 5 p. m. the descent of the Oro was made to the head of tide-water, within a mile of the sea.

The valley of the Rio Oro was narrow, with hills or mountains close up on either side. As with all these streams during the dry season, the water occupied but little of the broad bed, and we had rather a good roadway and excellent sites for camps, the banks furnishing grass for the horses.

The tide was low enough at 10 o'clock on the 22d, and we went to the mouth of the river. On the beach were a few pebbles of argillite as the nearest approach to jadeite. I had made the trip across the peninsula of Nicoya, carefully examining the rock at every opportunity, following the bed of the stream almost continuously from the divide to the sea, only to be disappointed once more.

A guide from Nicoya, who was to pilot us from this point, arrived about noon, but as the route lay for some distance mostly along the beach, we were constrained to return to our camp and pass another night there. A start was made at 6.15; at half past 11 we arrived at the Rio Buena Vista, some 2 miles above its mouth. The road was along the beach most of the way, and at several places we passed snug little harbors like that at San Juan del Sur Nicaragua. While the horses were resting, I took the guide and, wading down the river or scrambling through the thickets for about a mile, reached a point about 40 yards from the river where was a bank some 7 feet high, 40 yards long, and 20 wide, formed apparently almost entirely of fragments of red-painted pottery of large and small vessels. This was in a mangrove swamp, and the water at high tide came up to the foot of the bank. It looked as if thousands of vessels had been collected here and deliberately broken. No shells were mixed with the fragments, but most probably they were relics of repeated encampments here during the dry season for people from inland who came to feast on fish, turtle, &c.

We went a few miles up the Buena Vista and camped for the night, that is, we cut some palm leaves on which our blankets were spread, and we considered ourselves in camp. We had not killed any game since the morning before, and our commissary stores were running quite low. Sardines and the tender buds of a small variety of palm made our dinner. Next morning a small allowance of the same luxuries, and we started on a forced march for Nicoya and something to eat. At noon we stopped on a small stream for lunch, my portion of which consisted of half a sardine and a palm bud. The trail all day lay over rocky hills where the vegetation showed that the soil was unusually poor for that country. Late in the afternoon we reached the small collection of houses at Lazartito, within 10 miles of Nicoya, where was the first hut we had seen since leaving Las Huacas.

As usual after such a trip I was ill for a day or two with fever and dysentery, but after resting Saturday was in condition to take the saddle again at 2 P. M. on Sunday for Bolson and Punta Arenas.

Early on the morning of March 29, I was called for my trip to San José. I was in a room on the second floor of the hotel at Punta Arenas, sitting on the edge of my cot when the room began to rock like a boat in a sea-way. The tiles on the roof rattled and danced overhead, and outside the tops of the trees lashed the air as if shaken by a giant hand; the chickens cackled, and women rushed screaming into the streets. It was the heaviest earthquake of my experience, and I in an upstairs room with the door locked; but in a frame house built with an eye to resisting just such strains there was little danger of accident.

The road was along the beach for 8 or 10 miles, then struck inland and began to ascend. By much labor on my lazy mule, I made more than half the distance, and slept at Atena. A ride of three hours next morning took me to Alajuela, a town at the western end of the valley of San José, from which a railroad passing through the principal towns extends eastward to Cartago. The valley is some 4,000 feet above the sea, and surrounded by mountains rising several thousand more, the peak —— being —— feet in elevation. This is one of the finest coffee-growing regions in the world, and the superb plantations, with here and there a town or village, and in every direction a background of mountain range or volcanic peak, make up landscapes as fair to view as any beneath the sun.

On my arrival at San José I was met by Mr. Minor C. Keith, a young American, who had been in Costa Rica some ten years, and who had by pluck and perseverance at last completed a railroad from Port Limon on the Atlantic to a point within 25 miles of the capital. The intervening distance was covered by a cart road which he was then finishing. These gave a continuous line from San José to the sea with much cutting, and I accepted Mr. Keith's invitation to accompany him over the roads.

One of the ministers, Mr. Sanez, who, in the absence of the President, was in charge, received me most kindly, gave directions for facilitating my work, and promised permission for the *jefe politico* of Nicoya to accompany me for one month on my explorations. I was also introduced to Don Leon Fernandez, who was in charge of the Government archives and then engaged in his work "Documentos para la Historia de Costa Rica," the first volume of which was out.* Señor Fernandez was found an enthusiastic antiquarian and historian. The chapters of his work first came out in the official gazette, in addition to the ordinary circulation, of which copies were sent to the officials in all parts of the republic, and everywhere awakened an interest in antiquities and the history of the Indians, which must work valuable results. Repeatedly I had co-

* The second volume has since appeared.

operation which was due to the interest excited by these papers. In company with this gentleman I called on the bishop of Costa Rica, who, while interested in anthropology, was especially fond of ornithology. In his collection were jadeites, one very fine, and several specimens in argillite and marble. These two gentlemen were to start in about a week on a Government expedition for exploration in the country of the Guatuso, or Rio Frio Indians, and kindly invited me to join them. Here was a rare opportunity, but on consideration I concluded to stick to my instructions and give my time to the department of Liberia.*

April 4, we (Keith, some half-dozen Costa Rica gentlemen, and I) left San José for Port Limon. We crossed the ridge between the central valley or plateau and the Atlantic slope, and took breakfast at one of the stations of the parties building the cart road. This was a graded road which followed a stream in its rapid but tortuous descent through the mountains to the point where the railroad entered the gorge and crossed the Rio Lucio. An extra train was made up in the evening, and we made a night trip of a few hours to Port Limon, distance 71 miles. At the upper end of a curved beach is a promontory formed of coral rock, and off this an island making a very beautiful harbor. There were no antiquities found in this neighborhood, but in the storehouse of Mr. Keith was a collection made along the line of the railroad, and several people in the town had very pretty specimens from the same source. Mr. Keith agreed to send his to the Smithsonian by his brig Nile on her next trip to New York, so I spent the 6th hard at work packing.

We were back in San José on the 8th, and in San Mateo, on the road to Punta Arenas on the 10th, and sailed in a dug-out for Puerto Jesus on the 11th at midday. The first showers of the coming wet season had been at Alajuela as I passed on the 9th, and I found the road from Jesus to Nicoya in some places miry from the heavy shower of the evening of the 12th. The ride was made at night, and progress in the intense darkness was only made practicable by a lantern carried by my companion. Three o'clock the morning of the 13th found me at Nicoya. I had not had a night's rest for six nights, and the well-deserved fever promptly made its call. The northeast wind came up strong again and blew the wet season back for another two weeks.

The leave of absence for the *jefe politico*, Don Juan José Mata-Rita, not having arrived, he and I went to Santana on the 20th to make some investigations in the *huacas* of that place. As around Nicoya and Canillas, they were indicated by low piles of stones, principally limestone from the neighboring hills. These piles only rose 1 or 2 feet above the surface. Commencing excavation in one, the stones were found for first 3 feet, at the bottom of which were human bones and some fragments of Chorotega pottery. Lower still was the hard clay of this sec-

* In November, Don Leon wrote me a most interesting letter informing me of their success.

tion. In one place the excavation was carried to a depth of 6 feet; pieces of coarse pottery were found near the bottom, where apparently undisturbed clay discouraged further digging. In neighboring *huacas* were found some fine specimens a few years ago. One of them, No. 59891, which was afterwards broken, was secured and mended. It is well burned, light, and strong, and altogether a very fine specimen of old Indian work.

The afternoon of the 22d of April I started on an extended trip accompanied by Don Juan Mata-Rita, the *jefe politico*. Before leaving the Department of Nicoya the fragment of a figure in argillite was obtained at Savana Grande. There was much pretty quartz in the ridge which separates Nicoya from Santa Cruz. We spent the night at the latter place, and, furnished with letters from the jefe to the officials of his department along our proposed route, we resumed our journey in the morning towards the Pacific. For some miles the road was along the plain of Santa Cruz, and then we crossed a ridge not more than 200 or 300 feet high, and entered the township or *barrio* of El Gallo (the cock). The game-cocks of El Gallo, who are mostly smugglers, got into some trouble a few years since, and the name of the *barrio* was changed to El Veinte-Siete de Abril, the anniversary of President Guardia's accession to power. The land here was very poor, and the inhabitants correspondingly wretched. The business of smuggling over the Nicaragua line helps them in their struggle. These people at once took us for Government officers in search of *contraband*, and viewed every act and word with suspicion. They apparently had forgotten how to tell the truth, and really seemed the greatest liars on the face of the earth. While sitting on our horses at the door of a hut with the whole family protesting that they had never heard of any relics of antiquity in that region, we pointed out fragments of pottery, etc., in a bank not 20 feet away, and we knew that at the time these people had some good specimens in their house, but they could not conceive such folly as two men traveling in these parts merely in search of old pots; believed us to be revenue officers, and did not wish to give us any pretext for remaining in their neighborhood. But in this abominable *barrio* we had a most delightful surprise. Riding up to the house of the school-master, we presented our letter and were received with charming courtesy. There were two school-houses, one for girls the other for boys, on opposite sides of a *plaza*. Between the two and a little back was the domicile of the teacher, all in bamboo, and so neat and new, for a moment I thought I was back in Japan. He was a *mestizo* of excellent manner and tolerable education. His wife managed domestic affairs, while a daughter of seventeen years relieved him of the girl school. She was an exquisite specimen of the *mestiza seńorita*, slender and graceful as a wand, with hands and feet of a sylph, and eyes so large and so soft—verily I did want to go to school again, and if there had only been the excuse of some

decent *huacas* in the neighborhood, the worthy dominie would have had me for a guest for some time.

The alcalde, after having our horses attended to by his policeman, escorted us around the neighborhood in search of antiquities, but we only secured a few specimens of extremely rude ware. The ancient inhabitants were no doubt as miserable as those now here, and probably could ill afford the extravagance of jadeite ornaments.

Next morning, with the policeman as guide, we pursued our journey to Santa Rosa, where were two more schools. Don Juan wore an argillite gorget suspended around his neck, and this was shown the children, and one little fellow said there were things like that at his house, and we decided to accompany him to his home. Before his school hours were over he had been so frightened by suspicious natives that it was with the utmost difficulty we persuaded him to accompany us. On the road we met a man and asked him the usual question, if he could tell us where to find *huacas*, when he stepped back aghast and with the most ludicrous expression of alarm, exclaimed "*Huacas!* the Lord preserve me! What do I know about *huacas?*" I have travelled a great deal in Central America, but never before saw a place where ignorance and suspicions put such obstacles in the way of simple investigations. The trials of a foreigner travelling alone may be imagined, when it is remembered that I was accompanied by Don Juan himself, a nearly pure blood Indian, who was born and raised in the Nicoya and was *jefe politico* of that district.

Some 5 or 6 miles more and we stopped at a cattle ranch of the rudest class—three miserable cane huts near by a corral for such cattle as needed attention, and an inclosed area of a few acres for maize and plantains. The proprietor, owner of a large number of cattle, was here, and lived as poorly as his meanest *vaquero*. The morning of the 25th April we rode to within a short distance of the sea to examine an old burial ground. The graves were indicated by slight piles of stone, showing but little above the surface. There is very little soil above the rock here and the relics, human bones, extremely rude pottery, celts, and broken grinders were found within 15 inches of the surface. This was on a slope, and apparently the surface had been much denuded by the wash of the wet seasons. One skeleton was extended with head to southwest; on one side of the skull was a celt, edge down, on the other a small rude vessel in pottery. Of eight celts collected, all but one were blunt, the edge apparently chipped off to render the implement useless. The one excepted was a very small one. The collection, interesting for the very rudeness of the pottery made here, was intrusted to the school-master at Santa Rosa, who failed to forward it to Santa Cruz and it was lost. That worthy was as stupid and ill-mannered as his colleague at El Gallo was pleasant and courteous.

We only worked at that place half a day, then returned via the ranch to Santa Rosa, and thence to a small hamlet, Las Huacas, on the route

towards Sardinal country, of the same wretched character. Next day, about noon, after touching the coast west of Cape Vela, we struck the barrio of Sardinal, and were at once in a different country. Evidences of greater prosperity were apparent on every side, and besides, at the first house a specimen in green stone, argillite No. —, was obtained. Proceeding along the valley the houses became more frequent until near that of Don Pizarro; it was rather after the order of a scattered village. Here nearly two days were spent riding from house to house, and rarely inquiring in vain for *antiquedades*. Some objects in stone, usually, if not always, gorgets, were secured, besides a pretty collection of pottery.

The afternoon of the 28th we crossed the ridge between Sardinal and the bay of Culebra to a place called Panama, near the mouth of the bay. Here at the house of ——— Pizarro* we got Nos ——— ———. Near the road from that house to the beach were lying two fine images in the Zapaterra style† about 6 feet high, with the head of a serpent for a head-dress. The head of one was broken off. It was the finest specimen of that class that I had ever seen. Nearer the beach in the bank of a stream was a lot of pottery fragments, as in the Buena Vista, and near by a section of a shell heap which had been covered by alluvium.

Staying at the house of ——— Espinosa that night, next morning we visited the *huaca* of Panama, on a hill overlooking the bay. At the edge of a mangrove swamp near the foot of this hill was a bank about 8 feet high and 30 by 50 yards surface, composed, as at Buena Vista, almost entirely of shards. On this bank stood a *pochate* tree 6 feet in diameter, at 10 feet above the surface. There was another near by, the two forming islands occasionally in very high tides. On the beach near by were some Chiriqui Indian women in bivouac, the mates of some pearl fishermen, and they, on a small scale, were building their shell-heap, and furnishing an illustration of how these immense banks of pottery and others of shell may have grown in the old times. Shells were not mixed with the shards in the large banks. The fragments, as at Buena Vista, were almost all of unpainted ware, or that which was only painted solid red; but there were a few pieces in yellow ornamentation, or in bands of black or dark brown. The most ordinary pieces were well burned.

Just south of these banks the hill of the *huacas* rises some 150 or 200 feet, culminating in a point which overlooks sea and land for miles around. The valley of Panama runs off inland, and to the north stretches the beautiful bay of Culebra, the *hacienda* of Culebra bearing north 10° east. On the top of this hill was the finest *huaca* yet seen. The graves had on them stones in pieces about a foot in diameter. Many of these had been opened, and a great many objects were reported to have been obtained. The burials were shallow, the excavations being only about 3 feet in depth. Scattered around were bones, fragments of handsome

* I mention the names of these houses to facilitate the work of other investigators.

† Squier.

metates, and numberless shards of painted ware, celts, etc. Among the remains were some pieces of large jars. A head in green argillite was found, but there were no specimens of the Santa Helena ware seen at Ometepec and supposed to have been of Aztec manufacture.*

In the evening we rode to the *hacienda* El Jovo, and spent a quiet day with Don David Hurtado. The owner of the *hacienda*, Jesus Maria, dined with us and after giving accounts of shell heaps, stone images, etc., told of a large block between his place and Nagaseola, on which were carved the sun, moon, and other figures. The morning of May 1 we rode to Jesus Maria and accompanied the *hidalgo* in search of his remarkable monolith. About midday we found a quarry of columnar rock, whitish and soft; near it lay the object of our search, found after hours of riding over hills parched by the sun and wind of the dry season, and on this precious stone seemed concentrated the rays of the tropic sun. We dismounted and walked around it in search of hieroglyphs. There were sundry marks and scratches as if a careless cowboy had made this his seat and scraped his spurs against the side. Oh!—We remounted and turned our horses homeward, and conversation was not animated for some hours.

The explorer who goes to Spanish-America and lends a willing ear to the yarns of the natives, will follow a will-o'-the-wisp from Texas to Cape Horn, and return empty handed. I have accomplished little except when I have settled down at a point and by laborious investigation ferreted out whatever of archæological treasure was stored around, sometimes to the great surprise of natives, who, born and raised in the neighborhood, had never suspected the existence of the *antiquedades*.

May the 2d we rode to the *hacienda* San Raphael, 6 miles north of El Jovo. The burials here were in a clump of trees on a slight elevation above the plain, where enough of soil had accumulated above the lava rock to support something more than the usual coat of grass. The burials were not more than 2 feet below surface. A vase 12 inches deep, 16 in diameter, and $3\frac{3}{4}$ across the mouth, contained burnt human bones. The guide said that he found another here containing bones, and in other cases fragments of large jars with bones. There were lying around celts, fragments of red unpainted ware and of finely worked *metates*. The graves were indicated by large stones.

Continuing our journey to the northward, we visited the *hacienda* Pelon, where on a slight eminence about a mile north of the house were seen *huacas* like those seen in 1877 opposite Boquerones.† The pottery was in some cases painted red. There was a fragment of coarse ware, $1\frac{3}{4}$ inches thick, which must have been part of an immense vessel, judging by the curve. The guide reported the finding here of large jars 3 feet high, containing bones and charcoal. The two objects—— and —— were found in the loose dirt of an excavation.

* Archæological researches in Nicaragua, pp. 55, 80.

† Archæological Researches in Nicaragua p. 74.

We left Pelon at 4 P. M., and at dusk were at the Rio Deshozados, where some fodder was obtained for the horses and some corn cakes and eggs for ourselves. After a bath in the sparkling rapids, I spread my blanket on the ground and looked up at the stars until tired "nature's sweet restorer" got ahead of the noise of laughter and chatter made by an Indian wench and her beaus. We were up at 3 A. M. and took the road again for Liberia, where we spent the midday hours. It was a lifeless little town, the capital of this department, with its white houses and streets glaring in the sunshine. We were shown a handsome vase of Luna ware, the prettiest specimen of ancient American ware I have ever seen; but could not purchase it, and, as the owner was absent, could not get a history of its origin. A good specimen of a Choratega vase was presented, with the information that it was exhumed at Nagaseola, in Culebra Bay.

In the afternoon we rode some 15 or 20 miles to Boquerones. Next morning, securing fresh horses, we visited the hamlet of Comunidad, up the river. There and in Boquerones were secured four small *chalcihuitls*. That afternoon we stopped at Siete Cueros, on the road to Santa Cruz, and obtained a broken tripod of Luna ware, which was said to have been the cover of a vase found in the burial ground some miles lower, on the west side of the Tempisque. There were also some fragments of Santa Helena and Choratega ware, which I was informed were found at the same place, as they were near the Luna burials, Ometepec.

May the 5th we got back to Nicoya, and after the excitement of the trip came fever and dysentery. I was pretty well used up; the wet season was beginning and I determined to leave. Sending special messengers to Boquerones for the objects there, the collection was packed and taken to Punta Arenas, whence I sailed on the 13th.

To Prof. SPENCER F. BAIRD,
Secretary Smithsonian Institution.

ABSTRACTS FROM ANTHROPOLOGICAL CORRESPONDENCE.

EDITED BY OTIS T. MASON.

The archæological work of the Bureau of Ethnology withdraws a great deal of material formerly published under this head. The danger of losing facts in a great mass of current correspondence, however, makes it advisable to publish brief abstracts of letters in this form :

Baxter, J.—Reports opening a grave on the shores of the Gulf of St. Lawrence, 40 miles from Chatham, N. B., and finding the skeleton of a large man. The head was covered with a sealskin cap and the feet with moccasins of the same material. There were pieces of canvas and birch bark about the remains, and inclosed within these a piece of Spanish cedar and a short piece of rope, “served,” as though it had been a piece of standing rigging. Over the body were three large copper kettles, overturned, one over the head, the largest over the body, and the third over the flexed extremities.

Brown, E. L.—Reports several groups of mounds near Durand, Wis. On the farm of the writer, at the depth of about 6 inches, are found old fire-beds of burnt rock and ashes, pottery, and arrow-heads. In the village of Durand is a group of twelve burial mounds. On the bank of Bear Creek, 2½ miles east of Durand, near a grist-mill, is a group of seven mounds in a row, extending north and south. In the town of Nelson, Buffalo County, are several groups of mounds, one hundred and fifty altogether. The mounds are generally located on the river terraces in groups. They are composed of sand and drift, not stratified. Several mounds have been explored. On the rocks near Dumaville, Wis., are figures of canoes and animals. The dead buried in the mounds are in a sitting posture, facing the east. The remains are entirely decayed. North of Durand, in *Ojalla*, two caches have been found, one containing about seventy-five large chipped disks; the other one hundred, in various stages of completion. Mr. Brown will make further researches for the Smithsonian Institution.

Burns, Frank.—Reports a cave near Blountsville, Ala., in a cliff of limestone. It was formerly a burial place, as a number of skeletons were found deposited in wooden troughs. The bodies had been wrapped in some sort of matting made of bark. Twelve ornaments of native copper rudely hammered out and two chisels were found there, as well as sea shells. The cave was dug over during the civil war for the purpose of extracting saltpeter. The writer also reports the discovery of a cache of seventeen chipped spear heads in a field near Blountsville. The specimens are said to be beautifully wrought.

Gray, William.—Is studying the prehistoric relics of Kingsbury County, Dakota Territory. Many evidences of ancient habitation exist here and should be saved to history while they are accessible.

Luttrell, Elston.—In Calhoun and Talladega Counties, Alabama, mounds, stone implements, sculptures, &c., abound. Two and a half miles east, and thence five-eighths of a mile south from Oxford, Calhoun County, is a large isolated mound. It lies about 300 yards from Choccolocco Creek, on the Caver place. It has never been examined; it is about 20 feet in vertical height, and has a large, flat surface on top. The perimeter is an ellipse, the major axis of which is about 100 feet and the minor axis about 75 feet. On the west side, a few feet from the base, is an excavation or mardelle. The interior has never been examined. There is a group of mounds, orderly arranged, 15 miles southwest of Oxford. They lie on the south bank of Choccolocco Creek. Pipes and stone implements are found in the vicinity. At the Elston Store place, in an excavation for a cellar, a body was found buried in a sitting posture, and many stone implements were also found in the grave.

Mackie, Joseph S.—Writes from Lima, Peru, describing observations made at Chorillo, on the coast, at a point forming an equilateral triangle with Callao and Lima. Passing up the sandy hillside on one occasion he observed a scrap of cloth protruding, and immediately dug it out. The fabric was of the peculiar Peruvian embroidery, on which were wrought fierce animals in a threatening attitude. Inclosed was the mummy of a female child not more than two days old. The continuation of the digging revealed a large quantity of bones wrapped in nets, the bundles resembling dumb-bells—the head at one end, the long bones in the middle, and the small bones at the other end.

MacLean, J. P., writing about the great Cahokia mound, says:

“Almost everywhere on its sides you can pick up fragments of pottery, broken bones, and white or milk chert chips. Some of the pottery is decorated. I found the frontal bone of a human skull on the side of the mound.

“In vol. II, Peabody Museum Report, p. 474, will be found a cut of the Cahokia mound. While this restoration is a good one, yet it is not accurate. I came to the opinion that on this mound were four temples, representing four orders of priests, the highest order erecting their temple on the upper platform.

“The lowest platform is not a graded way, as represented by Ancient Monuments, page 174. No evidence of a graded way presents itself at any place. On the west side I discovered traces of baked bricks.

“Professor Putnam is guilty of an amusing oversight (p. 471) in calling attention to the fact that its exact location is not given by writers who have attempted to describe the mound, and then neglects to do so himself, although he visited it. It is located in Madison County, Illinois,

on the south boundary of Namioka township, 6 miles east of East Saint Louis, on the road leading to Collinsville."

Moore, J. H.—Reports that there are many mounds in the vicinity of Oakley, Arkansas County, Arkansas.

Parish, Sidney.—Writes that near his house, 18 miles above Memphis, Tenn., is a large mound, upon which relics have been found.

Poynter, Robert H.—Writing from Desha County, Arkansas, speaks of Wal-ka-ma-tu-ba, an old Indian, who was buried in 1834, in the following manner: The house in which the family lived was built of round logs, covered with bark and daubed with mud. In the middle of the house a board was driven about 3 feet into the ground, and the old man was lashed to this with thongs, in a sitting posture, with his knees drawn up in front of his chin and his hands crossed and fastened under his knees. The body was then entirely encased in mud, built up like a round mound and smoothed over. A fire was kindled over the pile and the clay burnt to a crisp. Six months afterward the family were moved away and the mound opened. The body was well preserved. Another body had been wrapped in bark of the birch and deposited in the cavity of a dry spring.

Reed, J. W. K., makes the following remarks about Cross Creek, Pa.:

"In this vicinity are to be found many small mounds. On the top of a high ridge, partly on my farm, and partly on my neighbor's, are many traces of prehistoric races. At one point on the level, on top of the ridge, is a mound which was about $5\frac{1}{2}$ feet high and from 2 to 3 rods in diameter, in which an excavation was made a few years ago, and a stone wall was uncovered. The wall was built alongside of a crack in a large rock; the crack is V shaped, which shows that one side has settled down; the mound is principally formed of stones, intermixed with some earth, and on it was growing large trees. There was nothing found in it except the stone-wall. It was only partially excavated. In the immediate vicinity are to be found other mounds, and several large rocks with a peculiar kind of *carving* on them. The carving is rather indistinct, but it is the work of human hands. Partly surrounding these carved rocks and mounds can be traced a circle formed by flat stones set in on edge. From a point in this circle starts a straight line of these stones that are set in on edge which runs near the center of the circle; this line can be traced 30 or 40 rods. In other places in this region, where there are large rocks, we find these carvings. The circular row of stones set on edge appear to follow around the top of the point of the hill. If the timber was cleared off this hill there would be a great view from it. At one point objects can be seen beyond the Ohio River (about 10 miles). Many stones about the mounds show marks of having been rudely dressed. We find many arrowheads, stone axes, stone hammers, &c., in this vicinity."

Richardson, A. S.—Calls attention to the existence of two mounds in the vicinity of West Point, King William County, Virginia.

Stubbs, Charles H.—In reply to the assertion made in Smithsonian Annual Report, 1879, page 446, that there are no mounds in Northeast Maryland, states that there are mounds or stone cairns in Cecil County, from one of which he obtained twenty pieces of pottery. There are no sculptured rocks in the Susquehanna River at Conowingo, but many in the river at Bald Friar, $1\frac{1}{2}$ miles above Conowingo. Mr. Stubbs claims to have first brought these rocks to the notice of scientific men. Lancaster County was once the home of the Susquehannocks, the Shawanoes, and the Conestogoes, and wherever they lived are yet to be found relics of these tribes, and in all probability of a race far anterior to them. In the southern end of this county is the Rock Spring, excavated by the aborigines. On the Hutton farm is an Indian village site. In the Susquehanna, at Peach Bottom, Mount Johnson Island, is a famous locality for gathering stone relics. In Mastic Township are the evidences of another Indian village. In Manor, at what was once Indian Town, are yet to be found large quantities of pottery. Near Christiana and the Gap resided the Shawnees. Here is the quarry at which the steatite pots were made, one of which has not been severed from the rock. Mr. Stubbs cautions archæologists about committing themselves to names for aboriginal implements whose functions are still unknown.

Woods, E. H.—States that on the plantation of a friend close to the Roanoke River, near Avoca, N. C., is an old Indian camping-ground. During some excavations there were found bones, arrowheads, pottery, and a skeleton in a sitting posture.



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